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# EVERGREEN LAGOON UPGRADE-REBID

## CITY OF EVERGREEN
EVERGREEN, ALABAMA

**SRF PROJECT NO.: CS010335-05**  
**GMC PROJECT NO.: CMGM-190092**

## TABLE OF CONTENTS

### VOLUME 1

<table>
<thead>
<tr>
<th>SECTION</th>
<th>TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS</strong></td>
<td></td>
</tr>
<tr>
<td>00002</td>
<td>Table of Contents</td>
</tr>
<tr>
<td>00003</td>
<td>Memo to Plan Holders</td>
</tr>
<tr>
<td>00052</td>
<td>Owner’s Instructions for Bonds and Insurance</td>
</tr>
<tr>
<td>00111</td>
<td>Advertisement for Bids</td>
</tr>
<tr>
<td>00152</td>
<td>Immigration Status Verification</td>
</tr>
<tr>
<td>00152a</td>
<td>E-Verify Program for Employment Verification (MOU)</td>
</tr>
<tr>
<td>00152b</td>
<td>Certificate of Compliance with the Beason-Hammon Alabama Taxpayer and Citizen Protection Act</td>
</tr>
<tr>
<td>00200</td>
<td>Instructions to Bidders</td>
</tr>
<tr>
<td>00400</td>
<td>Statement of Contractors Qualification</td>
</tr>
<tr>
<td>00410</td>
<td>Bid Form</td>
</tr>
<tr>
<td>00410a</td>
<td>Accounting of Sales Tax</td>
</tr>
<tr>
<td>00430</td>
<td>Bid Bond</td>
</tr>
<tr>
<td>00510</td>
<td>Notice of Award</td>
</tr>
<tr>
<td>00520</td>
<td>Agreement</td>
</tr>
<tr>
<td>00550</td>
<td>Notice to Proceed</td>
</tr>
<tr>
<td>00610</td>
<td>Performance Bond</td>
</tr>
<tr>
<td>00615</td>
<td>Payment Bond</td>
</tr>
<tr>
<td>00620</td>
<td>Contractor’s Application for Payment</td>
</tr>
<tr>
<td>00625</td>
<td>Certificate of Substantial Completion</td>
</tr>
<tr>
<td>00700</td>
<td>General Conditions</td>
</tr>
<tr>
<td>00750</td>
<td>Supplemental General Conditions - Owner’s</td>
</tr>
<tr>
<td>00752</td>
<td>Supplemental General Conditions – SRF with Bacon Davis Wage Rates</td>
</tr>
<tr>
<td>00800</td>
<td>Supplemental General Conditions</td>
</tr>
<tr>
<td>00940</td>
<td>Work Change Directive</td>
</tr>
<tr>
<td>00941</td>
<td>Change Order</td>
</tr>
<tr>
<td>00942</td>
<td>Field Order</td>
</tr>
</tbody>
</table>
DIVISION 01 – GENERAL REQUIREMENTS
01 10 00 Summary
01 21 00 Allowances
01 25 00 Substitution of Major Equipment Items & Products
01 26 00 Contract Modification Procedures
01 29 00 Payment Procedures
01 31 00 Project Management and Coordination
01 32 00 Construction Progress Documentation
01 33 00 Submittal Procedures
01 40 00 Quality Requirements
01 42 00 References
01 50 00 Temporary Facilities and Controls
01 60 00 Product Requirements
01 70 00 Execution and Closeout Requirements
01 78 23 Operation and Maintenance Data
01 78 39 Project Record Documents
01 79 00 Demonstration and Training
01 79 99 Special Specifications
01 81 00 Geotechnical Data

DIVISION 02 – EXISTING CONDITIONS
02 41 19 Selective Demolition

DIVISION 03 – CONCRETE
03 20 00 Anchorage in Concrete
03 30 00 Cast-In-Place Concrete
03 39 00 Concrete Curing
03 60 00 Grouting

DIVISION 04 - MASONRY (NOT USED)

DIVISION 05 – METALS
05 12 00 Structural Steel
05 40 00 Aluminum Handrail
05 50 00 Metal Fabrications
05 51 19 Metal Grating Stairs
05 52 13 Pipe and Tube Railings
05 53 13 Bar Gratings
05 60 00 Aluminum Hatches

DIVISION 06 – WOOD, PLASTICS, AND COMPOSITES (NOT USED)
DIVISION 07 – THERMAL AND MOISTURE PROTECTION
07 92 00 Joint Sealants

DIVISION 08 - DOORS AND WINDOWS (NOT USED)

DIVISION 09 – FINISHES
09 96 00 High-Performance Coatings

DIVISION 10 – 12 (NOT USED)

DIVISION 13 – SPECIAL CONSTRUCTION
13 10 00 Bypass Pumping
13 31 00 FRP Building Enclosure
13 40 00 Pre-Engineered Aluminum Canopy

DIVISION 14 – 25 (NOT USED)

VOLUME 2

DIVISION 26 – ELECTRICAL
26 05 00 Common Work Results for Electrical
26 05 19 Low-Voltage Electrical Power Conductors and Cables
26 05 23 Control-Voltage Electrical Power Cables
26 05 26 Grounding and Bonding for Electrical Systems
26 05 29 Hangers and Supports for Electrical Systems
26 05 33 Raceways and Boxes for Electrical Systems
26 05 44 Sleeves and Sleeve Seals for Electrical Raceways and Cabling
26 05 53 Identification for Electrical Systems
26 05 93 Common Motor Requirements for Process Equipment
26 22 00 Low-Voltage Transformers
26 24 13 Switchboards
26 24 16 Panelboards
26 27 13 Electricity Metering
26 27 26 Wiring Devices
26 28 13 Fuses
26 28 16 Enclosed Switches and Circuit Breakers
26 29 13.06 Soft-Start Motor Controllers
26 30 00 Duplex Control Panel
26 35 33 Power Factor Correction Equipment
26 36 00 Transfer Switches
26 43 13 Surge Protection for Low-Voltage Electrical Power Circuits
26 51 19 LED Interior Lighting
26 56 13 Lighting Poles and Standards
DIVISION 27 – COMMUNICATION (NOT USED)

DIVISION 28 – 30 (NOT USED)

DIVISION 31 – EARTHWORK
31 05 16  Aggregates for Earthwork
31 10 00  Site Clearing
31 20 00  Earthmoving
31 25 00  Erosion and Sedimentation Controls

DIVISION 32 – EXTERIOR IMPROVEMENTS
32 91 13  Soil Preparation
32 92 00  Turf and Grasses

DIVISION 33 – UTILITIES
33 05 16.13 Precast Concrete Utility Structures
33 47 13.00 Pond and Reservoir Liners

DIVISION 34 – 39 (NOT USED)

DIVISION 40 – PROCESS INTERCONNECTION
40 05 06  Couplings, Adapters, and Specials for Process Piping
40 05 07  Hangers and Supports for Process Piping
40 05 13  Common Requirements for Process Piping
40 05 17  Copper Process Pipe and Tubing
40 05 19  Ductile Iron Process Pipe
40 05 31  Thermoplastic Process Pipe
40 05 51  Common Requirements for Process Valves
40 05 53  Identification for Process Piping
40 05 57  Actuators for Process Valves and Gates
40 05 62  Plug Valves
40 05 63  Ball Valves
40 05 65  Swing Check Valves
40 05 66  Pressure-Regulating Valves
40 05 67  Pressure-Relief Valves
40 05 78  Combination Air Valves for Wastewater Service
40 05 82  Solenoid Valves for Process Service
40 72 23  Radar Level Open Channel Flow Meters
40 72 76  Level Switches
40 73 13  Pressure and Differential Pressure Gauges
40 73 63  Diaphragm Seals
DIVISION 41 – 42 (NOT USED)

DIVISION 43 – PROCESS GAS AND LIQUID HANDLING, PURIFICATION, AND STORAGE EQUIPMENT

43 12 51  Rotary Screw Compressors
43 23 40  Horizontal Self-Priming Centrifugal Pumps
43 25 13  Submersible Non-Clog Centrifugal Pumps
43 26 50  Air Operated Double-Diaphragm Pumps

DIVISION 44 – 45 (NOT USED)

DIVISIONS 46 – WATER AND WASTEWATER EQUIPMENT

46 33 33  Polymer Blending and Feed Equipment
46 41 26  Floating Mechanical Aerators
46 43 63  Dissolved Air Flotation Equipment

DIVISION 47 – 48 (NOT USED)

APPENDIX A

Geotechnical Report – Dated August 20, 2018
DIVISION 26

ELECTRICAL SPECIFICATIONS

PREPARED BY

John Averrett, PE
PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Work under this item of the Contract shall include the furnishing of all labor, material, equipment, supplies, and services necessary to construct and install the complete electrical systems, including exterior and interior of buildings as shown on the drawings and specified herein.

B. The CONTRACTOR shall base his proposal on the materials specified herein and on the drawings. Reference to a particular product by the manufacturer, trade name, or catalog number establishes the quality standards of materials and equipment required for this installation and is not intended to exclude products equal in quality and similar in design. Where two or more designations are listed, choice shall be optional with the Contractor. The Engineer reserves the sole right to decide the equality of materials proposed for use in lieu of those specified.

1.2 RELATED DOCUMENTS:

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

B. Related work specified elsewhere includes:
   1. Section 02200 – Earthwork
   2. Section 09900 – Painting
   3. Division 11 - Equipment

1.3 CODES, PERMITS, AND INSPECTIONS

A. Comply with applicable laws of the community, with latest edition of NEC where not in conflict with those laws, and with the service rules of the local utility company. Obtain and pay for all permits required. After completion of the work, submit certificate of final inspection and approval from the local electrical inspector, certifying that the installation complies with all regulations governing same.

1.4 DRAWINGS AND SPECIFICATIONS

A. Consider as complementary each to the other. What is called for by one shall be as binding as if called for by both. Where conflicts occur, secure clarification from Engineer in advance of bidding; otherwise provide the more expensive quality or quantity. Follow figures in preference to scale dimensions; verify all dimensions and existing conditions.

1.5 CONFLICTS, COORDINATION AND CHANGES

A. In the event that interferences or conflicts develop, the ENGINEER shall decide which equipment shall be relocated regardless of which was first installed. In the interest of avoiding such conflicts, the electrical sub-contractor who is using common space such as mechanical rooms, chases, ceiling space, etc., shall coordinate his work with all other trades and other parts of his
own work. If, during this coordination, it is discovered that necessary or desirable changes should be made, advise the ENGINEER and secure his decision in writing.

1.6 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data including manufacturer’s product specifications, standard details, certified product test results, installation instructions, accessories and general recommendations, as applicable to materials and finishes for each component.

C. Samples: Provide samples indicated in each Section, representative of products and/or components to be provided.

D. Color Selection: Where a color selection is required and is not preselected, include physical samples of materials and full range of colors available at bid date.

E. Shop Drawings: Provide shop drawings where indicated or otherwise required for complete and proper illustration of products, systems and installation, including in part, showing layouts, details, elevations, edge conditions, joints, corners, profiles, supports, anchorages, trim, flashings, closures, accessories, special details and similar conditions. Distinguish between factory and field assembly work. The manufacturer’s technical engineering department shall approve the drawings before they are submitted.

F. Qualification data for manufacturer, Design Engineer, fabricator and installer.

G. Sample of warranties specified and of incidental warranties of components, which are all to be extended to the Owner.

1.7 WARRANTY

A. Warrant the entire electrical system in proper working order. Replace, without additional charge, all work or material which may develop defects (ordinary wear and tear or damage resulting from improper handling excepted) within a period of one year from date of final acceptance.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall be new and shall be listed as approved by the Underwriter’s Laboratories, Inc. in every case where a standard has been established for the particular type of material in question. All work shall be executed in workmanlike manner and shall present a neat and mechanical appearance when completed.

2.2 ELECTRICAL SERVICE

A. General: Coordinate with owner. Provide all material and labor so as to produce a complete installation meeting the owner regulations. The Electrical Contractor shall be responsible for including all fees associated with bringing power to this site in their original bid.
B. Metering: Obtain metering equipment from Utility Company and install in compliance with the Utility Company's requirements.

C. Main Service Equipment: Provide U.L. listed service entrance components as shown or specified hereinafter.

D. Service Feeder: Of type and size shown on Riser Diagram. Extend (2)5” PVC with Poly-Pull 48” deep underground from service equipment to transformer location (verify exact location with Utility Company). Install utility furnished pull boxes as shown on drawings and terminate conduit at transformer as directed by the Utility Company and leave sufficient slack conductors for connection to transformer lugs. Coordinate any increase or decrease in service size with utility.

E. Transformer: Will be furnished and installed by Utility Company on concrete pad for underground service. Installation shall be in accordance with Utility Company standard drawings. Provide connectors as directed by Utility Company for terminating feeder at transformer lugs. Coordinate any increase or decrease in transformer size with utility.

PART 3 - EXECUTION

3.1 VISIT TO SITE

A. Before submitting a bid, visit the site and ascertain all existing conditions. Make such adjustments in work as are required by the actual conditions encountered.

3.2 CUTTING AND CHASING

A. Where possible all work shall be built in as the job progresses. Where this is not possible, secure approval and do necessary cutting, chasing, etc. required. Do not cut through any structural members without securing approval in advance; such holes shall be neatly cut or drilled – not chipped.

3.3 TRENCHING AND BACKFILLING

A. Do all excavating necessary for installation of work; backfill trenches and excavations after work has been installed and inspected. Backfill within the building and under paved areas shall meet compaction requirements and fill material shall be pit run gravel or similar granular material.

3.4 ELECTRICAL SERVICE INSTALLATION

A. Project Conditions: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated.

B. Notify Project Manager and Owner no fewer than seven days in advance of proposed interruption of electrical service.

C. Indicate method of providing temporary electrical service.

D. Do not proceed with interruption of electrical service without Project Manager’s written permission.

END OF SECTION 260500
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SECTION 260519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Copper building wire rated 600 V or less.
   2. Connectors, splices, and terminations rated 600 V and less.
B. Related Requirements:
   1. Section 260513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35,000 V.
   2. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.
   3. Section 271313 "Communications Copper Backbone Cabling" for twisted pair cabling used for data circuits.
   4. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair cabling used for data circuits.

1.3 DEFINITIONS
A. PV: Photovoltaic.
B. RoHS: Restriction of Hazardous Substances.
C. VFC: Variable-frequency controller.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Sustainable Design Submittals:
C. Product Schedule: Indicate type, use, location, and termination locations.
1.5 **INFORMATIONAL SUBMITTALS**

A. Qualification Data: For testing agency.

B. Field quality-control reports.

1.6 **QUALITY ASSURANCE**

A. Testing Agency Qualifications: Member company of NETA.
   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

**PART 2 - PRODUCTS**

2.1 **COPPER BUILDING WIRE**

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. RoHS compliant.
   3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 and ASTM B 496 for stranded conductors.

D. Conductor Insulation
   1. Type THHN and type THWN-2: Comply with UL 83.

E. Shield:
   1. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire symmetrically applied ground wires, and sunlight- and oil-resistant outer PVC jacket.

2.2 **CONNECTORS AND SPLICES**

A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Feeders: Copper for feeders smaller than No. 4 AWG; copper for feeders No. 4 AWG and larger. Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

D. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

E. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.


3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN/THWN-2, single conductors in raceway

B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway

E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway

F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor materials.
   1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least [6 inches] [12 inches] of slack.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."
3.8 **FIELD QUALITY CONTROL**

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.
   1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
   2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements:
   3. Perform each of the following visual and electrical tests:
      a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
      b. Test bolted connections for high resistance using one of the following:
         1) A low-resistance ohmmeter.
         2) Calibrated torque wrench.
         3) Thermographic survey.
      c. Inspect compression-applied connectors for correct cable match and indentation.
      d. Inspect for correct identification.
      e. Inspect cable jacket and condition.
      f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
      g. Continuity test on each conductor and cable.
      h. Uniform resistance of parallel conductors.
   4. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
      a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
      b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
   5. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports to record the following:
   1. Procedures used.
   2. Results that comply with requirements.
   3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.
SECTION 260523
CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Backboards.
   2. Category 5e twisted pair cable.
   3. Category 6 twisted pair cable.
   4. Category 6a twisted pair cable.
   5. Twisted pair cabling hardware.
   6. RS-485 cabling.
   7. Low-voltage control cabling.

1.3 DEFINITIONS
A. EMI: Electromagnetic interference.
B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.
D. RCDD: Registered Communications Distribution Designer.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Sustainable Design Submittals
1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency, RCDD, layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.
   1. Testing Agency’s Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
   1. Flame Travel Distance: 60 inches or less.
   2. Peak Optical Smoke Density: 0.5 or less.
   3. Average Optical Smoke Density: 0.15 or less.

C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

E. RoHS compliant.

2.2 BACKBOARDS

A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels in Section 061000 "Rough Carpentry."

B. Painting: Paint plywood on all sides and edges with eggshell black latex paint. Comply with requirements in Section 099123 "Interior Painting."
2.3 **CATEGORY 5e TWISTED PAIR CABLE**

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz.

B. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 5e cables.

C. Conductors: 100-ohm, 24 AWG solid copper.

D. Shielding/Screening: Screened and shielded twisted pairs (F/FTP).

E. Cable Rating: Plenum.

F. Jacket: Gray thermoplastic.

2.4 **CATEGORY 6 TWISTED PAIR CABLE**

A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.


C. Conductors: 100-ohm, 23 AWG solid copper.

D. Shielding/Screening: Screened and shielded twisted pairs (F/FTP).

E. Cable Rating: Plenum.

F. Jacket: Blue thermoplastic.

2.5 **CATEGORY 6a TWISTED PAIR CABLE**

A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.

B. Standard: Comply with TIA-568-C.2 for Category 6a cables.

C. Conductors: 100-ohm, 23 AWG solid copper.

D. Shielding/Screening: Screened and shielded twisted pairs (F/FTP).

E. Cable Rating: Plenum.

F. Jacket: Blue thermoplastic.
2.6 TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. General Requirements for Twisted Pair Cable Hardware:
1. Comply with the performance requirements of Category 5e
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

C. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer See discussion in the Evaluations about 110-style IDC connectors and connector blocks.

D. Connecting Blocks: 110-style IDC for Category 5e, 110-style IDC for Category 6 IDC for Category 5e for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
1. Number of Terminals per Field: One for each conductor in assigned cables.

F. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
1. Features:
   a. Universal T568A and T568B wiring labels.
   b. Labeling areas adjacent to conductors.
   c. Replaceable connectors.
   d. 24 or 48 ports.
2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
3. Number of Jacks per Field: One for each four-pair cable indicated, conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

G. Patch Cords: Factory-made, four-pair cables in 36-inch lengths; terminated with an eight-position modular plug at each end.
1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

H. Plugs and Plug Assemblies:
1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded twisted pair cable.
2. Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7-5.
3. Marked to indicate transmission performance.

I. Jacks and Jack Assemblies:
1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standards:
   a. Category 5e, unshielded twisted pair cable shall comply with IEC 60603-7-2.
   b. Category 5e, shielded twisted pair cable shall comply with IEC 60603-7-3.
   c. Category 6, unshielded twisted pair cable shall comply with IEC 60603-7-4.
   d. Category 6, shielded twisted pair cable shall comply with IEC 60603-7-5.
   e. Category 6a, unshielded twisted pair cable shall comply with IEC 60603-7-41.
   f. Category 6a, shielded twisted pair cable shall comply with IEC 60603-7-51.

4. Marked to indicate transmission performance.

J. Faceplate:
   1. **Six** port, vertical single-gang faceplates designed to mount to single-gang wall boxes.
   2. Eight port, vertical double-gang faceplates designed to mount to double-gang wall boxes.
   4. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
   5. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
      a. Flush mounting jacks, positioning the cord at a 45-degree angle.

K. Legend:
   1. Machine printed, in the field, using adhesive-tape label.
   2. Snap-in, clear-label covers and machine-printed paper inserts.

2.7 **TWIN-AXIAL DATA HIGHWAY CABLE**

A. Standard Cable: NFPA 70, Type CM.
   1. Paired, pairs, No. 20 AWG, stranded (7x28) tinned-copper conductors.
   2. Polypropylene insulation.
   3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
   4. PVC jacket.
   5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.

B. Plenum-Rated Cable: NFPA 70, Type CMP.
   1. Paired, pairs, No. 20 AWG, stranded (7x28) tinned-copper conductors.
   2. Plastic insulation.
   3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
   5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.

2.8 **RS-485 CABLE**

A. Standard Cable: NFPA 70, Type CMG.
   1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated Cable: NFPA 70, Type CMP.
   1. Paired, one pair, No. 22 AWG, stranded (7x30) tinned-copper conductors.
   2. Fluorinated ethylene propylene insulation.
   3. Unshielded.
   4. Fluorinated ethylene propylene jacket.

2.9 **LOW-VOLTAGE CONTROL CABLE**

A. Paired Cable: NFPA 70, Type CMG.
   1. Multi-pair, twisted, No. 16 AWG, stranded (19x30) tinned-copper conductors.
   2. PVC insulation.
   3. Unshielded.
   4. PVC jacket.
   5. Flame Resistance: Comply with UL 1685.

   B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
      1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
      2. PVC insulation.
      3. Unshielded.
      4. PVC jacket.
      5. Flame Resistance: Comply with NFPA 262.

2.10 **CONTROL-CIRCUIT CONDUCTORS**

A. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway

B. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway

D. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.
   1. Smoke control signaling and control circuits.

2.11 **SOURCE QUALITY CONTROL**

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test twisted pair cables according to TIA-568-C.2.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Test cables on receipt at Project site.
   1. Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
   1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
   2. Outlet boxes for cables shall be no smaller than 4 inches square by 1-1/2 inches 2-1/8 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
   3. Flexible metal conduit shall not be used.

B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:
   1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
   2. Install cable trays to route cables if conduits cannot be located in these positions.
   3. Secure conduits to backboard if entering the room from overhead.
   4. Extend conduits 3 inches above finished floor.

E. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:
   2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
   3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
   4. Cables may not be spliced.
   5. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.

7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.


10. Support: Do not allow cables to lie on removable ceiling tiles.

11. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

C. Twisted Pair Cable Installation:
   2. Install termination hardware as specified in Section 271513 "Communications Copper Horizontal Cabling" unless otherwise indicated.
   3. Do not untwist UTP cables more than 1/2 inch at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:
   1. Install wiring in raceways. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

E. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
   3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Installation of Cable Routed Exposed under Raised Floors:
   1. Install plenum-rated cable only.
   2. Install cabling after the flooring system has been installed in raised floor areas.
   3. Below each feed point, neatly coil a minimum of 72 inches of cable in a coil not less than 12 inches in diameter.

G. Separation from EMI Sources:
   1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
   2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
      a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches.
      b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches.
      c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.

6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.5 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:
   1. Class 1 remote-control and signal circuits; No 14 AWG.
   2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
   3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.6 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.7 GROUNDING

A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
3.8 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.

E. Tests and Inspections:
   1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.
      a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

F. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

G. End-to-end cabling will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports.

END OF SECTION 260523
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes grounding and bonding systems and equipment.

B. Section includes grounding and bonding systems and equipment, plus the following special applications:
   1. Underground distribution grounding.
   2. Ground bonding common with lightning protection system.
   3. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Sustainable Design Submittals

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
   1. Test wells.
   2. Ground rods.
   3. Ground rings.
   4. Grounding arrangements and connections for separately derived systems.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   a. Plans showing as-built, dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
      1) Test wells.
      2) Ground rods.
      3) Ground rings.
      4) Grounding arrangements and connections for separately derived systems.
   b. Instructions for periodic testing and inspection of grounding, ground rings, and grounding connections for separately derived systems based on NETA MTS and NFPA 70B.
      1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
      2) Include recommended testing intervals.

1.6 QUALITY ASSURANCE

   A. Testing Agency Qualifications: Certified by NETA.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

   B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS

2.3 CONDUCTORS

   A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

   B. Bare Copper Conductors:
      4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
      5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
      6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless exothermic -type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.

E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

F. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

G. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

H. Conduit Hubs: Mechanical type, terminal with threaded hub.

I. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt or socket set screw.

J. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

K. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.

L. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.

M. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.

N. Straps: Solid copper. Rated for 600 A.

O. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal two-piece clamp.

P. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

Q. Water Pipe Clamps:
   1. Mechanical type, two pieces with stainless-steel bolts.
b. Listed for direct burial.
2. U-bolt type with malleable-iron clamp and copper ground connector rated for direct burial.

2.5 **GROUNDING ELECTRODES**

A. Ground Rods: Copper-clad, sectional type; 3/4 inch by 10 feet.

B. Ground Plates: 1/4 inch thick, hot-dip galvanized.

**PART 3 - EXECUTION**

3.1 **APPLICATIONS**

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 3/0 AWG minimum.
   1. Bury at least 24 inches below grade.
   2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

E. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.

3.2 **GROUNDING AT THE SERVICE**

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.
3.3 **GROUNDING SEPARATELY DERIVED SYSTEMS**

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 **GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS**

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install copper conductor not less than No. 3/0 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.5 **EQUIPMENT GROUNDING**

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   1. Feeders and branch circuits.
   2. Lighting circuits.
   3. Receptacle circuits.
   5. Three-phase motor and appliance branch circuits.
   6. Flexible raceway runs.
   7. Armored and metal-clad cable runs.
   8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

F. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

G. Metallic Fences: Comply with requirements of IEEE C2.
   1. Grounding Conductor: Bare tinned copper, not less than No. 8 AWG.
   2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
   3. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.6 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
   2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.
1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
   3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install [tinned] bonding jumper to bond across flexible duct connections to achieve continuity.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

I. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
   1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
   2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

J. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections. Retain "Tests and Inspections" Paragraph below to describe tests and inspections to be performed.

E. Tests and Inspections:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
   a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
   b. Perform tests by fall-of-potential method according to IEEE 81.
4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

F. Grounding system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).

I. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526
SECTION 260529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Steel slotted support systems.
   2. Aluminum slotted support systems.
   3. Nonmetallic slotted support systems.
   4. Conduit and cable support devices.
   5. Support for conductors in vertical conduit.
   6. Structural steel for fabricated supports and restraints.
   7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
   8. Fabricated metal equipment support assemblies.

B. Related Requirements:
   1. Section 260548.16 "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
      a. Slotted support systems, hardware, and accessories.
      b. Clamps.
      c. Hangers.
      d. Sockets.
      e. Eye nuts.
      f. Fasteners.
      g. Anchors.
      h. Saddles.
      i. Brackets.
   2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for electrical hangers and support systems.
2. Slotted support systems.
3. Equipment supports.
4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For hangers and supports for electrical systems.
   1. Include design calculations and details of hangers.
   2. Include design calculations for seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Suspended ceiling components.
   2. Ductwork, piping, fittings, and supports.
   3. Structural members to which hangers and supports will be attached.
   4. Size and location of initial access modules for acoustical tile.
   5. Items penetrating finished ceiling, including the following:
      a. Luminaires.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.
      f. Projectors.

B. Seismic Qualification Data: Certificates, for hangers and supports for electrical equipment and systems, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M

B. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M.
   2. AWS D1.2/D1.2M.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.

B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the supported equipment and systems will be fully operational after the seismic event."
   2. Component Importance Factor 1.5

C. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame Rating: Class 1.
   2. Self-extinguishing according to ASTM D 635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
   1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
   2. Material for Channel, Fittings, and Accessories: Galvanized steel Retain first option in "Channel Width" Subparagraph below to allow Contractor to select size of slotted support system.
   3. Channel Width: Selected for applicable load criteria 1-5/8 inches Retain one or more of "Metallic Coatings," "Nonmetallic Coatings," and "Painted Coatings" subparagraphs below. Coordinate with appropriate coating or painting Section.
   4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
   6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface.
   1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
   2. Channel Material: 6063-T5 aluminum alloy.
   4. Channel Width: Selected for applicable load criteria 1-5/8 inches Retain "Nonmetallic Coatings" or "Painted Coatings" Subparagraph below, or both. Coordinate with appropriate coating or painting Section.
   5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
   6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
C. Conduit and Cable Support Devices: Galvanized Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
   4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
   5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
   1. NECA 1.
   2. NECA 101
   3. NECA 102.
   4. NECA 105.
   5. NECA 111.

B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for RMC as required by scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with two-bolt conduit clamps, single-bolt conduit clamps, and single-bolt conduit clamps using spring friction action for retention in support channels.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA 1, RMC may be supported by openings through structure members, according to NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
   6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69 Spring-tension clamps.
   7. To Light Steel: Sheet metal screws.
   8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.
E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base as follows:
   1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Section 099113 "Exterior Painting", Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529
SECTION 260533

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Metal conduits, tubing, and fittings.
   2. Nonmetal conduits, tubing, and fittings.
   3. Metal wireways and auxiliary gutters.
   4. Nonmetal wireways and auxiliary gutters.
   5. Surface raceways.
   7. Handholes and boxes for exterior underground cabling.

B. Related Requirements:
   1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
   2. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.
B. GRC: Galvanized rigid steel conduit.
C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
B. Sustainable Design Submittals:
C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

D. Samples: For wireways, nonmetallic wireways and surface raceways and for each color and texture specified, 12 inches long.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
   1. Structural members in paths of conduit groups with common supports.
   2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
   4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. GRC: Comply with ANSI C80.1 and UL 6.

C. ARC: Comply with ANSI C80.5 and UL 6A.

D. IMC: Comply with ANSI C80.6 and UL 1242.

E. PVC-Coated Steel Conduit: PVC-coated
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch, minimum.

F. FMC: Comply with UL 1; zinc-coated steel or aluminum.

G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
   1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
   2. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
   3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fiberglass:
   2. Comply with UL 2515 for aboveground raceways.
   3. Comply with UL 2420 for belowground raceways.

C. RNC: [Type EPC-40-PVC], complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. Rigid HDPE: Comply with UL 651A.

E. Continuous HDPE: Comply with UL 651A.

F. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.

G. RTRC: Comply with UL 2515A and NEMA TC 14.

H. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

I. Fittings for LFNC: Comply with UL 514B.

J. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 3R unless otherwise indicated, and sized according to NFPA 70.
   1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
C. Wireway Covers: Screw-cover type unless otherwise indicated.
D. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

C. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

E. Solvents and Adhesives: As recommended by conduit manufacturer.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, Box extensions used to accommodate new building finishes shall be of same material as recessed box.

H. Device Box Dimensions: 4 inches by 2-1/8 inches by 2-1/8 inches deep.

I. Gangable boxes are prohibited

J. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 or Type 12 with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic or Fiberglass.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

K. Cabinets:
1. NEMA 250, Type 1, Type 3R and Type 12 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 HAN DHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:
1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC."
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of polymer concrete.
1. Standard: Comply with SCTE 77.
2. Color of Frame and Cover: Gray
3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC."
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
2.7 **SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES**

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
   1. Tests of materials shall be performed by an independent testing agency.
   2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
   3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

**PART 3 - EXECUTION**

3.1 **RACEWAY APPLICATION**

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
   2. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: GRC.
   2. Exposed, Not Subject to Severe Physical Damage: GRC.
   3. Exposed and Subject to Severe Physical Damage: GRC Raceway locations include the following:
      a. Loading dock.
      b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
      c. Mechanical rooms.
      d. Gymnasiums.
   4. Concealed in Ceilings and Interior Walls and Partitions: GRC
   5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   6. Damp or Wet Locations: GRC
   7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
   3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

G. Install surface raceways only where indicated on Drawings.

H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches of enclosures to which attached.

I. Raceways Embedded in Slabs:
   1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
   2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
   3. Arrange raceways to keep a minimum of 3 inches of concrete cover in all directions.
   4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
   5. Change from ENT to GRC before rising above floor.

J. Stub-ups to Above Recessed Ceilings:
   1. Use RMC for raceways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

S. Surface Raceways:
   1. Install surface raceway with a minimum 2-inch radius control at bend points.
   2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

T. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service raceway enters a building or structure.
   3. Where otherwise required by NFPA 70.

V. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

W. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.

2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
   c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
   d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.

4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
   1. Use LFMC in damp or wet locations subject to severe physical damage.
   2. Use LFMC in damp or wet locations not subject to severe physical damage.

Y. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to [center] [top] [bottom] of box unless otherwise indicated.

Z. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

AA. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

BB. Locate boxes so that cover or plate will not span different building finishes.

CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

EE. Set metal floor boxes level and flush with finished floor surface.

FF. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
   1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.
   2. Install backfill as specified in Section 312000 "Earth Moving."
   3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
   4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
   5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
      a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
      b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
   6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits but a minimum of 6 inches below grade. Align planks along centerline of conduit.
   7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes with bottom below frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533
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SECTION 260544
SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
   2. Sleeve-seal systems.
   5. Silicone sealants.

B. Related Requirements:
   1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:
   2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
      b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Sealing Elements: Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Stainless steel.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.


C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
      b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
   2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed[or unless seismic criteria require different clearance].
   4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
   5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
   2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using [steel] [cast-iron] pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.
3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544
SECTION 260553

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Color and legend requirements for raceways, conductors, and warning labels and signs.
   2. Labels.
   4. Tapes and stencils.
   5. Tags.
   7. Cable ties.
   9. Fasteners for labels and signs.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

D. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS


B. Comply with NFPA 70.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Comply with NFPA 70E and Section 260574 "Overcurrent Protective Device Arc-Flash Study" requirements for arc-flash warning labels.

F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:
   1. Black letters on an orange field.
   2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and] [branch-circuit] conductors.
   1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
   2. Colors for 208/120-V Circuits:
      a. Phase A: Black.
      b. Phase B: Red.
      c. Phase C: Blue.
   3. Colors for 240-V Circuits:
      a. Phase A: Black.
      b. Phase B: Red.
   4. Colors for 480/277-V Circuits:
      b. Phase B: Orange.
      c. Phase C: Yellow.
   5. Color for Neutral White or gray.
   6. Color for Equipment Grounds: Bare copper, Green or Green with a yellow strip.
   7. Colors for Isolated Grounds: Green with white stripe.

C. Raceways and Cables Carrying Circuits at More Than 600 V:
   1. Black letters on an orange field.
   2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

D. Warning Label Colors:
   1. Identify system voltage with black letters on an orange background.

E. Warning labels and signs shall include, but are not limited to, the following legends:
   1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
   2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

   1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
   2. Marker for Labels: Permanent, waterproof, black ink marker recommended by tag manufacturer.
   3. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
   1. Minimum Nominal Size:
      a. 1-1/2 by 6 inches for raceway and conductors.
      b. 3-1/2 by 5 inches for equipment.
      c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.

B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

2.5 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.

C. Tape and Stencil: 4-inch- wide black stripes on 10-inch centers placed diagonally over orange background and is 12 inches wide. Stop stripes at legends.

D. Floor Marking Tape: 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

E. Underground-Line Warning Tape:
   1. Tape:
a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.

b. Printing on tape shall be permanent and shall not be damaged by burial operations.

c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

2. Color and Printing:
   b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
   c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".

3. Tag: Type IID:
   a. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
   b. Width: 3 inches.
   c. Overall Thickness: 8 mils.
   d. Foil Core Thickness: 0.35 mil.
   e. Weight: 34 lb/1000 sq. ft.
   f. Tensile according to ASTM D 882: 300 lbf and 12,500 psi.

F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.6 TAGS

A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.023 inch thick, color-coded for phase and voltage level, with factory screened permanent designations; punched for use with self-locking cable tie fastener.

C. Write-on Tags:
   1. Polyester Tags: 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment.
   2. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
   3. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.7 SIGNS

A. Baked-Enamel Signs:
   1. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
   2. 1/4-inch grommets in corners for mounting.
B. Metal-Backed Butyrate Signs:
   1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
   2. 1/4-inch grommets in corners for mounting.
   3. Nominal Size: 10 by 14 inches.

C. Laminated Acrylic or Melamine Plastic Signs:
   1. Engraved legend.
   2. Thickness:
      a. For signs up to 20 sq. in., minimum 1/16 inch thick.
      b. For signs larger than 20 sq. in., 1/8 inch thick.
      c. Engraved legend with black letters on white face
      d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
      e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
   2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
   2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
   2. Tensile Strength at 73 Deg F according to ASTM D 638: 7000 psi.
   3. UL 94 Flame Rating: 94V-0.
   4. Temperature Range: Minus 50 to plus 284 deg F.
   5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.
PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
   1. Secure tight to surface of conductor, cable, or raceway.

H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
   1. Secure tight to surface of conductor, cable, or raceway.


J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch high letters for emergency instructions at equipment used for [power transfer or load shedding.

K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
   1. "EMERGENCY POWER."
   2. "POWER."
3. "UPS."

M. Vinyl Wraparound Labels:
1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

N. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.

O. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.

P. Self-Adhesive Labels:
1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.

Q. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

R. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.

S. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.

T. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

U. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

V. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.

W. Underground Line Warning Tape:
1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench [or concrete envelope] exceeds 16 inches overall.
2. Limit use of underground-line warning tape to direct-buried cables.
3. Install underground-line warning tape for direct-buried cables and cables in raceways.

X. Metal Tags:
1. Place in a location with high visibility and accessibility.
2. Secure using UV-stabilized cable ties.

Y. Nonmetallic Preprinted Tags:
1. Place in a location with high visibility and accessibility.
2. Secure using UV-stabilized cable ties.

Z. Baked-Enamel Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.

AA. Metal-Backed Butyrate Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.

BB. Laminated Acrylic or Melamine Plastic Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.

CC. Cable Ties: General purpose, for attaching tags, except as listed below:
1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

1. Locate identification at changes in direction, at penetrations of walls and floors, and at 10-foot maximum intervals.

D. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Vinyl wraparound labels
1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

E. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive.
1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
F. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."

G. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify the phase.
1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

H. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.

I. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.

J. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with the conductor designation.

K. Conductors to Be Extended in the Future: Attach [write-on tags] [marker tape] to conductors and list source.

L. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

M. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

N. Concealed Raceways and Duct Banks, More Than 600 V, within Buildings: Apply floor marking tape to the following finished surfaces:
1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to raceways concealed within wall.
3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

O. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

P. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.

Q. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs
1. Apply to exterior of door, cover, or other access.
2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
   a. Power-transfer switches.
   b. Controls with external control power connections.


S. Operating Instruction Signs: Self-adhesive labels Emergency Operating Instruction Signs: [Self-adhesive labels with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer and load shedding.

T. Equipment Identification Labels:
   1. Indoor Equipment: Self-adhesive label Outdoor Equipment: Laminated acrylic or melamine sign Stenciled legend 4 inches high
   2. Equipment to Be Labeled:
      a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a engraved, laminated acrylic or melamine label.
      b. Enclosures and electrical cabinets.
      c. Access doors and panels for concealed electrical items.
      d. Switchgear.
      e. Switchboards.
      f. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
      g. Substations.
      h. Emergency system boxes and enclosures.
      i. Motor-control centers.
      j. Enclosed switches.
      k. Enclosed circuit breakers.
      l. Enclosed controllers.
      m. Variable-speed controllers.
      n. Push-button stations.
      o. Power-transfer equipment.
      p. Contactors.
      q. Remote-controlled switches, dimmer modules, and control devices.
      r. Battery-inverter units.
      s. Battery racks.
      t. Power-generating units.
      u. Monitoring and control equipment.
      v. UPS equipment.

END OF SECTION 260553
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Single- and three-phase motors for application on equipment provided under other Sections and for motors furnished loose to Project.

B. Related Requirements:
   1. Division 26 – Electrical

1.2 REFERENCE STANDARDS

A. American Bearing Manufacturers Association:
   1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. National Electrical Manufacturers Association:
   1. NEMA MG 1 - Motors and Generators.

C. International Electrical Testing Association:

1.3 SUBMITTALS

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

B. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, physical dimensions, weights, mechanical performance data, and support points.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Test and Evaluation Reports: Indicate procedures and results for specified factory and field testing and inspection.

E. Qualifications Statements:
   1. Submit qualifications for manufacturer and testing agency.
1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' documented experience.

B. Testing Agency: Member of International Electrical Testing Association and specializing in testing products specified in this Section with minimum ten years' documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.

C. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.

D. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS FOR MOTORS FURNISHED WITH EQUIPMENT

A. Motors 3/4 hp and Larger: Three-phase motor as specified below.

B. Motors Smaller than 3/4 hp: Single-phase motor as specified below, except motors less than 250 watts or 1/4 hp may be equipment manufacturer's standard.

C. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor with windings to accomplish starting methods and number of speeds.

1. Voltage:
   a. As indicated on Drawings.

2. Service Factor: 1.15.

3. Enclosure: Meet conditions of installation unless specific enclosure is indicated on Drawings.

4. Design for continuous operation in 40-degree C environment, with temperature rise according to NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

5. Insulation System: NEMA Class H.

6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
7. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy-encapsulated solid state-control relay with wiring to terminal box.

8. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum, V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.


D. Single-Phase Motors:

1. Permanent split-capacitor type where available; otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
2. Voltage: 115/230 volts, single phase, 60 Hz.

E. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.2 THREE-PHASE MOTORS FURNISHED LOOSE

A. Manufacturers:

1. Baldor.
2. US Motors.
3. WEG.
4. GE.
5. Or Approved Equal.

B. Description: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds indicated.

C. Voltage: As indicated on Drawings.

D. Service Factor: 1.15.

E. Enclosure: Meet conditions of installation unless specific enclosure is specified or indicated.

F. Design for continuous operation in 40-degree C environment, with temperature rise according to NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

G. Insulation System: NEMA Class H.

H. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

I. Thermistor System (Motor Frame Sizes 254T and Larger): Two PTC thermistors per winding embedded in motor windings and epoxy-encapsulated solid state-control relay with wiring to terminal box.
J. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum, V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

K. Sound Power Levels: Conform to NEMA MG 1.

L. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Factory Testing: Test motors according to NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

PART 3 - EXECUTION

3.1 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Disconnect and remove abandoned motors.

C. Clean and repair existing motors to remain or those to be reinstalled.

3.2 INSTALLATION

A. Maintain access to existing motors and other installations remaining active and requiring access. Modify installation or provide access panel.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Install engraved plastic nameplates according to Section 26 05 53 - Identification for Electrical Systems.

D. Ground and bond motors according to Section 26 05 26 - Grounding and Bonding Electrical Systems.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.
B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Inspect and factory test according to NETA ATS, except Section 4.

END OF SECTION 26 05 93
SECTION 262200
LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes: Distribution, dry-type transformers rated 600 V and less, with capacities up to 1500 kVA.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
   2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.
B. Shop Drawings:
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
   3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS
A. Seismic Qualification Certificates: For transformers, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
B. Qualification Data: For testing agency.
C. Source quality-control reports.
D. Field quality-control reports.
1.5 **CLOSEOUT SUBMITTALS**
   
   A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 **QUALITY ASSURANCE**
   
   A. Testing Agency Qualifications: Accredited by NETA.
      1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 **DELIVERY, STORAGE, AND HANDLING**
   
   A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

**PART 2 - PRODUCTS**

2.1 **MANUFACTURERS**
   
   A. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 **GENERAL TRANSFORMER REQUIREMENTS**
   
   A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

   B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

   C. Transformers Rated 15 kVA and Larger: Comply with NEMA TP 1 energy-efficiency levels as verified by testing according to NEMA TP 2.

   D. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

   E. Coils: Continuous windings without splices except for taps.
      1. Internal Coil Connections: Brazed or pressure type.
      2. Coil Material: Copper.

   F. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.

   G. Shipping Restraints: Paint or otherwise color code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.
2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Cores: One leg per phase.

D. Enclosure: Ventilated.
   1. NEMA 250, Core and coil shall be encapsulated within resin compound utilizing a vacuum pressure impregnation process to seal out moisture and air.
   2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.

E. Transformer Enclosure Finish: Comply with NEMA 250.
   1. Finish Color: NSF/ANSI 61 gray.

F. Taps for Transformers 3 kVA and Smaller: None Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

H. Insulation Class, Smaller than 30 kVA: 185 deg C, UL-component-recognized insulation system with a maximum of 115-deg C rise above 40-deg C ambient temperature.

I. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of [115-deg C rise above 40-deg C ambient temperature.

J. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
   1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
   2. Indicate value of K-factor on transformer nameplate.
   3. Unit shall meet requirements of NEMA TP 1 when tested according to NEMA TP 2 with a K-factor equal to one.

K. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
   1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
   2. Include special terminal for grounding the shield.

L. Neutral: Rated 200 percent of full load current for K-factor rated transformers.

M. Wall Brackets: Manufacturer's standard brackets

N. Retain "Fungus Proofing" Paragraph below for installations in tropical environments where transformers might be disconnected from normal electrical supply or are lightly loaded for extended periods of time.
O. Fungus Proofing: Permanent fungicidal treatment for coil and core.

P. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91.

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each [distribution] [buck-boost] transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
1. Resistance measurements of all windings at the rated voltage connections and at all tap connections.
2. Ratio tests at the rated voltage connections and at all tap connections.
3. Phase relation and polarity tests at the rated voltage connections.
4. No load losses, and excitation current and rated voltage at the rated voltage connections.
5. Impedance and load losses at rated current and rated frequency at the rated voltage connections.
6. Applied and induced tensile tests.
7. Regulation and efficiency at rated load and voltage.
8. Insulation Resistance Tests:
   a. High-voltage to ground.
   b. Low-voltage to ground.
   c. High-voltage to low-voltage.
9. Temperature tests.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
   1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
   2. Brace wall-mounted transformers as specified in Section 260548.16 "Seismic Controls for Electrical Systems."

B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

C. Construct concrete bases according to Section 033000 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
   1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

D. Secure transformer to concrete base according to manufacturer's written instructions.

E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS for dry-type, air-cooled, low-voltage transformers. Certify compliance with test parameters.

E. Remove and replace units that do not pass tests or inspections and retest as specified above.

F. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
   1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
   2. Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
   3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

G. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200
SECTION 262413
SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Service and distribution switchboards rated 600 V and less.
   2. Surge protection devices.
   3. Disconnecting and overcurrent protective devices.
   4. Instrumentation.
   5. Control power.
   6. Accessory components and features.
   7. Identification.

1.3 RELATED SECTIONS

A. Section 260574 "Overcurrent Protective Device Arc-Flash Study" for arc-flash study and arc-flash label requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.
   1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
   6. Detail utility company's metering provisions with indication of approval by utility company.
   7. Include evidence of NRTL listing for series rating of installed devices.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
10. Include diagram and details of proposed mimic bus.
11. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Samples: Representative portion of mimic bus with specified material and finish, for color selection.

D. Delegated Design Submittal:
   1. For arc-flash hazard study.
   2. For arc-flash labels.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Data: Certificates, for switchboards, overcurrent protective devices, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field Quality-Control Reports:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Routine maintenance requirements for switchboards and all installed components.
      b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
      c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
1.7 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.
   2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
   4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
   5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
   6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.

1.8 QUALITY ASSURANCE
A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
B. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency’s Field Supervisor: Certified by NETA to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.
C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.10 FIELD CONDITIONS
A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
B. Environmental Limitations:
   1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding 104 deg F.
      b. Altitude: Not exceeding 6600 feet.
C. Unusual Service Conditions: NEMA PB 2, as follows:
1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electric service.
   2. Indicate method of providing temporary electric service.
   3. Do not proceed with interruption of electric service without Construction Manager's written permission.
   4. Comply with NFPA 70E.

1.11 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.12 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Three years from date of Substantial Completion.

B. Manufacturer's Warranty: Manufacturer's agrees to repair or replace surge protection devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
   2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2.2 SWITCHBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Square D; by Schneider Electric.
3. Eaton
4. General Electric
5. Engineer Approved Equal.

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 2.

F. Comply with NFPA 70.

G. Comply with UL 891.

H. Front-Connected, Front-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   3. Sections front and rear aligned.

I. Front- and Side-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   3. Section Alignment: Front and Rear aligned.

J. Front- and Rear-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   2. Branch Devices: Panel and fixed, individually mounted.
   3. Sections front and rear aligned.

K. Nominal System Voltage: As indicated on the drawings.

L. Main-Bus Continuous: As indicated on the drawings.

M. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

N. Indoor Enclosures: Steel, NEMA 250, Type 1.

O. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

P. Outdoor Enclosures: Type 3R.
1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
2. Enclosure: Downward, rearward sloping roof; bolt-on rear covers for each section, with provisions for padlocking.
3. Doors: Personnel door at each end of aisle, minimum width of 30 inch; opening outwards; with panic hardware and provisions for padlocking. At least one door shall be sized to permit the largest single switchboard section to pass through without disassembling doors, hinges, or switchboard section.
4. Accessories: Fluorescent lighting fixtures, ceiling mounted; wired to a three-way light switch at each end of aisle; ground-fault circuit interrupter (GFCI) duplex receptacle; emergency battery pack lighting fixture installed on wall of aisle midway between personnel doors.
5. Walk-in Aisle Heating and Ventilating:
   a. Factory-installed electric unit heater(s), wall or ceiling mounted, with integral thermostat and disconnect and with capacities to maintain switchboard interior temperature of 40 deg F with outside design temperature of 0 deg F.
   b. Factory-installed exhaust fan with capacities to maintain switchboard interior temperature of 100 deg F with outside design temperature of 90 deg F.
   c. Ventilating openings complete with replaceable fiberglass air filters.
   d. Thermostat: Single stage; wired to control heat and exhaust fan.
6. Power for Space Heaters, Ventilation, Lighting, and Receptacle: Include a control-power transformer, with spare capacity of 25 percent, within the switchboard. Supply voltage shall be 120 V ac.
7. Power for space heaters, ventilation, lighting, and receptacle provided by a remote source.

Q. Barriers: Between adjacent switchboard sections.

R. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

S. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
1. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.

T. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

U. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's
current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

V. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks.

W. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

X. Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.

Y. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

Z. Pull Box on Top of Switchboard:
   1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
   2. Set back from front to clear circuit-breaker removal mechanism.
   3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
   4. Bottom shall be insulating, fire-resistant material with separate holes for cable drops into switchboard.
   5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

AA. Buses and Connections: Three phase, four wire unless otherwise indicated.
   1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
   4. Copper feeder circuit-breaker line connections.
   5. Tin-plated aluminum feeder circuit-breaker line connections.
   8. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
   9. Disconnect Links:
      a. Isolate neutral bus from incoming neutral conductors.
      b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
   10. Neutral Buses: 50 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
11. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.


BB. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

CC. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

DD. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.


3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long and short time adjustments.
   d. Ground-fault pickup level, time delay, and $I^2t$ response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.

6. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).


8. MCCB Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
   d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
f. Communication Capability: Universal-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."

g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

i. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.

1. Fixed circuit-breaker mounting.

2. Two-step, stored-energy closing.

3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Time adjustments for long- and short-time pickup.
   c. Ground-fault pickup level, time delay, and $I_2t$ response.

4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

5. Remote trip indication and control.


7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

8. Control Voltage: 120-V ac.

C. Fuses are specified in Section 262813 "Fuses."

2.4 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, and the following:

1. Potential Transformers: NEMA EI 21.1; 120 V, 60 Hz, double secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.

2. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary; wound type; double secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.

3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
   1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
      a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
      b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
      c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
      d. Megawatts: Plus or minus 1 percent.
      e. Megavars: Plus or minus 1 percent.
      f. Power Factor: Plus or minus 1 percent.
      g. Frequency: Plus or minus 0.1 percent.
      h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
      i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
      j. Contact devices to operate remote impulse-totalizing demand meter.
   2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

C. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.

D. Watt-Hour Meters and Wattmeters:
   2. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.
   3. Suitable for connection to three- and four-wire circuits.
   4. Potential indicating lamps.
   5. Adjustments for light and full load, phase balance, and power factor.
   6. Four-dial clock register.
   7. Integral demand indicator.
   8. Contact devices to operate remote impulse-totalizing demand meter.
   9. Ratchets to prevent reverse rotation.
   10. Removable meter with drawout test plug.
   11. Semiflush mounted case with matching cover.

E. Impulse-Totalizing Demand Meter:
   2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.
   3. Cycloimeter.
   4. Four-dial, totalizing kilowatt-hour register.
   5. Positive chart drive mechanism.
   6. Capillary pen holding a minimum of one month's ink supply.
   7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
   8. Capable of indicating and recording 30-minute integrated demand of totalized system.

2.5 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.
B. Control Circuits: 120-V ac, supplied from remote branch circuit.

C. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.

D. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

E. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.


D. Overhead Circuit-Breaker Lifting Device: Mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.

E. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

F. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems" or manufacturer's instructions.

2.7 IDENTIFICATION

A. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on a photoengraved nameplate.
   1. Nameplate: At least 0.032-inch-thick anodized aluminum, located at eye level on front cover of the switchboard incoming service section.

B. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on an engraved laminated-plastic (Gravoply) nameplate.
   1. Nameplate: At least 0.0625-inch-thick laminated plastic (Gravoply), located at eye level on front cover of the switchboard incoming service section.
C. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram.

D. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.

E. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

F. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.
   1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
   2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
   3. Protect from moisture, dust, dirt, and debris during storage and installation.
   4. Install temporary heating during storage per manufacturer's instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete.
   1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after switchboard is anchored in place.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to switchboards.
6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices, surge protection devices, and instrumentation.
   1. Set field-adjustable switches and circuit-breaker trip ranges.

H. Install spare-fuse cabinet.

I. Comply with NECA 1.

3.3 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.

B. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

C. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.

D. Support and secure conductors within the switchboard according to NFPA 70.

E. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 **FIELD QUALITY CONTROL**

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. **Acceptance Testing:**
      a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
      b. Test continuity of each circuit.
   2. Test ground-fault protection of equipment for service equipment per NFPA 70.
   4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   5. Perform the following infrared scan tests and inspections, and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
         1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 **ADJUSTING**

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."
3.7 **PROTECTION**

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 **DEMONSTRATION**

A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 262413
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PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS
A. ATS: Acceptance testing specification.
B. GFCI: Ground-fault circuit interrupter.
C. GFEP: Ground-fault equipment protection.
D. HID: High-intensity discharge.
E. MCCB: Molded-case circuit breaker.
F. SPD: Surge protective device.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of panelboard.
   1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
   2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details.
   2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
   3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
   4. Detail bus configuration, current, and voltage ratings.
   5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of NRTL listing for series rating of installed devices.
7. Include evidence of NRTL listing for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.
B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Keys: Two spares for each type of panelboard cabinet lock.
   2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.
   3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
B. Handle and prepare panelboards for installation according to NEMA PB 1.
1.10 FIELD CONDITIONS

A. Environmental Limitations:
1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature: Not exceeding minus 22 deg F to plus 104 deg F.
   b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Construction Manager no fewer than two days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Construction Manager's written permission.
3. Comply with NFPA 70E.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.
1. SPD Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

F. Enclosures: Surface-mounted, dead-front cabinets.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
      b. Outdoor Locations: NEMA 250, Type 3R.
      c. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
      d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
      e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
   2. Height: 84 inches maximum.
   3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
   4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
   5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
   6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
   7. Finishes:
      a. Panels and Trim: galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
      b. Back Boxes: Galvanized steel
      c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

G. Incoming Mains:
   1. Location: Convertible between top and bottom
   2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

H. Phase, Neutral, and Ground Buses:
      a. Plating shall run entire length of bus.
      b. Bus shall be fully rated the entire length.
   2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
   3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
   4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
   5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
   6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.
7. Split Bus: Vertical buses divided into individual vertical sections.

I. Conductor Connectors: Suitable for use with conductor material and sizes.
   1. Material: [Tin-plated aluminum] [Hard-drawn copper, 98 percent conductivity].
   2. Terminations shall allow use of 75 deg C rated conductors without derating.
   3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
   4. Main and Neutral Lugs: [Compression] [Mechanical] type, with a lug on the neutral bar for each pole in the panelboard.
   5. Ground Lugs and Bus-Configured Terminators: [Compression] [Mechanical] type, with a lug on the bar for each pole in the panelboard.
   6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
   7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
   8. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.

J. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

K. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
   1. Percentage of Future Space Capacity: 20 percent.

L. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.
   1. Panelboards rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
   2. Panelboards rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

M. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
   1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
   2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.3 POWER PANELBOARDS

A. Panelboards: NEMA PB 1, distribution type.

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
   1. For doors more than 36 inches high, provide two latches, keyed alike.

C. Mains: Circuit breaker and Lugs only

D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

F. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
   1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
   2. External Control-Power Source: 120-V branch circuit.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

B. Mains: Circuit breaker or lugs only.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
   1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
   2. External Control-Power Source: 120-V branch circuit

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

F. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall
permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.5 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Directory card inside panelboard door, mounted in a metal frame with transparent protective cover
   1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
   1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards according to NEMA PB 1. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 INSTALLATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Comply with NECA 1.

C. Install panelboards and accessories according to NEMA PB 1.1.

D. Equipment Mounting:
   1. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete
   2. Attach panelboard to the vertical finished or structural surface behind the panelboard.
   3. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

G. Mount top of trim 90 inches above finished floor unless otherwise indicated.

H. Mount panelboard cabinet plumb and rigid without distortion of box.

I. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

J. Mount surface-mounted panelboards to steel slotted supports 1 1/4 inch in depth. Orient steel slotted supports vertically.

K. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.
   2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

L. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

M. Install filler plates in unused spaces.

N. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

O. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
P. Mount spare fuse cabinet in accessible location.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

D. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage optional tests. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Panelboards will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.
   1. Measure loads during period of normal facility operations.
   2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
   3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
   4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes MCCs for use with ac circuits rated 600 V and less, with combination controllers and having the following factory-installed components:

1. Automatic power transfer.
2. Feeder-tap units.
3. Measurement and control.
4. Auxiliary devices.
5. Panelboards.
6. Transformers.

1.3 DEFINITIONS

A. CPT: Control power transformer.
B. MCC: Motor-control center.
C. MCCB: Molded-case circuit breaker.
D. MCP: Motor-circuit protector.
E. OCPD: Overcurrent protective device.
F. PID: Control action; proportional plus integral plus derivative.
G. PT: Potential transformer.
H. SPD: Surge protective device.
I. SCR: Silicon-controlled rectifier.
J. VFD: Variable-frequency drive.
K. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
1.4 **ACTION SUBMITTALS**

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for MCCs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories for each cell of the MCC.

B. Shop Drawings: For each MCC, manufacturer's approval and production drawings as defined in UL 845. In addition to requirements specified in UL 845, include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
   a. Each installed unit's type and details.
   b. Factory-installed devices.
   c. Enclosure types and details.
   d. Nameplate legends.
   e. Short-circuit current (withstand) rating of complete MCC, and for bus structure and each unit.
   f. Features, characteristics, ratings, and factory settings of each installed controller and feeder device, and installed devices.
   g. Specified optional features and accessories.

2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring for each installed controller.

3. Nameplate legends.

4. Vertical and horizontal bus capacities.

5. Features, characteristics, ratings, and factory settings of each installed unit.

1.5 **INFORMATIONAL SUBMITTALS**

A. Standard Drawings: For each MCC, as defined in UL 845.

B. Production Drawings: For each MCC, as defined in UL 845.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around MCCs where pipe and ducts are prohibited. Show MCC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Qualification Data: For testing agency.

E. Seismic Qualification Certificates: For MCCs, accessories, and components, from manufacturer.
1. **Basis for Certification:** Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. **Dimensioned Outline Drawings of Equipment Unit:** Identify center of gravity and locate and describe mounting and anchorage provisions.

3. **Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.**

F. **Product Certificates:** For each MCC.

G. **Source quality-control reports.**

H. **Field quality-control reports.**

I. **Load-Current and Overload Relay Heater List:** Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

J. **Load-Current and List of Settings of Adjustable Overload Relays:** Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

K. **Sample Warranty:** For special warranty.

### 1.6 CLOSEOUT SUBMITTALS

A. **Operation and Maintenance Data:** For MCCs, all installed devices, and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

2. **Manufacturer's Record Drawings:** As defined in UL 845. In addition to requirements specified in UL 845, include field modifications and field-assigned wiring identification incorporated during construction by manufacturer, Contractor, or both.

3. **Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.**

4. **Manufacturer's written instructions for setting field-adjustable overload relays.**

5. **Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage, solid-state controllers.**

6. **Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.**

7. **Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.**

### 1.7 MAINTENANCE MATERIAL SUBMITTALS

A. **Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.**

1. **Power Fuses:** Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Indicating Lights: Two of each type and color installed.
4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA.
   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain MCCs and controllers of a single type from single source from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, and marked for intended use.

D. UL Compliance: MCCs shall comply with UL 845 and shall be listed and labeled by a qualified testing agency.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver MCCs in shipping splits of lengths that can be moved past obstructions in delivery paths.

B. Handle MCCs according to the following:
   1. NECA 402, "Recommended Practice for Installing and Maintaining Motor Control Centers."
   2. NEMA ICS 2.3, "Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600 Volts."

C. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside MCCs; install temporary electric heating, with at least 250 W per vertical section.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace MCC and SPD that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 MANUFACTURERS:
   A. Square D.
   B. Allen-Bradley.
   C. Or Approved Equal.

2.2 SYSTEM DESCRIPTION
   A. NEMA Compliance: Fabricate and label MCCs to comply with NEMA ICS 18.
   B. Ambient Environment Ratings:
      1. Ambient Temperature Rating: Not less than 0 deg F and not exceeding 104 deg F, with an average value not exceeding 95 deg F over a 24-hour period.
      2. Ambient Storage Temperature Rating: Not less than minus 4 deg F and not exceeding 140 deg F.
      3. Humidity Rating: Less than 95 percent (noncondensing).
      4. Altitude Rating: Not exceeding 6600 feet, or 3300 feet if MCC includes solid-state devices.
   C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 PERFORMANCE REQUIREMENTS
   A. Seismic Performance: MCCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
      1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
      2. Component Importance Factor: 1.5.
      3. Component Amplification Factor: 2.5.
   B. Capacities and Characteristics:
      1. MCC Enclosure and Assembly:
         b. Service Equipment Rated: Yes.
         c. Enclosure: NEMA 250, Type as indicated on the plans.
      2. Integrated Short-Circuit Rating for MCC:
         a. Fully rated; As indicated on the plans.
      3. Wiring Class: 3C.
4. Bus:
   a. Horizontal Bus: As indicated on the plans.

5. Main Disconnect Device:
   a. Main Disconnect: MCCB, UL 489, three pole, sized as shown on the plans. Manually operated, electrically tripped.
   b. SPD: UL 1449, Type 1.

Magnetic Controllers: As described in specification 262913.03 “MANUAL AND MAGNETIC MOTOR CONTROLLERS”.

6. Reduced-Voltage Solid-State Controllers: As described in specification 262913.06 “SOFT-START MOTOR CONTROLLERS”.

7. VFDs: As described in specification 262923 “VARIABLE FREQUENCY MOTOR CONTROLLERS”.

8. Controller-Mounted Auxiliary Devices:
   a. Push Buttons and Selector Switches: Heavy-duty, oiltight type.
   b. Feeder Tap Units: Main Disconnect: MCCB, UL 489, three pole, sized as indicated on the drawings. Manually operated, electrically tripped.

9. Panelboards: As indicated on the drawings and as described in specification 262416 “PANELBOARDS”.

10. Transformer(s): As indicated on the drawings and as described in specification 262200 “LOW-VOLTAGE TRANSFORMERS”.

2.4 ENCLOSURES

A. Indoor Enclosures: Freestanding steel cabinets unless otherwise indicated. NEMA 250, Type 12 unless otherwise indicated to comply with environmental conditions at installed location.

B. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
   1. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.
   2. Space-Heater Power Source: Transformer, factory installed in MCC.

C. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

D. Outdoor Enclosures: Type 3R, with interior-lighted walk-in aisle.
   1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
2. Enclosure: Downward, rearward sloping roof; bolt-on rear covers for each section, with provisions for padlocking.

3. Doors: Personnel door at each end of aisle, minimum width of 30 inches; opening outwards; with panic hardware and provisions for padlocking.

4. Accessories: Fluorescent lighting fixtures, ceiling mounted; wired to a three-way light switch at each end of aisle; GFCI duplex receptacle; emergency battery pack lighting fixture installed on wall of aisle midway between personnel doors.

5. Walk-in Aisle Heating and Ventilating:
   a. Factory-installed electric unit heater(s), wall or ceiling mounted, with integral thermostat and disconnect and with capacities to maintain switchboard interior temperature of 40 deg F with outside design temperature of plus 23 deg F.
   b. Factory-installed exhaust fan with capacities to maintain switchboard interior temperature of 100 deg F with outside design temperature of 104 deg F.
   c. Ventilating openings.
   d. Thermostat: Single stage; wired to control heat and exhaust fan.

6. Power for Space Heaters, Ventilation, Lighting, and Receptacle: Include a CPT within the switchboard. Supply voltage shall be 120-V ac.

7. Power for space heaters, ventilation, lighting, and receptacle supplied from a remote source.

2.5 ASSEMBLY

A. Structure:
   1. Comply with UL requirements for service entrance equipment.
   2. Units up to and including Size 3 shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
   3. Units in Type B and Type C MCCs shall have pull-apart terminal strips for external control connections.
   4. Pull Boxes:
      a. Include provisions for ventilation to maintain temperature in pull box within same limits as the MCC.
      b. Set the box back from front to clear circuit-breaker removal mechanism.
      c. Covers: Removable covers forming top, front, and sides.
      d. Insulated bottom of fire-resistive material with separate holes for cable drops into MCC.
      e. Cable Supports: Arranged to facilitate cabling and adequate to support cables, including supports for future cables.
      f. When equipped with barriers, supply with access to check bus bolt tightness.

B. Compartments: Modular; individual doors with concealed hinges and quick-captive screw fasteners.
   1. Interlock compartment door to require that the disconnecting means is "off" before door can be opened or closed, except by operating a concealed release device.
2. Compartment construction shall allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC.
3. The same-size compartments shall be interchangeable to allow rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.

C. Bus Transition and Incoming Pull Sections: Included and aligned with the structure of the MCC.

D. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC; same-size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.

E. Wiring Spaces:
   1. Vertical wireways in each vertical section for vertical wiring to each unit compartment; supports to hold wiring in place.
   2. Horizontal wireways in bottom of each vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.

F. Provisions for Future:
   1. Compartments marked "future" shall be bused, wired and equipped with guide rails or equivalent, and ready for insertion of drawout units.
   2. Compartments marked "spare" shall include provisions for connection to the vertical bus.

G. Integrated Short-Circuit Rating:
   1. Short-Circuit Current Rating of MCC: Fully rated with its main overcurrent device; as indicated on the plans.

H. Control Power:
   1. 120-V ac, supplied centrally from a CPT.
   2. 120-V ac; obtained from CPT integral with controller; with primary and secondary fuses. The CPT shall be of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
      a. CPT Spare Capacity: 100 VA.

I. Factory-Installed Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.
   1. Wiring Class: NEMA ICS 18, Class II, Type C.
   2. Control and Load Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.
   3. All terminations shall have ring or fork type terminals.
J. Bus:

1. Main Horizontal and Equipment Ground Buses: Uniform capacity for entire length of MCC's main and vertical sections. Provide for future extensions.
2. Vertical Phase and Equipment Ground Buses: Uniform capacity for entire usable height of vertical sections, except for sections incorporating single units.
3. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity or tin-plated, high-strength, electrical-grade aluminum alloy, with mechanical connectors for outgoing conductors.
4. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for ground conductors, minimum size 1/4-by-2 inches (6 by 50 mm). Equip with mechanical connectors for outgoing conductors.
5. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch (6-by-50-mm) copper bus, arranged to connect neutral bus to ground bus.
6. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Insulation temperature rating shall not be less than 105 deg C.

2.6 MAIN DISCONNECT AND OVERCURRENT PROTECTIVE DEVICE(S)

A. MCCB (to 2500 A): Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.

1. MCCB shall have quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, its position shall be shown by the position of the handle, and manual push-to-trip push button.
2. Solid-state monitoring and tripping system to show system status monitoring, adjustable time-current protection, and shunt trip.
   a. Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
   b. Trip-setting dials or interchangeable plugs to establish the continuous trip of the circuit breaker. Plugs shall not be interchangeable between frames, and the breaker may not be closed without the plug. With neutral ground-fault sensor.
   c. Time-current adjustments to achieve protective-device coordination as follows:
      1) Adjustable long-time delay.
      2) Adjustable short-time setting and delay to shape the time-current curve.
      3) Adjustable instantaneous setting.
      4) Individually adjustable ground-fault setting and time delay.
   d. Built-in connector to test the long-time delay, instantaneous, and ground-fault functions of the breaker.
   e. Built-in digital ammeter display, showing load current and tripping cause.
3. Switch operator power shall be from control power specified in "Assembly" Article.

B. MCCB (1600 to 2500 A): Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.
1. MCCB shall have quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, its position shall be indicated by the position of the handle, and manual push-to-trip push button.

2. Solid-state monitoring and tripping system to show system status monitoring, adjustable time-current protection, and shunt trip.
   a. Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
   b. LED indicators or display, with manual reset, to show reasons of automatic trip.
   c. Display panel to indicate the status of the system circuitry, or give fault location based on automatic diagnosis.
   d. Trip the circuit breaker when closing on a fault.
   e. Time-current adjustments to achieve protective-device coordination as follows:
      1) Adjustable long-delay pickup and time.
      2) Individual adjustments for short-delay pickup, time, and I-squared-t setting.
      3) Adjustable instantaneous pickup.
      4) Individually adjustable ground-fault pickup and time, with I-squared-t setting.
   f. One test kit to test each trip function.
   g. Battery backup for informational displays after automatic trip, with battery status indicator.

3. Switch operator power shall be from control power specified in "Assembly" Article.

C. Surge Suppression: Factory installed as an integral part of the incoming feeder, complying with UL 1449, SPD Type I.

2.7 CONTROLLER-MOUNTED AUXILIARY DEVICES


   a. Push Buttons: Covered types; momentary contact unless otherwise indicated.
   b. Pilot Lights: LED types; push to test.
   c. Selector Switches: Rotary type.

B. Elapsed-Time Meters: Heavy duty with digital readout in hours; resettable.

C. Meters: Panel type, 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy, with selector switches having an off position.

D. Auxiliary Dry Contacts: NO.

E. Control Relays:

1. Time Delay: Auxiliary and adjustable solid-state time-delay relays.

2.8 FEEDER TAP UNITS

A. MCCBs (to 1200 A): Fixed mounted, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger. Comply with UL 489, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

2. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long- and short-time time adjustments.
   d. Ground-fault pickup level, time delay, and \( I^2t \) response.
3. With built-in digital ammeter and a digital display, showing tripping cause.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
6. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
7. Alarm Switch: One NC contact that operates only when circuit breaker has tripped.
8. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.


1. Indication whether the switch is open or closed, and provisions for padlocking the operating handle.
2. Include fuse clips and fuses.
3. Electrically tripped switches shall include the following:
   a. Shunt trip.
   b. Ground-fault protection, with adjustable time delay and test panel.
   c. Single-phase protection, tripping the switch on loss of a source phase.
   d. Blown fuse protection, tripping the switch on a blown fuse, with blown fuse indication.
2.9 **PANELBOARDs**

A. Comply with NEMA PB 1.

B. Branch OCPDs for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

C. Branch OCPDs for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; or plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

D. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.


2.10 **TRANSFORMERS**

A. Factory-assembled and -tested, air-cooled, two-winding, low-voltage dry-type transformers; with primary circuit breaker. Comply with NEMA ST 20.

B. Taps for Transformers Smaller Than 3 kVA: One 5 percent tap above normal full capacity.

C. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.

D. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

E. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

F. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying with NEMA TP 1, Class 1 efficiency levels.
2. Tested according to NEMA TP 2.

2.11 **SOURCE QUALITY CONTROL**

A. MCC Testing: Test and inspect MCCs according to requirements in NEMA ICS 18.

B. VFD Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.

1. Test each VFD while connected to a motor that is comparable to that for which the VFD is rated.
2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

C. MCCs will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive MCCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. NEMA Industrial Control and Systems Standards: Comply with parts of NEMA ICS 2.3 for installation and startup of MCCs.

B. Floor Mounting: Install MCCs on 4-inch nominal-thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Seismic Bracing: Comply with requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install fuses in each fusible switch.

F. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

G. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

H. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

I. Install power factor correction capacitors. Connect to the line side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.

J. Comply with NECA 1.
3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification of MCC, MCC components, and control wiring.

1. Identify field-installed conductors, interconnecting wiring, and components.
2. Install required warning signs.
3. Label MCC and each cubicle with engraved nameplate.
4. Label each enclosure-mounted control and pilot device.
5. Mark up a set of manufacturer's connection wiring diagrams with field-assigned wiring identifications and return to manufacturer for inclusion in Record Drawings.

B. Operating Instructions: Frame printed operating instructions for MCCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of MCCs.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between master terminal boards and remote devices and facility's central-control system. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
2. Connect selector switches within enclosed controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 CONNECTIONS

A. Comply with requirements for installation of conduit in Section 260533 "Raceways and Boxes for Electrical Systems." Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.
D. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safety. Replace damaged and malfunctioning controls and equipment.
4. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multipole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multipole enclosed controller 11 months after date of Substantial Completion.
   c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Submit calibration record for device.
5. Test and adjust controls, remote monitoring, and safety. Replace damaged and malfunctioning controls and equipment.
6. Mark up a set of manufacturer's drawings with all field modifications incorporated during construction and return to manufacturer for inclusion in Record Drawings.

F. MCCs will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to NETA Acceptance Testing Specification and manufacturer's written instructions.

3.8 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload relay pickup and trip ranges.
B. Adjust overload relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager and Owner before increasing settings.

D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage, solid-state controllers.

E. Program microprocessors in VFDs for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

F. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers, and to use and reprogram microprocessor-based, reduced-voltage, solid-state controllers.

END OF SECTION 262419
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes work to accommodate utility company revenue meters,

1.3 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Construction Manager shall be notified and issued written permission no fewer than two days in advance of proposed interruption of electrical service.

1.4 COORDINATION

A. Electrical Service Connections:

1. Coordinate with utility companies and utility-furnished components.
   a. Comply with requirements of utility providing electrical power services.
   b. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 916.

C. Arc-Flash Warning Labels;

1. Labels: Comply with requirements for "Arc-Flash Warning Labels" in Section 260574 "Overcurrent Protective Device Arc-Flash Study." Apply a 3-1/2-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis.
2. **Labels**: Comply with requirements for "Self-Adhesive Equipment Labels" and "Signs" in Section 260553 "Identification for Electrical Systems." Apply a 3-1/2-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.
   a. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
      1) Location designation.
      2) Nominal voltage.
      3) Flash protection boundary.
      4) Hazard risk category.
      5) Incident energy.
      6) Working distance.
      7) Engineering report number, revision number, and issue date.

2.2 **ELECTRICITY METERS**

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written instructions. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

C. Install arc-flash labels as required by NFPA 70.

D. **Wiring Method:**
   1. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
   2. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 271513 "Communications Copper Horizontal Cabling."
   3. Minimum conduit size shall be 1¼ inches.

#### 3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
   1. **Series Combination Warning Label**: Self-adhesive labels, with text as required by NFPA 70.
   2. **Equipment Identification Labels**: Self-adhesive labels with clear protective overlay

#### 3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

3.4 DEMONSTRATION

A. Owner's clerical and maintenance personnel to use, adjust, operate, and maintain the electronic metering and billing software.

END OF SECTION 262713
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SECTION 262726
WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Straight-blade convenience, hospital-grade, isolated-ground, and tamper-resistant receptacles.
   2. GFCI receptacles.
   3. Hazardous (classified) location receptacles.
   4. Twist-locking receptacles.
   5. Cord and plug sets.
   6. Toggle switches.
   7. Wall plates.

1.3 DEFINITIONS

A. Abbreviations of Manufacturers' Names:
   1. Cooper: Cooper Wiring Devices; Division of Cooper Industries, Inc.

B. BAS: Building automation system.

C. EMI: Electromagnetic interference.

D. GFCI: Ground-fault circuit interrupter.

E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

F. RFI: Radio-frequency interference.

G. SPD: Surge protective device.

H. UTP: Unshielded twisted pair.
1.4 **ACTION SUBMITTALS**

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

1.5 **INFORMATIONAL SUBMITTALS**

A. Field quality-control reports.

1.6 **CLOSEOUT SUBMITTALS**

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.7 **MAINTENANCE MATERIAL SUBMITTALS**

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Service/Power Poles: One for every 10, but no fewer than one.
   2. Floor Service-Outlet Assemblies: One for every 10, but no fewer than one.
   3. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.
   4. SPD Receptacles: One for every 10 of each type installed, but no fewer than two of each type.

**PART 2 - PRODUCTS**

2.1 **GENERAL WIRING-DEVICE REQUIREMENTS**

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
   1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
   2. Devices shall comply with the requirements in this Section.

D. Devices for Owner-Furnished Equipment:
   1. Receptacles: Match plug configurations.
   2. Cord and Plug Sets: Match equipment requirements.
E. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STRAIGHT-BLADE RECEPTACLES

A. Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

B. Hospital-Grade, Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.

C. Isolated-Ground, Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
   1. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.3 USB CHARGER DEVICES

A. Tamper-Resistant, USB Charger Receptacles: 12 V dc, 2.0 A, USB Type A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 1310, and FS W-C-596.
   2. USB Receptacles: [Single] [Dual] [Quad], Type A.
   3. Line Voltage Receptacles: [Single] [Dual], two pole, three wire, and self-grounding.

B. Hospital-Grade, USB Charger Receptacles: 12 V dc, 2.0 A, USB Type A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, UL 1310, and FS W-C-596.
   1. Description: Labeled and complying with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.
   2. USB Receptacles Type A.

2.4 GFCI RECEPTACLES

A. General Description:
   1. 125 V, 20 A, straight blade, feed-through type.
   2. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A, and FS W-C-596.
   3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles:
2.5 **RECEPTACLES**

A. **General Description**: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 1449, and FS W-C-596, with integral SPD in line to ground, line to neutral, and neutral to ground.
   1. 125 V, 20 A, straight-blade type.
   2. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
   3. Active SPD Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."

2.6 **HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES**

A. **Hazardous (Classified) Locations Receptacles**: Comply with NEMA FB 11 and UL 1010


   1. Grounding: Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.7 **PENDANT CORD-CONNECTOR DEVICES**

A. **Description**:
   1. Matching, locking-type plug and receptacle body connector.
   2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
   4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.8 **CORD AND PLUG SETS**

A. **Description**:
   1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
   2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
2.9 **TOGGLE SWITCHES**

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:
   1. Single Pole:
   2. Two Pole:
   3. Three Way:
   4. Four Way:

C. Pilot-Light Switches: 120/277 V, 20 A.
   1. Description: Single pole, with LED-lighted handle, illuminated when switch is off.

D. Key-Operated Switches: 120/277 V, 20 A.
   1. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.

F. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

2.10 **WALL PLATES**

A. Single and combination types shall match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces: Type 302 stainless steel 0.04-inch-thick
   3. Material for Unfinished Spaces: Galvanized steel
   4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

PART 3 - EXECUTION

3.1 **INSTALLATION**

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:
   1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:
1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.
3.3 **IDENTIFICATION**

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with red-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 **FIELD QUALITY CONTROL**

A. Test Instruments: Use instruments that comply with UL 1436.

B. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

C. Perform the following tests and inspections
   1. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

D. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

E. Wiring device will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

**END OF SECTION 262726**
SECTION 262813

FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Cartridge fuses rated 600 V ac and less for use in the following:
      a. Control circuits.
      b. Enclosed switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
   1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
      a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
      b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
   2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
   4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in electronic format suitable for use in coordination software.
   5. Coordination charts and tables and related data.
   6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017700 "Closeout Procedures," Section 017823 "Operation and Maintenance Data," include the following:
   1. Ambient temperature adjustment information.
   2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in electronic format suitable for use in coordination software.

4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 or more than 100 deg F apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
   1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay. Type RK-5: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
   2. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, time delay.
   3. Type CD: 600-V, 31- to 60-A rating, 200 kAIC, time delay.
   4. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
   5. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
   6. Type T: [250-V, zero- to 1200-A] 600-V, zero- to 800- rating, 200 kAIC, time delay

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:
   1. Service Entrance: Class L, time delay Class RK1, time delay Feeders:Class L, time delay Motor Branch Circuits Class RK1, motor duty], time delay.
   2. Large Motor Branch (601-4000 A): Class L, time delay.
   3. Power Electronics Circuits: Class T, fast acting
   4. Other Branch Circuits: Class RK1, time delay Control Transformer Circuits: Class CC, time delay, control transformer duty.
   5. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813
SECTION 262816
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary
   Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Fusible switches.
   2. Non-fusible switch.
   3. Molded-case circuit breakers (MCCBs).
   4. Enclosures.

1.3 DEFINITIONS
A. NC: Normally closed.
B. NO: Normally open.
C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component
   indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and
   manufacturers' technical data on features, performance, electrical characteristics, ratings,
   accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series
      rating of installed devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent
      protective devices, accessories, and auxiliary components.
   6. Include time-current coordination curves (average melt) for each type and rating of
      overcurrent protective device; include selectable ranges for each type of overcurrent
      protective device. Provide in electronic format.
B. Shop Drawings: For enclosed switches and circuit breakers.
   1. Include plans, elevations, sections, details, and attachments to other work.
   2. Include wiring diagrams for power, signal, and control wiring.
1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
      b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in electronic format.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Fuse Pullers: Two for each size and type.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
   2. Altitude: Not exceeding 6600 feet.
1.10 WARRANTY
A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 GENERAL REQUIREMENTS
A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
D. Comply with NFPA 70.

2.3 FUSIBLE SWITCHES
A. Type HD, Heavy Duty:
   1. Single throw.
   2. Three pole.
   3. 600-V ac.
   4. 1200 A and smaller
   5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses.
   6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
B. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
   4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Auxiliary Contact Kit: [One] [Two] NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: [Mechanical] type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.

2.4 NONFUSIBLE SWITCHES

A. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

B. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
   4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   5. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating -120-V ac Hookstick Handle: Allows use of a hookstick to operate the handle.
   6. Lugs: Mechanical type, suitable for number, size, and conductor material.
   7. Service-Rated Switches: Labeled for use as service equipment.

2.5 MOLDED-CASE CIRCUIT BREAKERS

A. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

B. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

C. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated or series rated as indicated on the Drawings. Combinations for series connected interrupting ratings shall be listed by UL as recognized component combinations. Any series rated combination used shall be marked on the end-use equipment along with the statement "Caution - Series Rated System. MCCBs shall be equipped with a device for locking in the isolated position.

D. Lugs shall be suitable for 140 deg F rated wire on 125-A circuit breakers and below Standards: Comply with UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents.

F. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

G. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
   1. Instantaneous trip.
   2. Long- and short-time pickup levels.
   3. Long- and short-time time adjustments.
   4. Ground-fault pickup level, time delay, and I-squared t response.

H. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

I. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

J. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

K. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

L. Features and Accessories:
   1. Standard frame sizes, trip ratings, and number of poles.
   2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
   3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
   4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
   5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
   6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

2.6 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1)] gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (NEMA 250 Types 3R, 12), a brush finish on Type 304 stainless steel NEMA 250 Type 4-4X stainless steel copper-free cast aluminum alloy (NEMA 250 Types 7, 9).
C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.

D. Operating Mechanism: The circuit-breaker operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover and externally operable with the operating mechanism being an integral part of the cover (NEMA 250 Types 7, 9)]. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 PREPARATION

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Construction Manager's written permission.
4. Comply with NFPA 70E.

3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 4X.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7 with cover attached by Type 316 stainless steel bolts.

3.4 INSTALLATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install fuses in fusible devices.

F. Comply with NFPA 70 and NECA 1.

3.5 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Tests and Inspections for Switches:
   1. Visual and Mechanical Inspection:
      a. Inspect physical and mechanical condition.
      b. Inspect anchorage, alignment, grounding, and clearances.
      c. Verify that the unit is clean.
      d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
e. Verify that fuse sizes and types match the Specifications and Drawings.
f. Verify that each fuse has adequate mechanical support and contact integrity.
g. Inspect bolted electrical connections for high resistance using one of the two following methods:
   1) Use a low-resistance ohmmeter.
      a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
      a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
i. Verify correct phase barrier installation.
j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:
   a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.

e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

F. Tests and Inspections for Molded Case Circuit Breakers:
   1. Visual and Mechanical Inspection:
      a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
      b. Inspect physical and mechanical condition.
      c. Inspect anchorage, alignment, grounding, and clearances.
      d. Verify that the unit is clean.
      e. Operate the circuit breaker to ensure smooth operation.
      f. Inspect bolted electrical connections for high resistance using one of the two following methods:
         1) Use a low-resistance ohmmeter.
            a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
   a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
   g. Inspect operating mechanism, contacts, and chutes in unsealed units.
   h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical Tests:
   a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
   b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
   c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
   d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
   e. Determine the following by primary current injection:
      1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
      2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
      3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
      4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.
   f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.
   g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
   h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
i. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

4. Perform the following infrared scan tests and inspections and prepare reports:
   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
   c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

G. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

H. Prepare test and inspection reports.
   1. Test procedures used.
   2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
   3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.7 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

END OF SECTION 262816
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. Section includes soft-start motor controllers that are designed for reduced-voltage start and full-voltage run duty.
      1. Enclosed soft-start controllers.
      2. Combination soft-start controllers.
      4. Enclosures.
      5. Accessories.
      6. Identification.

1.3 DEFINITIONS
   A. CPT: Control power transformer.
   B. FLA: Full-load current.
   C. MCCB: Molded-case circuit breaker.
   D. MCP: Motor circuit protector.
   E. NC: Normally closed.
   F. NO: Normally open.
   G. OCPD: Overcurrent protective device.
   H. SCCR: Short-circuit current rating.
   I. SCPD: Short-circuit protective device.
   J. SCR: Silicon-controlled rectifier.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product.
1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each type of controller.
   1. Include plans, elevations, sections, and mounting details.
   2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
   3. Wire Termination Diagrams and Schedules: Include diagrams for signal and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
   4. Include features, characteristics, ratings, and factory settings of individual OCPD and auxiliary components.

C. Product Schedule: For each enclosed controller.
   1. Each installed soft-start controller type.
   2. NRTL listing.
   3. Factory-installed accessories.
   5. SCCR of integrated unit.
      a. For each combination soft-start controller, include features, characteristics, ratings, and factory setting of the SCPD and OCPD.
         1) Listing document proving Type 2 coordination.
      b. For each series-rated combination, state the listed integrated SCCR (withstand) of SCPDs and OCPDs by an NRTL acceptable to authorities having jurisdiction.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Seismic Qualification Data: Certificates, for soft-start controllers, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source quality-control reports.

D. Field quality-control reports.
1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For soft-start controllers to include in operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   a. Routine maintenance requirements for soft-start controllers and installed components.
   b. Manufacturer's written instructions for testing and adjusting circuit-breaker and MCP trip settings.
   c. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage soft-start controllers.
   d. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate FLAs.
   e. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Indicating Lights: Two of each type and color installed.
4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store soft-start controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect soft-start controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
B. If stored in areas subject to weather, cover soft-start controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 50 W per controller.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 32 deg F and not exceeding 104 deg F, humidity noncondensing.
2. Altitude: Not exceeding 3300 feet.
3. The effect of solar radiation is insignificant.

PART 2 - PRODUCTS

2.1 MOTOR CONTROLLER PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. UL Compliance: Fabricate and label enclosed controllers to comply with UL 508.

C. NEMA Compliance: Fabricate motor controllers to comply with NEMA ICS 2.

D. Seismic Performance: Soft-start controllers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Component Importance Factor: 1.5.

2.2 ENCLOSED SOFT-START MOTOR CONTROLLERS

A. Description: Controllers designed for reduced-voltage start, full-voltage run, and optional soft stop. The controller shall be an integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and user interface module, run-bypass contactor, and overload relay(s); suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.

1. Run-Bypass Contactor: Magnetic contactor in parallel with the SCR of the soft-start controller, bypassing the SCR when full voltage is achieved.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D; by Schneider Electric.
3. GE.
4. Eaton.
5. Engineer Approved Equal.

C. Standard: Comply with NEMA ICS 2, general purpose, Class A.

D. Configuration: Severe Duty.
   1. At least two SCRs per phase to control the starting and stopping of the motor.
   2. Microprocessor control shall continuously monitor current and proper operation of the SCRs.
   3. Bypass Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Soft-start controller protective features and deceleration controls shall remain active when this contactor is in the bypass mode.
   4. Power Electronics Disconnect Contactor. Where indicated, installed ahead of the power electronics equipment, and shall open automatically when the motor is stopped, or a controller fault is detected, or when an SCR shorts.
   5. Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.

E. Control Power:
   1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
   2. Spare CPT Capacity: As indicated on Drawings, available in increments of 100 VA, from 100 to 500 VA.

F. Controller Diagnostics and Protection:
   1. Microprocessor-based thermal-protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
   2. Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and under-load conditions; and line frequency over or under normal.
   3. Input isolation contactor that opens when the controller diagnostics detect a faulted soft-start component or when the motor is stopped.

G. Cover mounted-controller status panel with LED lights or alphanumeric display to show the following:
   1. Starter Status: "Ready," "starting," "stopping," or "run."
   3. Faults:
      a. Motor overcurrent trip.
      b. Motor thermal overload.
      c. Starter thermal fault.
      d. Low line voltage.
e. Loss of a phase.
f. Phases reversed.
g. Maximum starting time exceeded.
h. Serial communications error.

H. Interface Panel: Mounted on controller door.

1. Guarded adjustable set points, not readily accessible.
   a. Motor FLA, adjustable from 40 to 110 percent of the controller's rating.
   b. Current limitation on starting, adjustable from 200 to 500 percent of FLA, typically set at 300 percent.
   c. NEMA ICS 2 overload class. Selections shall include the following tripping classes: Class 5, Class 10, Class 15, Class 20, and Class 30.

2. Adjustable set points, readily accessible, password protected.
   a. Linear acceleration, adjustable from 1 to 60 s.
   b. Maximum start time, adjustable from 1 to 250 s.
   c. Selector switch; select coast to stop or soft stop.
   d. Linear deceleration, adjustable from 1 to 60 s.

I. Remote Output Features. All outputs shall be prewired to terminal blocks.

1. Analog output for field-selectable assignment of motor operating characteristics; 4- to 20-mA dc.
2. Form C status contacts that change state when controller is running.
3. Form C alarm contacts that change state when a fault condition occurs.

J. Digital Communication Module: EthernetIP to transmit the following to the LAN:

1. Instantaneous root mean square (rms) current each phase, and three-phase average.

2.3 COMBINATION SOFT-START MOTOR CONTROLLERS

A. Description: Factory-assembled, combination, reduced-voltage soft-start controller with a disconnecting means, SCPD and OCPD, in a single enclosure. The reduced-voltage soft-start controller shall consist of an integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and user interface module, run-bypass contactor, and overload relay(s); suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.

1. Run-Bypass Contactor: Magnetic contactor in parallel with the SCR of the soft-start controller, bypassing the SCR when full voltage is achieved.
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Square D; by Schneider Electric.
   2. Rockwell Automation, Inc.
   3. Engineer Approved Equal.

C. Standard: Comply with NEMA ICS 2, general purpose, Class A.

D. Configuration: Severe Duty.
   1. At least two SCRs per phase to control the starting and stopping of the motor.
   2. Microprocessor control shall continuously monitor current and proper operation of the SCRs.
   3. Bypass Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Soft-start controller protective features and deceleration controls shall remain active when this contactor is in the bypass mode.
   4. Power Electronics Disconnect Contactor. Where indicated, installed ahead of the power electronics equipment, and shall open automatically when the motor is stopped, or a controller fault is detected, or when an SCR shorts.
   5. Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.

E. Control Power:
   1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
   2. Spare CPT Capacity: As indicated on Drawings, available in increments of 100 VA, from 100 to 500 VA.

F. Controller Diagnostics and Protection:
   1. Microprocessor-based thermal-protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
   2. Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and under-load conditions; and line frequency over or under normal.
   3. Input isolation contactor that opens when the controller diagnostics detect a faulted soft-start component or when the motor is stopped.

G. Cover mounted-controller status panel with LED lights or alphanumeric display to show the following:
   1. Starter Status: "Ready," "starting," "stopping," or "run."
   3. Faults:
      a. Motor overcurrent trip.
      b. Motor thermal overload.
      c. Starter thermal fault.
d. Low line voltage.
e. Loss of a phase.
f. Phases reversed.
g. Maximum stating time exceeded.
h. Serial communications error.

H. Interface Panel: Mounted on controller door.

1. Guarded adjustable set points, not readily accessible.
   a. Motor FLA, adjustable from 40 to 110 percent of the controller's rating.
   b. Current limitation on starting, adjustable from 200 to 500 percent of FLA, typically set at 300 percent.
   c. NEMA ICS 2 overload class. Selections shall include the following tripping classes: Class 5, Class 10, Class 15, Class 20, and Class 30.

2. Adjustable set points, readily accessible, password protected.
   a. Linear acceleration, adjustable from 1 to 60 s.
   b. Maximum start time, adjustable from 1 to 250 s.
   c. Selector switch; select coast to stop or soft stop.
   d. Linear deceleration, adjustable from 1 to 60 s.

I. Remote Output Features: All outputs shall be prewired to terminal blocks.

1. Analog output for field-selectable assignment of motor operating characteristics; 4- to 20-mA dc.
2. Form C status contacts that change state when controller is running.
3. Form C alarm contacts that change state when a fault condition occurs.

J. Digital Communication Module: EthernetIP to transmit the following to the LAN:

1. Instantaneous rms current each phase, and three-phase average.

K. MCP Disconnecting Means:

1. UL 489 and NEMA AB 3 (with interrupting capacity to comply with available fault currents) instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
3. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
4. NC alarm contact that operates only when MCP has tripped.
   a. Current-limiting module to increase controller SCCR (withstand) to 100 kA.
2.4 ENCLOSURES

A. Comply with NEMA 250, Type designations as indicated on Drawings, to comply with environmental conditions at installed location.

B. Construction of the enclosures shall comply with NEMA ICS 6.

C. Controllers in hazardous (classified) locations shall comply with UL 1203.

2.5 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Standard duty, except as needed to match enclosure type. Heavy-duty or oiltight where indicated in the controller schedule.

   a. Push Buttons: As indicated in the controller schedule.
   b. Pilot Lights: As indicated in the controller schedule.

2. Elapsed Time Meters: Heavy duty with digital readout in hours; resetable.

3. Meters: Panel type, 2-1/2-inch minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy. Where indicated, provide selector switches with an off position.

B. Breather assemblies, to maintain interior pressure and release condensation in Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

C. Space heaters, with NC auxiliary contacts, to mitigate condensation in Type 3R or Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

D. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

2.6 IDENTIFICATION

A. Controller Nameplates: Metal-backed, butyrate signs, as described in Section 260553 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.
3.2 INSTALLATION

A. Comply with NECA 1.

B. Wall-Mounted Controllers: Install controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on slotted support systems complying with Section 260529 "Hangers and Supports for Electrical Systems," and bolted to wall.

C. Freestanding Controllers: Provide slotted support systems complying with Section 260529 "Hangers and Supports for Electrical Systems."

D. Floor-Mounted Controllers: Install controllers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

E. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

F. Control Wiring: Separate control wiring from power wiring. Where unavoidable, use twisted pair cabling or shielded cables for control wiring.

G. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

H. Setting of Overload Relays: Select and set overloads on the basis of FLA rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for high-torque, high-efficiency, and so on motors.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Tests and Inspections:

2. Visual and Mechanical Inspection:
a. Compare equipment nameplate data with Drawings and the Specifications.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, and grounding.
d. Verify that the unit is clean.
e. Ensure that vent path openings are free from debris and that heat-transfer surfaces are clean.
f. Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.
g. Inspect Contactors:
   1) Verify mechanical operation.
   2) Verify that contact gap, wipe, alignment, and pressure are according to manufacturer's published data.

h. Motor-Running Protection:
   1) Verify that motor FLA is at, or under, the controller current rating.
   2) Verify that overload element setting is correct for its application.
   3) Apply minimum- and maximum-speed set points. Verify that set points are within limitations of the load coupled to the motor.
   4) If motor-running protection is provided by fuses, verify correct fuse rating.

i. Inspect bolted electrical connections for high resistance using one of the following two methods:
   1) Use a low-resistance ohmmeter. Compare bolted-connection-resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.

j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

3. Electrical Tests:

a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS, Table 100.1. In the absence of manufacturer's published data, use Table 100.5. Values of insulation resistance less than this table or manufacturer's written instructions shall be investigated and corrected.

b. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.

c. Test motor protection devices according to manufacturer's published data.

d. Test circuit breakers as follows:
1) Operate the circuit breaker to ensure smooth operation.
2) For adjustable circuit breakers, adjust protective device settings according to the coordination study. Comply with coordination study recommendations.

e. Test the electronic motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.

f. Test the following parameters according to NETA relay calibration procedures, or as recommended by manufacturer:

1) ANSI No. 49R, Overtemperature Protection:
   a) Determine time delay at 300 percent of setting.
   b) Determine a second point on the operating curve.
   c) Determine pickup.

2) ANSI No. 47, Input Phase Loss and Reversed Phases Protection:
   a) Determine positive sequence voltage to close the NO contact.
   b) Determine positive sequence voltage to open the NC contact (undervoltage trip).
   c) Verify negative sequence trip.
   d) Determine time delay to close the NO contact with sudden application of 120 percent of pickup.
   e) Determine time delay to close the NC contact on removal of voltage when previously set to rated system voltage.

3) ANSI No. 81, Overfrequency Protection:
   a) Verify frequency set points.
   b) Determine time delay.
   c) Determine undervoltage cutoff.

4) Fault Alarm Outputs: Verify that each relay contact performs its intended function in the control scheme including breaker trip tests, close inhibit tests, lockout tests, and alarm functions.

g. Perform operational tests by initiating control devices.

4. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove all necessary covers prior to the inspection.

   b. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of each motor controller.
   c. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each motor controller 11 months after date of Substantial Completion.
   d. Report of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used, and lists the following results:
1) Description of equipment to be tested.
2) Discrepancies.
3) Temperature difference between the area of concern and the reference area.
4) Probable cause of temperature difference.
5) Areas inspected. Identify inaccessible and unobservable areas and equipment.
6) Identify load conditions at time of inspection.
7) Provide photographs and thermograms of the deficient area.
8) Recommended action.

e. Equipment: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1°C at 30°C. The equipment shall detect emitted radiation and convert detected radiation to a visual signal.
f. Act on inspection results, recommended action, and considering recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

F. Motor controllers will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.5 SYSTEM FUNCTION TESTS

A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality-control tests have been completed and all components have passed specified tests.

1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
3. Verify the correct operation of sensing devices, alarms, and indicating devices.

B. Motor controllers will be considered defective if they do not pass the system function tests and inspections.

C. Prepare test and inspection reports.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor controllers.

END OF SECTION 262913.06
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SECTION 263000
DUPLEX CONTROL PANEL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

B. Related work specified elsewhere includes:
   1. Division 11 – Equipment
   2. Section 16000 – Electrical
   3. Section 16060 – Grounding and Bonding
   4. Section 16075 – Electrical Identification
   5. Section 16120 – Conductors and Cables

1.2 SUMMARY

A. This section includes the requirements for the (2) Two Duplex Pump Control Panels at the Evergreen WWTP.

1.3 SUBMITTALS

A. Submit the following information in accordance with Section 01330, Section 01782 and Section 16000:
   1. Shop Drawings showing layout and dimensions
   2. Product Data
   3. Installation Instructions
   4. O&M Manuals

PART 2 - PRODUCTS

2.1 DUPLEX PUMP CONTROL PANEL

A. Each pump control panel shall be housed in a NEMA 4X cabinet with back panel and hinged inner-door and including external feet for mounting to galvanized equipment mounting frame. All components shall have a UL label for purpose intended and the panel shall be UL listed in compliance with UL508A. The panel shall also be constructed in accordance with NFPA 70E. Heat generated by all equipment shall be accounted for and ventilation supplied so as not to exceed 40 degree C ambient operating temperature. Panel Supplier shall submit heat load calculations and ventilation requirement calculations for verification by Engineer. Cabinets by Schaefer, Hoffman, Rittal or equal.

B. A control power panel Siemens # 1 1224 ML 1 125 CU back plate complete with ground bar and neutral bar. The control power panel shall be equipped with one (1) 30 Amp 2 pole main breaker, seven (7) Siemens # QP110 breakers for the following: level controller, GFI maintenance receptacle, control circuit, space
heater, future SCADA equipment, and two (2) spares for future use and 1-QP115 15 Amp 1 pole for the ventilation unit. Each control device shall be connected to its respective breaker with #14 AWG conductors, unless otherwise noted on the plans. The back panel shall be mounted so that the circuit breakers extend through the inner door of the pump control panel. Each circuit shall be numbered and identified with a nameplate. A typed directory shall be laminated and mounted to the inside of the outer door.

C. A power distribution block shall be installed to accept three feeds in a range of #14 - #2 incoming line conductors. The distribution side shall have a minimum of 6 branches with a range of #14-#2. Square D Class 9080 LB series or equal by Bussman or Phoenix Contact.

D. A green run pilot shall be provided for each pump. Siemens #52PE4C3, 30mm type, as well as, a red motor failure pilot, an amber pump seal failure pilot for each pump. Also, provide a blue “Hi-HI” level pilot, and a white normal power on pilot, or equal by SquareD or Cutler-Hammer.

E. An alarm horn and strobe light mounted on the top of the pump controller shall be an Edwards #48FIN series weather-proof type shall activate if the following occurs:

   1. Pump #1 Fails  
   2. Pump #1 Seal Leaks  
   3. Pump #2 Fails  
   4. Pump #2 Seal Leaks  
   5. High Level Alarm  
   6. Low level Alarm

F. A hand-off-automatic switch for each pump shall be provided on the inner door. Siemens #52SXBA/2-52BAK or equal complete with all contact blocks required or equal by SquareD or Cutler-Hammer.

G. The control relays required shall be Siemens #3TX 71 plug-in type with socket base with number of poles and contacts as required to perform functions desired or equal by SquareD or Cutler-Hammer.

H. A space heater with thermostat shall be furnished to prevent moisture from accumulating in the control panel and connected to the control power panel. Rating shall not exceed 200 watts at 120V.

I. All control and power conductors from each component shall terminate in numbered terminal blocks equal to Siemens #8WA2, SquareD or Cutler-Hammer with box lugs sized as required din rail mounted. A point-to-point number wiring diagram shall be supplied showing internal and remote interconnections with each control panel in a seal pouch inside each unit. All wiring to be numbered at both terminations and a descriptive list made of the numbered terminations shall be supplied.

J. A phase failure relay shall be installed to monitor the power to the panel. Loss of phase shall signal loss of phase and phase sequence monitoring reversal signal to the controller and stop the pumps from running. The relay shall be Siemens #3UG30-13-1BP60 series or approved equal by SquareD or Cutler-Hammer.
K. An elapsed time meter for each pump motor shall be provided on the inner/door. The flush mounted gasketed hour meter shall provide runtime indication up to 99,999.9 hours. The display shall have a 4.8mm x 10.6mm 6 digit LCD display 120 volt. The unit shall be ENM, Omron, Honeywell or Eaton complete with all mounting hardware.

L. Starters: None required

M. A Ground Fault 15 Amp, 120V receptacle P&S #1594 shall be mounted on the inner door for maintenance purposes and connected to the control power panel.

N. A seal fail and temperature Relay furnished by CSI or approved equal pump manufacturer, shall be installed and wired per manufacturers’ instructions for each pump in the control panel. The pump control panel shall be equipped to terminate the operation of any pump due to a high motor winding temperature, or the presence of moisture in the motor housing. Should either of these events occur, the respective soft starter in the MCC shall drop out and a mechanical indicator, visible on the inner door, will indicate the pump motor has been shutdown. Pump motors shall remain locked out until the condition has been corrected and the circuit manually reset. Automatic reset of protection circuitry is not considered acceptable.

O. Liquid Level Control System Panel

1. An automatic level control system shall be provided to start and stop the pump motors in response to sensed changes in wet well level(s), as set forth herein. The controller shall be capable of sensing wet well level via a 4-20 mA input from a level transducer one (1) in each wet well and be capable of controlling the number of pumps shown on the plans. The controller shall be capable of alternating the pumps to equalize run times, selecting which pumps are available to run based on wet well level, and limit the number of pumps running to prevent damage to the pipe system. The anticipated sequence of operation shall be as follows:
   a. Normal system operation shall be to start the lead pump when the liquid level rises to the “Lo” start level. The pump motor shall be energized and the water pumped down to a “Lo-Lo” stop level, after which the lead and lag pump position shall be switched via the controller/alternator relay.
   b. Should the lead pump not be able to keep up with the incoming flow rate and the water level in the wet well continues to rise, the controller shall turn on the lag pump when the liquid reaches the “Hi” level. The pump shall continue to run at until the “Lo-Lo” stop level is reached after which the lead and lag pump position shall be switched via the controller/alternator relay.

2. Additionally, a set point shall be provided to detect a “high level” condition in the wet well, and an external alarm light shall be energized whenever this level is reached. Alarm indication shall remain energized until manually reset.
3. Also, any level in the wet well below the “common pump stop” level shall cause a deactivation of the pumps.
4. The controller shall be the CSI# DC101 controller, or Engineer approved equal.

P. Submersible Level Sensor:

1. The liquid level of the wet well shall be sensed by a submersible level transducer. The transducer shall be a 3-wire type to operate from a supply voltage of 10.5 to 24 VDC and
produce a 4-20 mA instrumentation signal in direct proportion to the measured level excursion over a factory-calibrated range of as directed by the Engineer or as indicated on plans. The transducer shall be the head-pressure sensing type, suitable for continuous submergence and operation, and shall be installed in accordance with the manufacturer's instructions. The bottom diaphragm face of the sensor shall be installed as shown on the process plans. The sensor shall be mounted using a vertical 1" stainless steel pipe in a location as shown on the Plans. 316 stainless steel pipe mounting clamps shall be provided by the manufacturer to suspend and fix the transducer in the proper position as shown on the Plans. The transducer shall be FMX21 series by Endress & Hauser, equal by KPSI, or Engineer Approved Equal.

2. The transducer housing shall be fabricated of type 316 stainless steel. The diaphragm shall be a 2-5/8" diameter molded Buna N synthetic rubber. The internal pressure to the lower transducer assembly shall be relieved to atmospheric pressure by means of a heavy-duty urethane jacketed hose/cable assembly and a slack PVC bellows mounted in the control panel enclosure. This breather system shall compensate for variations in barometric pressure and expansion and contraction of air due to temperature changes and altitude as well as prevent fouling from moisture and other corrosive elements. The Electronics and Breather System shall be mounted in a separate enclosure with a hazardous location boundary seal between the enclosure and the Pump Control Panel enclosure.

3. The transducer shall utilize a variable-capacitance transducer element to convert the sensed pressure to a corresponding electrical value. The sensed media shall exert pressure against the diaphragm which shall flex minutely to vary the proximity between an internal ceramic diaphragm and a ceramic substrate which shall vary the capacitance of an electrical field created between the two surfaces. A stable, hybrid, operational amplifier assembly shall be incorporated in the transducer to excite and demodulate the sensing mechanism. The transducer shall incorporate laser-trimmed, temperature compensated high quality components and construction to provide a precise, reliable, and stable output signal directly proportional to the sensed pressure over the specified factory-calibrated range.

Q. The transducer/transmitter shall include easily accessible offset and span adjustments in the upper assembly. Span shall be adjustable from 100% down to 15% of the sensor range. Fine and coarse adjustments for both span and offset shall be provided, using 25-turn potentiometers. Offset and span adjustments shall be non-interactive for ease of calibration.

R. Float Switches:

1. A total of four (4) float switches for each wet well will be provided with each pump control panel. Each with adequate cable to reach the panel without splicing. Switches shall be the direct-acting type, designed and constructed for extremely long life in severe applications. Each switch shall contain a single pole mercury switch in the normally open position, which shall close when the switch body is tilted. Switches shall be epoxy encapsulated, and the level sensors shall be impact and corrosion resistant.

2. The switch housing shall be fabricated of 316 stainless steel, and shall be provided with a Teflon coating to reduce the buildup of grease and other materials. #14/3 AWG Hypalon-jacketed Type SO cable shall be provided with each float switch, of the length as noted above. Cable shall have a minimum of 105 strands of copper in each conductor for maximum flexibility. A green ground wire shall also be included in the cable for each float switch, and shall be connected to the ground terminals in the pump control panel. Float switch contacts shall be rated for 20 amps @ 120VAC.
3. Each float switch shall be provided with the necessary hardware to be securely mounted on a 1/8” diameter 316 stainless steel mounting cable. A suitable weight kit shall be attached to the bottom of the float switch suspension cable to secure both the cable and the float in the wet well, and to prevent excessive movement. The float switch connection hardware shall be adjustable to allow repositioning in the wet well as required. The entire float assembly (weight, support cable, and all switches) shall be easily removed from the wet well for inspection, cleaning, or adjustment as required. Mounting hardware shall be included for installation of the float switches on the support cable assembly.

4. Float switches shall be Model P40NO-SST, manufactured by Anchor Scientific, Inc. or approved equal as manufactured by Consolidated Electric. A suitable support bracket shall be provided with the wet well access cover, for securing the switch support cable to the top of the wet well. The bracket shall be fabricated of 304 stainless steel.

S. Intrinsically Safe Barrier:

1. All level sensing devices (i.e. transducer, float switch, etc.) shall be provided with an intrinsically safe barrier to prevent potentially hazardous voltages from being introduced into the wet well. It shall not hinder the sensing function of the sensing device in any way.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install Duplex Control Panel in accordance with manufacturer’s recommendation and as shown on drawings.

END OF SECTION 263000
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SECTION 263600
TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes automatic transfer switches rated 600 V and less

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
   2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.
B. Shop Drawings:
   1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
   2. Include material lists for each switch specified.
   3. Single-Line Diagram: Show connections between transfer switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
   4. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For manufacturer-authorized service representative.
B. Seismic Qualification Certificates: For transfer switches, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
C. Field quality-control reports.
1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   a. Features and operating sequences, both automatic and manual.
   b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications:

1. Member company of NETA.
   a. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Construction Manager's written permission.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA ICS 1.

C. Comply with NFPA 99.

D. Comply with NFPA 110.

E. Comply with UL 1008 unless requirements of these Specifications are stricter.
F. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

G. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
   1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
   2. Short-time withstand capability for 30 cycles.

H. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

I. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

J. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

K. Service-Rated Transfer Switch:
   1. Comply with UL 869A and UL 489.
   2. Provide terminals for bonding the grounding electrode conductor to the grounded service conductor.
   3. In systems with a neutral, the bonding connection shall be on the neutral bus.
   4. Provide removable link for temporary separation of the service and load grounded conductors.
   5. Surge Protective Device: Service rated.

L. Neutral Terminal: Solid and fully rated unless otherwise indicated.

M. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.

N. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.

O. Battery Charger: For generator starting batteries.
   1. Float type, rated 10 A.
   2. Ammeter to display charging current.
   3. Fused ac inputs and dc outputs.

P. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.
Q. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable with printed tape markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."
   1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
   2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
   3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
   4. Accessible via front access.

R. Enclosures: General-purpose NEMA Type 3R, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
   1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
   2. Switch Action: Double throw; mechanically held in both directions.
   3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
   4. Conductor Connectors: Suitable for use with conductor material and sizes.
   5. Material: Hard-drawn copper, 98 percent conductivity
   6. Main and Neutral Lugs: Mechanical type.
   7. Ground Lugs and Bus-Configured Terminators: Mechanical type.
   8. Ground bar.
   9. Connectors shall be marked for conductor size and type according to UL 1008.

C. ATS shall be equipped with a main circuit breaker, sized accordingly to the switch and as indicated in the plans and specifications, on the main incoming utility power feed connection.

D. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.
   1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.

E. Automatic Delayed-Transition Transfer Switches: Pauses or stops in intermediate position to momentarily disconnect both sources, with transition controlled by programming in the automatic transfer-switch controller. Interlocked to prevent the load from being closed on both sources at the same time.
   1. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals for alternative source. Adjustable from zero to six seconds, and factory set for one second.
   2. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
   3. Fully automatic break-before-make operation with center off position.
   4. Fully automatic break-before-make operation with transfer when two sources have near zero phase difference.
2.3 **SOURCE QUALITY CONTROL**

A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

B. Prepare test and inspection reports.
   1. For each of the tests required by UL 1008, performed on representative devices, for systems. Include results of test for the following conditions:
      a. Overvoltage.
      b. Undervoltage.
      c. Loss of supply voltage.
      d. Reduction of supply voltage.
      e. Alternative supply voltage or frequency is at minimum acceptable values.
      f. Temperature rise.
      g. Dielectric voltage-withstand; before and after short-circuit test.
      h. Overload.
      i. Contact opening.
      j. Endurance.
      k. Short circuit.
      l. Short-time current capability.
      m. Receptacle withstand capability.
      n. Insulating base and supports damage.

**PART 3 - EXECUTION**

3.1 **INSTALLATION**

A. Floor-Mounting Switch:
   1. Provide workspace and clearances required by NFPA 70.

B. Identify components according to Section 260553 "Identification for Electrical Systems."

C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

D. Comply with NECA 1.

3.2 **CONNECTIONS**

A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, motor controls, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

   1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Connect twisted pair cable according to Section 260523 "Control-Voltage Electrical Power Cables."

G. Connect twisted pair cable according to Section 271513 "Communications Copper Horizontal Cabling."

H. Brace and support equipment according to Section 260548.16 "Seismic Controls for Electrical Systems."

I. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches in length.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. After installing equipment, test for compliance with requirements according to NETA ATS.
   2. Visual and Mechanical Inspection:
      a. Compare equipment nameplate data with Drawings and Specifications.
      b. Inspect physical and mechanical condition.
      c. Inspect anchorage, alignment, grounding, and required clearances.
      d. Verify that the unit is clean.
      e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
      f. Verify that manual transfer warnings are attached and visible.
      g. Verify tightness of all control connections.
      h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:
         1) Use of low-resistance ohmmeter.
         2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.
      i. Perform manual transfer operation.
      j. Verify positive mechanical interlocking between normal and alternate sources.
      k. Perform visual and mechanical inspection of surge arresters.
      l. Inspect control power transformers.
         1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.

3. Electrical Tests:
   a. Perform insulation-resistance tests on all control wiring with respect to ground.
   b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
   c. Verify settings and operation of control devices.
   d. Calibrate and set all relays and timers.
   e. Verify phase rotation, phasing, and synchronized operation.
   f. Perform automatic transfer tests.
   g. Verify correct operation and timing of the following functions:
      1) Normal source voltage-sensing and frequency-sensing relays.
      2) Engine start sequence.
      3) Time delay on transfer.
      4) Alternative source voltage-sensing and frequency-sensing relays.
      5) Automatic transfer operation.
      6) Interlocks and limit switch function.
      7) Time delay and retransfer on normal power restoration.
      8) Engine cool-down and shutdown feature.

   a. Check for electrical continuity of circuits and for short circuits.
   b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
   c. Verify that manual transfer warnings are properly placed.
   d. Perform manual transfer operation.

5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.
   a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
   b. Simulate loss of phase-to-ground voltage for each phase of normal source.
   c. Verify time-delay settings.
   d. Verify pickup and dropout voltages by data readout or inspection of control settings.
   e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
   f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
   g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

   a. Verify grounding connections and locations and ratings of sensors.

D. Coordinate tests with tests of generator and run them concurrently.
E. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

F. Transfer switches will be considered defective if they do not pass tests and inspections.

G. Remove and replace malfunctioning units and retest as specified above.

H. Prepare test and inspection reports.

I. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
   1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
   3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

C. Coordinate this training with that for generator equipment.

END OF SECTION 263600
SECTION 264313
SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes SPDs for low-voltage power, control, and communication equipment.
B. Related Sections include the following:
   1. Division 26 Section "Wiring Devices" for devices with integral SPDs.
   2. Division 26 Section "Switchboards" for factory-installed SPDs.
   3. Division 26 Section "Panelboards" for factory-installed SPDs.

1.3 DEFINITIONS
B. SVR: Suppressed voltage rating.
C. TVSS: Transient voltage surge suppressor (known now as SPD.)
D. SPD: Surge Protection Device

1.4 SUBMITTALS
A. Product Data: For each type of product indicated. Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.
B. Product Certificates: For transient voltage suppression devices, signed by product manufacturer certifying compliance with the following standards:
   1. UL 1283.
   2. UL 1449 3rd edition.
C. Qualification Data: For testing agency.
D. Field quality-control test reports, including the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Failed test results and corrective action taken to achieve requirements.
E. Operation and Maintenance Data: For transient voltage suppression devices to include in emergency, operation, and maintenance manuals.

F. Warranties: Special warranties specified in this Section.

SCHEDULE 1 - Provide test reports from a recognized independent testing laboratory verifying the COMPLETE SPD will survive the published and specified maximum surge current rating. Test reports will clearly show that all components that make up a COMPLETE system were included in these tests (including but not limited to all necessary fuses, thermal disconnects, integral disconnects and monitoring systems).

SCHEDULE 2 - Provide data confirming that the SPD will survive the published and specified repetitive surge current rating (longevity characteristic).

SCHEDULE 3 - Per the requirements of NEC Article 285.6, provide test data demonstrating that the SPD is capable of surviving the published and specified short circuit current capability (AIC rating) without the use of external fusing.

SCHEDULE 4 - Provide a COMPLETE set of test and ratings data per the recommendations of NEMA LS1 – 1992.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.

C. Product Options: Drawings indicate size, dimensional requirements, and electrical performance of suppressors and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


F. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices."

G. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Transient Voltage Surge Suppressors."
1.6 PROJECT CONDITIONS

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

B. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:
   1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
   2. Operating Temperature: 30 to 120 deg F.
   3. Humidity: 0 to 85 percent, noncondensing.
   4. Altitude: Less than 20,000 feet above sea level.

C. Placing into Service: Do not energize or connect service entrance equipment, panelboard, control terminals, data terminals, to their sources until the surge protective devices are installed and connected.

1.7 COORDINATION

A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.

B. Coordinate surge protection devices with Division 26 Section "Electrical Power Monitoring and Control."

1.8 WARRANTY

A. General Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within ten (10) years from date of Substantial Completion.

B. Special Warranty for Cord-Connected, Plug-in Surge Suppressors: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic equipment connected to circuits protected by surge suppressors.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Replaceable Protection Modules: One of each size and type installed.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Liebert Corporation; a division of Emerson.
   2. Surge Suppression, Inc.
   3. Advanced Protection Technologies, Inc.
   6. Intermatic, Inc.
   7. LEA International.
   8. Square D; Schneider Electric.

B. Manufacturers of Category A and Telephone/Data Line Suppressors:
   1. EDCO
   2. NTE Electronics, Inc.
   3. Telebyte Technology, Inc.

2.2 SERVICE ENTRANCE SUPPRESSORS

A. Surge Protection Device Description: Non-modular type:

   The SPD will be provided with the following features and accessories:
   1. Repetitive Rating: SPD shall be capable of surviving at least 10,000 ANSI/IEEE C62.41 Category C3 impulses (10kA) without failure or less than 10% degradation of original performance characteristics.
   2. Fusing system to provide 200kAIC short circuit rating.
   3. Individually fused MOVs to provide system redundancy.
   4. Integral disconnect (only when a breaker is NOT provided in distribution equipment).
   5. LED indicator lights for power and protection status.
   6. Audible alarm, with silencing switch, to indicate when protection has failed.
   7. One set of dry contacts rated at 5A and 250V ac, for remote monitoring of protection status.
   8. NEMA 12 Enclosure.

B. Surge Protection Device Description: Modular type:

   The modular SPD will be provided with the following features and accessories:
   1. Repetitive Rating: SPD shall be capable of surviving at least 15,000 ANSI/IEEE C62.41 Category C3 impulses (10kA) without failure or less than 10% degradation of original performance characteristics.
   2. Fusing system to provide 200kAIC short circuit rating.
   3. Fabrication using bolted compression lugs for internal wiring.
   4. Integral disconnect switch (only when a breaker is NOT provided in distribution equipment).
   5. Individually fused MOVs to provide system redundancy.
   6. Built-in push-to-test feature that tests the integrity of each fuse/MOV pair. Manufacturers who accomplish by use of an external surge generator will provide the device with their quotation.
7. Redundant replaceable modules
8. Arrangement with copper bus bars and for bolted connection to phase buses, neutral bus, and ground bus.
9. Arrangement with wire connection to phase buses, neutral bus, and ground bus.
10. LED indicator lights for power and protection status.
11. Audible alarm, with silencing switch, to indicate when protection has failed.
12. One set of dry contacts rated at 5A and 250V ac, for remote monitoring of protection status.
13. Surge event operations counter.
14. NEMA 4 Enclosure

C. Peak Single-Impulse Surge Current Rating: 250 kA per phase, 125kA per mode. Manufacturer will provide a higher maximum surge current rating if necessary to meet the repetitive requirements listed above. Connection Means:

D. Connection Means: Permanently wired.

E. Protection modes and UL 1449 SVR for grounded wye circuits with voltages of 480Y/277, 208Y/120, 3-phase, 4-wire circuits shall be as follows:
   1. Line to Neutral: 400 V for 208Y/120 and 700V for 480Y/277V.
   2. Line to Ground: 400 V for 208Y/120 and 700V for 480Y/277V.
   3. Neutral to Ground: 400 V for 208Y/120 and 700V for 480Y/277V.

F. Protection modes and UL 1449 SVR for 240/120-V, single-phase, 3-wire circuits shall be as follows:
   1. Line to Neutral: 400 V.
   2. Line to Ground: 400 V.
   3. Neutral to Ground: 400 V.

G. Protection modes and UL 1449 SVR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:
   1. Line to Neutral: 400 V, 800 V from high leg.
   2. Line to Ground: 400 V.
   3. Neutral to Ground: 400 V.

H. Protection modes and UL 1449 SVR for voltages of 240, 480, or 600, 3-phase, 3-wire, delta circuits shall be as follows:
   1. Line to Line: 2000V for 480V, 1000V for 240V, 2500V for 600V.
   2. Line to Ground: 2000V for 480V, 1000V for 240V, 2500V for 600V.

2.3 PANELBOARD SUPPRESSORS

I. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:
   1. LED indicator lights for power and protection status.
   2. Audible alarm, with silencing switch, to indicate when protection has failed.
   3. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.

J. Surge Protection Device Description: Modular design with field-replaceable modules, sign-wave-tracking type with the following features and accessories:
1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Redundant suppression circuits.
5. Redundant replaceable modules.
6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
7. LED indicator lights for power and protection status.
8. Audible alarm, with silencing switch, to indicate when protection has failed.
9. One set of dry contacts rated at 5 A and 250-V, ac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
10. Surge-event operations counter.


L. Protection modes and UL 1449 SVR for grounded wye circuits with voltages of 208Y/120, 3-phase, 4-wire circuits shall be as follows:
   1. Line to Neutral: 400 V for 208Y/120.
   2. Line to Ground: 400 V for 208Y/120.
   3. Neutral to Ground: 400 V for 208Y/120.

M. Protection modes and UL 1449 SVR for 240/120-V, single-phase, 3-wire circuits shall be as follows:
   1. Line to Neutral: 400 V.
   2. Line to Ground: 400 V.
   3. Neutral to Ground: 400 V.

N. Protection modes and UL 1449 SVR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:
   1. Line to Neutral: 400 V, 800 V from high leg.
   2. Line to Ground: 400 V.
   3. Neutral to Ground: 400 V.

O. Protection modes and UL 1449 SVR for voltages of 240, 480, or 600, 3-phase, 3-wire, delta circuits shall be as follows:
   1. Line to Line: 1000 V for 240 V.
   2. Line to Ground: 800 V for 240 V.

2.4 SUPPRESSORS FOR BRANCH PANELS

A. Surge Protection Device Description: Sine-wave-tracking type, panel-mounted design with the following features and accessories:
   1. LED indicator lights for power and protection status.
   2. Audible alarm, with silencing switch, to indicate when protection has failed.
   3. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
   4. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
   5. Fusing system to provide 200kAIC short circuit rating.
   6. Repetitive Rating: SPD shall be capable of surviving at least 6,000 ANSI/IEEE C62.41 Category C3 impulses (10kA) without failure or less than 10% degradation of original performance characteristics.
   7. NEMA 4X Enclosure
B. Peak Single-Impulse Surge Current Ratings; 130 kA per phase, 65kA per mode. Manufacturer will provide a higher maximum surge current rating if necessary to meet the repetitive requirements listed above.

C. Protection modes and UL 1449 SVR for grounded wye circuits with voltages of 480Y/277 208Y/120, 600Y/347, 4-wire circuits shall be as follows:
1. Line to Neutral: 800 for 480Y/277, 400V for 208Y/120, 1200V for 600Y/347.
2. Line to Ground: 800V for 480Y/277, 400V for 208Y/120, 1200V for 600Y/347.

D. Protection modes and UL 1449 SVR for 240/120-V, single-phase, 3-wire circuits shall be as follows:
1. Line to Neutral: 400 V.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

E. Protection modes and UL 1449 SVR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:
1. Line to Neutral: 400 V, 800 V from high leg.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

F. Protection modes and UL 1449 SVR for voltages of 240, 480, or 600, 3-phase, 3-wire, delta circuits shall be as follows:
2. Line to Ground: 2000V for 480V, 1000V for 240V, 2500V for 600V.

2.5 PLUG-IN SURGE SUPPRESSORS

A. Description: Non-modular, plug-in suppressors with at least four 15-A, 120-V ac, NEMA WD 6, Configuration 15-15R receptacles, suitable to plug into a NEMA WD 6, Configuration 15-15R receptacle; with the following features and accessories:
1. LED indicator lights for power and protection status.
2. LED indicator lights for reverse polarity and open outlet ground.
3. Circuit breaker and thermal fusing. When protection is lost, circuit opens and cannot be reset.
4. Circuit breaker and thermal fusing. Unit continues to supply power if protection is lost.
5. Close-coupled direct plug-in.
6. Rocker-type on-off switch, illuminated when in the on position.
7. One RJ11/12C telephone line protector, suitable for modem connection. Maximum clamping voltage 220 peak on pins No. 3 and No. 4.

B. Peak Single-Impulse Surge Current Rating: 26 kA per phase.

C. Protection modes and UL 1449 SVR shall be as follows:
1. Line to Neutral: 475 V.
2. Line to Ground: 475 V.
3. Neutral to Ground: 475 V.
2.6 **ENCLOSURES**

A. NEMA 250, with type matching the enclosure of panel or device being protected.

**PART 3 - EXECUTION**

3.1 **INSTALLATION OF SURGE PROTECTION DEVICES**

A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.

B. Install devices for panelboard and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Locate the externally mounted SPD as close as possible to the panelboard neutral lug. Locate the recommended breaker as close as possible to the SPD location. The panelboard manufacturer will supply the breaker. Do not exceed manufacturer’s recommended lead length. Do not bond neutral and ground.

C. Provide a 60A, multi-pole circuit breaker in the service entrance equipment and a 30A, multi-pole circuit breaker in branch panel equipment to serve as a dedicated disconnect for suppressor, unless otherwise indicated.

3.2 **CONNECTIONS**

A. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 **PLACING SYSTEM INTO SERVICE**

A. Do not energize or connect panelboards to their sources until surge protection devices are installed and connected.

3.4 **FIELD QUALITY CONTROL**

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust equipment installation, including connections, and to assist in field testing. Report results in writing.

1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. Testing: Engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports:

C. Testing: Perform the following field tests and inspections and prepare test reports:

1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with requirements.

2. Complete startup checks according to manufacturer's written instructions.
3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.

D. Remove and replace malfunctioning units and retest as specified above.

3.5 **DEMONSTRATION**

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transient voltage suppression devices. Refer to Division 01 Section "Demonstration and Training."

B. Train Owner’s maintenance personnel on procedures and schedules for maintaining suppressors.

C. Review data in maintenance manuals. Refer to Division 1 Section “Contract Closeout.”

D. Review data in maintenance manuals. Refer to Division 1 Section “Operation and Maintenance Data.”

E. Schedule training with Owner, through Architect, with at least seven days’ advanced notice.

END OF SECTION 264313
SECTION 265119

LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following types of LED luminaires:

1. Linear industrial.
2. Strip light.
3. Surface mount, linear.
4. Surface mount, nonlinear.
5. Finishes.
6. Luminaire support.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Section 260926 "Lighting Control Panelboards" for panelboards used for lighting control.
3. Section 260933 "Central Dimming Controls" or Section 260936 "Modular Dimming Controls" for architectural dimming systems and for fluorescent dimming controls with dimming ballasts specified in interior lighting Sections.
4. Section 260943.16 "Addressable-Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.
B. CRI: Color Rendering Index.
C. Fixture: See "Luminaire."
D. IP: International Protection or Ingress Protection Rating.
E. LED: Light-emitting diode.
F. Lumen: Measured output of lamp and luminaire, or both.
G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Arrange in order of luminaire designation.
   2. Include data on features, accessories, and finishes.
   3. Include physical description and dimensions of luminaires.
   4. Include emergency lighting units, including batteries and chargers.
   5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
   6. Photometric data and adjustment factors based on laboratory tests Retain or "Manufacturers' Certified Data" or "Testing Agency Certified Data" Subparagraph below. Retain first subparagraph if photometric data, based on testing by accredited manufacturers' laboratories, is considered adequate for luminaires in this Project. Retain second subparagraph if photometric data for one or more luminaires are based on independent laboratory tests; coordinate with the Interior Lighting Fixture Schedule on Drawings to indicate which units shall meet this requirement. See the Evaluations.
      a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
      b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

B. Shop Drawings: For nonstandard or custom luminaires.
   1. Include plans, elevations, sections, and mounting and attachment details.
   2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

C. Sustainable Design Submittals:

D. Samples: For each luminaire and for each color and texture with standard factory-applied finish.

E. Samples for Initial Selection: For each type of luminaire with custom factory-applied finishes.
   1. Include Samples of luminaires and accessories involving color and finish selection.

F. Samples for Verification: For each type of luminaire.
   1. Include Samples of luminaires and accessories to verify finish selection.

G. Product Schedule: For luminaires and lamps

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Luminaires.
   2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
4. Structural members to which luminaires will be attached.
5. Initial access modules for acoustical tile, including size and locations.
6. Items penetrating finished ceiling, including the following:
   a. Other luminaires.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.
   f. Ceiling-mounted projectors.
7. Moldings.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

D. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Product Certificates: For each type of luminaire.

F. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
   1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
   2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
   3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.
1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

E. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.
   1. Obtain Architect's approval of luminaires in mockups before starting installations.
   2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE 7.

B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
   1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified
2.2 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Standards:
   1. ENERGY STAR certified.
   2. California Title 24 compliant.
   3. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
   4. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
   5. UL Listing: Listed for damp location.
   6. Recessed luminaires shall comply with NEMA LE 4.
   7. User Replaceable Lamps:
      a. Bulb shape complying with ANSI C78.79.
   b. Lamp base complying with ANSI C81.61

C. CRI of . CCT of 3000 K

D. Rated lamp life of 35,000

E. Lamps dimmable from 100 percent to 0 percent of maximum light output.

F. Internal driver.

G. Nominal Operating Voltage: 120 V ac
   1. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

H. Housings:
   1. Extruded-aluminum housing and heat sink.
   2. Clear anodized finish.

2.3 Retain this article for a luminaire with a linear style lamp with no reflector, diffuser, or lens.

A. Minimum 750 lumens. Minimum allowable efficacy of 80 lumens per watt.

B. Integral junction box with conduit fittings.

2.4 SURFACE MOUNT, LINEAR

A. Minimum 750 lumens. Minimum allowable efficacy of 80 lumens per watt.

B. Integral junction box with conduit fittings.
2.5 **SURFACE MOUNT, NONLINEAR**

A. Minimum 750 lumens. Minimum allowable efficacy of 80 lumens per watt.

B. Integral junction box with conduit fittings.

2.6 **MATERIALS**

A. Metal Parts:
   1. Free of burrs and sharp corners and edges.
   2. Sheet metal components shall be steel unless otherwise indicated.
   3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:
   1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   2. Glass: Annealed crystal glass unless otherwise indicated.
   3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp characteristics:
      a. "USE ONLY" and include specific lamp type.
      b. Lamp diameter, shape, size, wattage, and coating.
      c. CCT and CRI for all luminaires.

2.7 **METAL FINISHES**

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.8 **LUMINAIRE SUPPORT**

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.


D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:
   1. Sized and rated for luminaire weight.
   2. Able to maintain luminaire position after cleaning and relamping.
   3. Provide support for luminaire without causing deflection of ceiling or wall.
   4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaire Support:
   1. Secured to outlet box.
   2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
   3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaire Support:
   Attached to structural members in walls. Do not attach luminaires directly to gypsum board.

G. Ceiling-Mounted Luminaire Support:
   1. Ceiling mount to structure.

H. Suspended Luminaire Support:
   1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

I. Ceiling-Grid-Mounted Luminaires:
   1. Secure to any required outlet box.
   2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
   3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
   2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Comply with requirements for startup specified in Section 260943.16 "Addressable-Luminaire Lighting Controls."

B. Comply with requirements for startup specified in Section 260943.23 "Relay-Based Lighting Controls."

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied
conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265119
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section Includes:
   1. Poles and accessories for support of luminaires.
   2. Luminaire devices.

1.3 DEFINITIONS
A. EPA: Equivalent projected area.
B. Luminaire: Complete lighting fixture.
C. Pole: Luminaire-supporting structure, including tower used for large-area illumination.
D. Standard: See "Pole."

1.4 ACTION SUBMITTALS
A. Product Data: For each pole, accessory, and luminaire-supporting and -lowering device, arranged as indicated.
   1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
   2. Include finishes for lighting poles and luminaire-supporting devices.
   3. Anchor bolts.
   4. Manufactured pole foundations.

B. Sustainable Design Submittals:

C. Shop Drawings:
   1. Include plans, elevations, sections, and details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Foundation
   4. Method and procedure of pole installation.
D. Samples: For each exposed lighting pole, standard, and luminaire-supporting device and for each color and texture specified.

1.5 INFORMATIONAL SUBMITTALS

A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements according to AASHTO LTS-6-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations signed and sealed by a professional engineer.

B. Qualification Data: For Installer.

C. Seismic Qualification Certificates: For accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Material Test Reports:
   1. For each pole, by a qualified testing agency.

E. Source quality-control reports.

F. Field quality-control reports.

G. Sample Warranty: Manufacturer's standard warranty.

H. Soil test reports

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include pole inspection procedures.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Pole repair materials

1.8 DELIVERY, STORAGE, AND HANDLING

A. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch deep. Do not apply tools to section of pole to be installed below finished grade.
1.9 **WOOD POLES**

A. Poles: Southern yellow pine, machine trimmed by turning, for wood species used; and bored, roofed, and grained before treatment.
   1. Pole Brand: Brand the manufacturer's trademark and date of treatment, height and class of pole, wood species, preservation code, and retention. Brand shall be placed so that the bottom of the brand is minimum 10 feet from pole butt.

B. Fasteners: Galvanized steel, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.
   1. Materials: Compatible with poles and standards as well as the substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.


**PART 2 - EXECUTION**

2.1 **EXAMINATION**

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine poles, luminaire-mounting devices, lowering devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

2.2 **POLE INSTALLATION**

A. Alignment: Align poles for optimum directional alignment of luminaires and their mounting provisions on pole. Align poles as indicated.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on drawing.
   1. Fire Hydrants and Water Piping: 60 inches.
   3. Trees: 15 feet from tree trunk.

C. Poles set in Concrete-Paved Areas: Install poles with a minimum 6-inch-wide, unpaved gap between the pole or pole foundation and the edge of the adjacent concrete slab. Fill unpaved ring with pea gravel. Insert material to a level 1 inch below top of concrete slab.

D. Raise and set pole using web fabric slings (not chain or cable) at locations indicated by manufacturer.
2.3 **GROUNDING**

A. Ground Nonmetallic Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
   1. Install grounding electrode for each pole.
   2. Install grounding conductor and conductor protector.
   3. Ground metallic components of pole accessories and foundation.

2.4 **IDENTIFICATION**

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

**END OF SECTION 265613**
SECTION 31 05 16 - AGGREGATES FOR EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   2. Fine aggregate materials.

B. Related Sections:
   1. Section 31 20 00 Earth Moving
   2. Section 31 25 00 Erosion and Sedimentation Control: Slope protection and erosion control
   3. Section 31 50 00 Excavation Support and Protection
   4. Section 32 91 13 Soil Preparation
   5. Geotechnical Report

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

B. ASTM International:
   2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³).
   3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³).
   4. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).


1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Samples: Submit, in air-tight containers, 10 lb sample of each type of fill to testing laboratory.

C. Materials Source: Submit name of imported materials suppliers.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.


C. Maintain one copy of each document on site.

PART 2 - PRODUCTS

2.1 COARSE AGGREGATE MATERIALS

A. Aggregate Designation: Macadam Base Course/Recycled Portland Cement Concrete (RPCC) Base Course


2. Aggregate Designation: Macadam Base Course/Recycled Portland Cement Concrete (RPCC) Base Course

a. Macadam Base Course: Use coarse aggregate for Macadam Base Course consisting of hard, durable particles of crushed slag or stone, excluding marine limestone. Ensure that the aggregate is free from vegetable matter, sand, lumps or balls of clay, or other deleterious matter. Ensure minimum weight for crushed slag used in Macadam Base Course, when dry and rodded, is 70 pounds per cubic foot. Use crushed slag that consists of angular fragments, reasonably uniform in density and quality, and reasonably free from glassy, thin or elongated pieces, dirt, or other objectionable material.

b. Recycled Portland Cement Concrete (RPCC) Base Course: Use coarse aggregate for Recycled Portland Cement Concrete Base Course consisting of sound, durable particles of recycled Portland cement concrete aggregate, excluding crushed concrete block or pipe.

3. Percent Passing per Sieve Size:

   a. 2 inches: 100.
   b. 1 1/2 inches: 95 to 100.
   c. 1 inch: 70 to 100.
   d. 3/4 inch: n/a.
   e. 1/2 inch: 48 to 75.
   f. 3/8 inches: n/a.
   g. No. 4: 30 to 50.
   h. No. 8: n/a.
i. No. 16: n/a.

j. No. 30: 11-30.

k. No. 100: n/a.

l. No. 200: 0 to 12

B. Aggregate Designation: 57


2. Percent Passing per Sieve Size:

   a. 2 inches: n/a.
   b. 1 1/2 inches: 100.
   c. 1 inch: 95 to 100.
   d. 3/4 inch: n/a.
   e. 1/2 inch: 25 to 60.
   f. 3/8 inches: n/a.
   g. No. 4: 0 to 10.
   h. No. 8: 0 to 5.
   i. No. 16: n/a.
   j. No. 100: n/a.

C. Aggregate Designation: 67


2. Percent Passing per Sieve Size:

   a. 2 inches: n/a.
   b. 1 1/2 inches: n/a.
   c. 1 inch: 100.
   d. 3/4 inch: 90 to 100.
   e. 1/2 inch: n/a.
   f. 3/8 inches: 20 to 55.
   g. No. 4: 0 to 10.
   h. No. 8: 0 to 5.
   i. No. 16: n/a.
   j. No. 100: n/a.

D. Aggregate Designation: Riprap Class A


2. Provide riprap conforming to the gradation classes in the following:

   a. Rock Size (ft): 0.75, Rock Size (lbs): 37, Percent of Riprap Smaller Than: 100.
   b. Rock Size (ft): 0.50, Rock Size (lbs): 11, Percent of Riprap Smaller Than: 50.
   c. Rock Size (ft): 0.20, Rock Size (lbs): 0.7, Percent of Riprap Smaller Than: 15.
2.2 FINE AGGREGATE MATERIALS

A. Fine Aggregate

1. Conform to State of Alabama Highways Standard
2. Aggregate No.: FA-10M.
3. Percent Passing per Sieve Size:
   a. 1/2 inch: n/a.
   b. 3/8 inches: 100.
   c. No. 4: 95 to 100.
   d. No. 8: 84 to 100.
   e. No. 16: 45 to 95.
   f. No. 30: 25 to 75.
   g. No. 50: 8 to 35.
   h. No. 100: 0.5 to 20.
   i. No. 200: 0 to 10*.

*Dust of fracture essentially free from clay or shale, final job site testing only.

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Testing and inspection services.

B. Coarse Aggregate Material - Testing and Analysis: Perform according to AASHTO T96 or ASTM C131 and AASHTO T11.

C. Fine Aggregate Material - Testing and Analysis: Perform according to ASTM D1557 or AASHTO T180.

D. When tests indicate materials do not meet specified requirements, change material and retest.

PART 3 - EXECUTION

3.1 INSTALLATION OF CRUSHED STONE

A. Crushed stone shall be placed in areas shown on the drawings. Stone shall be consolidated by mechanical means.

B. Unless otherwise specified or shown, crushed stone shall have a minimum thickness of 6”.

C. All crushed stone shall be underlain by an approved geotextile fabric to prevent erosion

3.2 STOCKPILING

A. Stockpile materials on site at locations designated by Architect/Engineer.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.
C. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.

D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

E. Stockpile unsuitable materials on impervious material and cover to prevent erosion and leaching, until disposed of.

3.3 STOCKPILE CLEANUP

A. Leave unused materials in neat, compact stockpile.

B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION 31 05 16
SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Clearing and grubbing.
2. Stripping and stockpiling topsoil.
3. Removing above- and below-grade site improvements.
4. Temporary erosion and sedimentation control.

B. Related Requirements:

1. Section 01 50 00 "Temporary Facilities and Controls" for temporary erosion- and sedimentation-control measures.

C. Related Requirements:

1. Section 01 50 00 "Temporary Facilities and Controls" for temporary erosion- and sedimentation-control measures.

1.3 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.

D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.
1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.6 INFORMATIONAL SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or video recordings.

2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.

B. Topsoil stripping and stockpiling program.

C. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.7 QUALITY ASSURANCE

A. Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

1.8 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Salvageable Improvements: Carefully remove items indicated to be salvaged and provide to the Owners.

C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
D. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.

E. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 31 20 00 "Earth Moving."
   1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Protect existing site improvements to remain from damage during construction.
   1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 EXISTING UTILITIES

A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.
1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
   1. Arrange with utility companies to shut off indicated utilities.
   2. Owner will arrange to shut off indicated utilities when requested by Contractor.

C. Locate, identify, and disconnect utilities indicated to be abandoned in place.

D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Engineer and Owner not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Architect's written permission.

E. Excavate for and remove underground utilities indicated to be removed.

F. Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections; and in Section 02 41 16 "Structure Demolition" and Section 02 41 19 "Selective Demolition."

3.4 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
   1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
   2. Grind down stumps and remove roots larger than 3 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
   3. Use only hand methods or air spade for grubbing within protection zones.
   4. Chip removed tree branches and stockpile in areas approved by Owner or dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
   1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.
B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.
   1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
   1. Limit height of topsoil stockpiles to 72 inches.
   2. Do not stockpile topsoil within protection zones.
   3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
   4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.6 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
   1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
   2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antitrust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Burning tree, shrub, and other vegetation waste is permitted according to burning requirements and permitting of authorities having jurisdiction. Control such burning to produce the least smoke or air pollutants and minimum annoyance to surrounding properties. Burning of other waste and debris is prohibited.

C. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 31 10 00
SECTION 31 20 00 - EARTHMOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Earthwork for this project is to be bid as Unclassified Excavation.
   a. Finished grades and elevations of below-grade structures are shown in the plans. No additional compensation will be given regardless of whether material is soil, rock, debris, etc. If any additional work not shown in the plans is required and authorized by the Engineer, it will be paid for by change order using the predetermined amounts in the “Unit Prices” Section for the particular material encountered.
   b. Definitions for soil, rock, etc. are only relevant for descriptive purposes related to the handling of material and for additional work not shown on the plans that may be required by the Engineer.

2. Preparing of subgrade for building slabs, walks, and pavements; and additional work indicated on the Drawings and in the Project Manual.
   a. Comply with this Section and other Division 31, 32, and 33 Sections: Refer also to Civil and Structural Drawings for additional information and requirements.
   b. Perform excavation by hand within 5'-0" of existing buildings and structures to remain. Design and provide all necessary supports, shoring, etc., as required to prevent settlement, collapse, and/or other damage to existing buildings and structures to remain.
      1) DO NOT EXCAVATE BELOW THE EFFECTIVE BEARING AREA OF FOUNDATIONS OF EXISTING BUILDINGS AND STRUCTURES. In the event of conflict during construction, notify Engineer prior to proceeding with work in the affected area.
   c. Compaction of backfill at any basement and below grade walls shall only be by hand-directed compaction equipment. Heavy construction equipment and/or heavy trucks shall not be allowed within 10-feet of any basement walls, and within 5-feet of foundation walls.

3. Excavating and backfilling of trenches within building lines and controlled areas.
4. Stripping and stockpiling of topsoil (if any) is specified in Section 31 10 00 - “Site Clearing.”
5. The extent of earthwork is indicated on the Drawings.
6. Removal of existing work and demolition may also be specified under various Division 2, 31, 32, and 33 Sections.
B. Excavating and Backfilling for Mechanical and Electrical Work: Refer to Divisions 23 and 26 sections for excavation and backfill required in conjunction with underground mechanical and electrical utilities and buried mechanical and electrical appurtenances, not work of this Section.

1. However, construction materials and execution for Mechanical and Electrical work shall comply with requirements of this Section 31 20 00, and related Division 31, 32, and 33 Sections, when the work and/or materials required are not indicated or only partially indicated in Divisions 26.

C. Placement and compaction of at least 4-inches of topsoil up to finish grades is included in the work of this Section.

1. Allow for thickness of topsoil and sod/grassing as indicated.

D. Placement and compaction of granular fill behind below-grade walls or at other locations shown on the drawings.

E. Placement and compaction of porous fill below slabs-on-grade or at other locations shown on the drawings.

F. Related Sections:

1. Section 31 10 00 - "Site Clearing"
2. Section 31 25 00 Erosion and Sedimentation Control: Slope protection and erosion control.
3. Section 31 50 00 Excavation Support and Protection.
4. Section 32 91 13 Soil Preparation
5. Document: Geotechnical report; bore hole locations and findings of subsurface materials.
6. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 MEASUREMENT AND PAYMENT

A. Basis of Measurement: Unclassified Excavation. Lump Sum Price included in the price bid.

1. Includes excavating all subsurface materials, stockpiling, spoiling and removal of spoil materials, preparation of subgrades and areas to receive fill, and fill placement including compaction.

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials:


B. ASTM International:
1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
3. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

1.4 DEFINITIONS

A. “Excavation” consists of removal of materials and existing improvements encountered to the elevations indicated and subsequent disposal of materials removed.

B. “Unauthorized” excavation consists of removal of materials beyond indicated elevations or dimensions without specific direction of Owner’s Geotechnical Engineer. Unauthorized excavation, as well as remedial work directed by Owner’s Geotechnical Engineer, shall be at Contractor’s expense.

1. Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position, when acceptable to Owner’s Geotechnical Engineer.

2. In locations other than those above, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Owner’s Geotechnical Engineer.

C. “Additional Excavation”: When excavation has reached required subgrade elevations or designated undercut elevation, if required, notify Owner’s Geotechnical Engineer, who will make an inspection of conditions. If Owner’s Geotechnical Engineer determines that bearing materials at required subgrade elevations are unsuitable, continue excavation until suitable bearing materials are encountered and replace excavated material as directed by Owner’s Geotechnical Engineer.

D. “Subgrade”: The undisturbed earth or the compacted soil layer immediately below pavement base course, drainage fill, or topsoil materials.

E. “Structure”: Buildings, foundations, slabs, tanks, curbs, or other man-made stationary features occurring above or below ground surface.

F. “Building Control Area” and/or “Controlled Area”: Below and at least 10-feet beyond building foot print or exterior walls, and below roofs, to include covered porches and canopies, and below and at least 5-feet beyond all walks and pavements subject to bearing vehicular traffic.

G. “Mud Footings” (if any): The at least 2-inches to 4-inches of lean 2,500 psi (minimum) concrete placed in the bottom of footing and foundation trenches and excavations, which is required if permanent or structural concrete cannot be placed the same day they are excavated.

1. Unless mud footings are indicated on Structural Drawings, their depth shall be compensated for by over-excavation.
2. Mud footings (if any) shall be completely clean prior to placement of any reinforcing and/or permanent or structural concrete.

3. Refer to the Owner’s “Report of Geotechnical Exploration,” and Structural Drawings for additional information and requirements for other “mud footings” (or “mud mats”, or “mud seals”).

H. Rock: Rock material in beds, ledges, unstratified masses, and conglomerate deposits and boulders of rock material exceeding 1 cu. yd. (0.76 cu. m) for bulk excavation or 1/2 cu. yd. (0.38 cu. m) for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- (1065-mm-) wide, short-tip-radius rock bucket; rated at not less than 120-hp (89-kW) flywheel power with bucket-curling force of not less than 25,700 lbf (114 kN) and stick-crowd force of not less than 18,700 lbf (83 kN); measured according to SAE J-1179.

2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 210-hp (157-kW) flywheel power and developing a minimum of 45,000 lbf (200-kN) breakout force; measured according to SAE J-732.

3. Definitions for rock are only relevant for descriptive purposes related to the handling of material and for additional work not shown on the plans that may be required by the Engineer.

1.5 SUBMITTALS

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

B. Samples: Submit, in air-tight containers, adequate sample of each type of material fill to testing laboratory.

C. Materials Source: Submit name of imported materials source.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

E. Test Reports: Submit the following reports directly to the Engineer, Civil Engineer, Structural Engineer, and the Owner, directly from the testing service, with a copy to the Contractor.

1. Test reports on fill and borrow material.

2. Verification of suitability of each foundation, floor slab and subgrade condition and material, in accordance with specified requirement

3. Field reports and in-place density tests

1.6 QUALITY ASSURANCE

A. Furnish each soil material from borrow source throughout the course of Work.
B. Perform road and pavement work in accordance with State of Alabama Highways Standard Specifications, latest edition, unless the requirements of these specifications or the Geotechnical Exploration Report is more stringent, in which case the more stringent shall apply.

C. Maintain one copy of the Geotechnical Exploration Report on site.

D. Codes and Standards: Perform excavation work on site and in right-of-ways in compliance with applicable requirements of authorities having jurisdiction.

E. Testing and Inspection Service: All required soil testing and inspection services during earthwork operations shall be performed by a qualified independent geotechnical testing laboratory.

1. Refer to Division 1 for additional information and requirements.
2. Provide samples of material to be used as fill to the materials testing laboratory at least 1 week prior to placement of material tested.

1.7 PROJECT CONDITIONS

A. Site Information: Refer to Section 31 10 00 - “Site Clearing”, and Civil Drawings, for additional information and recommendations.

B. Existing Utilities: Locate existing underground utilities in areas of excavation work. If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations in the vicinity, and as may also be required for other construction work.

1. Notify the Line Location Center (811) prior to any excavation work. This organization will contact its member utility companies to locate and mark of their own underground facilities.
2. Notify non-member companies directly, for them to perform this service.
3. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions and record locations on as-built record drawings. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
4. Do not interrupt existing utilities serving facilities occupied by Owner or others, during occupied hours, except when permitted in writing by Engineer and then only after acceptable temporary utility services have been provided.
5. Provide minimum of 48 hour notice to Owner and copy Engineer, and receive written notice to proceed before interrupting any utility.
6. Demolish and completely remove from the site any existing underground utilities indicated to be removed, and all existing underground utilities in “controlled areas”. Coordinate with utility companies for shutoff of services if lines are active.

C. Use of Explosives: If blasting is required during construction, control blasting so that the rock below the established final grade is not fractured to a high degree. Exercise strict elevation control when drilling the shot holes to control over blasting of rock below the final grade. The grading contractor shall be responsible for removing any over-blasted rock and replacing the disturbed rock with lean concrete or compacted engineered fill as appropriate at no additional cost. Over blasting of rock on slope faces shall be controlled to minimize the need for corrective
work. Any material that has been loosened or shattered by blasting is to be removed at no additional cost to provide a uniform slope.

1. Perform a Pre-Blast survey of nearby structures.

D. Protection of Persons and Property:

1. Barricade open excavations occurring as part of this work and post with warning lights.
2. Operate warning lights as recommended by authorities having jurisdiction.
3. Comply with requirements of current regulations of OSHA, applicable Codes, ordinances, and authorities having jurisdiction.
4. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
5. Perform excavation by hand within 5'-0" of existing buildings and structures to remain, and within dripline of large trees to remain. Protect root systems from damage or dryout to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with moistened burlap. Paint root cuts of 1-inch and larger with emulsified asphalt tree paint.

a. Do not under-mine or excavate below footings and/or foundations which are to remain.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory soil materials are defined as clean, non-saturated, non-organic earth taken from acceptable sources complying with ASTM D2487 soil classification groups and meet the following characteristics: liquid limit (LL) less than 50%, plasticity index (PI) less than 25%, maximum dry density (ASTM D-698) 100 pcf or greater, maximum particle size 3 inches or less, organic matter less than 5% and subject to approval by the project geotechnical engineer and testing laboratory.

B. Unsatisfactory soil materials are defined as those complying with ASTM D2487 soil classification groups other than those indicated above.

C. Drainage Fill Materials (or “porous fill” or “drainage aggregate”): Clean, washed, graded mixture of free-draining pea gravel, coarse sand, or crushed stone, with not more than 50 percent passing a No. 50 sieve and less than 5 percent passing a No. 200 sieve, and subject to approval by the project geotechnical engineer and testing laboratory. Satisfactory materials are non-saturated, non-organic from acceptable sources with ASTM D2487 soil classification groups: GW, GP, SW, and SP.

D. Granular Fill Material; Granular material consisting of sand, gravel, crushed stone, or a combination thereof with not more than 12 percent passing a No. 200 sieve, and subject to approval by the project geotechnical engineer and testing laboratory. Satisfactory materials are non-saturated, non-organic from acceptable sources with ASTM D2487 soil classification
groups: GW, GP, SW, SP, GW-GM, GW-GC, GP-GM, GP-GC, SW-SM, SW-SC, SP-SM, and SP-SC.

E. Rock Fill: Fill Material with a particle size larger than 3 inches.

1. Rock fill is not to be used within the Building Controlled Area.
2. Rock Fill is only to be used within pavement areas if allowed by the Owner’s Geotechnical Engineer.
3. Excess rock material is to be removed from the site and legally disposed of or disposed of onsite in areas designated by the Owner.

2.2 TOPSOIL MATERIALS

A. Topsoil: Topsoil furnished or stockpiled by the Contractor shall meet the requirements in ASTM D5268 “Standard Specification for Topsoil for Landscape Purposes”. The composition of the topsoil shall be as follows from ASTM D5268: deleterious materials (rock, gravel, slag, cinder, roots, sod) in the total sample 7% maximum by weight; organic material in portion of sample passing the No. 10 sieve 2 to 20% by weight; sand content in portion of sample passing the No. 10 sieve 10 to 90% by weight; silt and clay content in portion of sample passing the No. 10 sieve 10 to 90% by weight; and pH 5 to 7.

2.3 MISCELLANEOUS MATERIALS

A. Geotextile for Separation of Soil and Aggregate shall meet the requirements of AASHTO M288 for separation applications Class 2.

B. Geotextile for Underdrains and Drainage shall meet the requirements of AASHTO M288 Class 2 subsurface drainage geotextile.

C. Geosynthetics for Slopes and Soft Soil Reinforcement shall consist of a geogrid or geotextile constructed of polyester, polypropylene, or polyethylene polymer, resistant to all naturally occurring alkaline and acidic soil conditions, resistant to heat, ultraviolet light, and to attack by bacteria and fungi in the soil. The reinforcement shall meet or exceed the following values:

1. Soil Slope Reinforcement

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<th>Type</th>
<th>Creep Reduced Strength at 10%</th>
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<td>Total Strain Limit (lb./ft.)</td>
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<tr>
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<td>2</td>
<td>800</td>
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<td>3</td>
<td>1200</td>
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2. Soft Soil Stabilization Reinforcement

<table>
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<tr>
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<th>Ultimate Strength</th>
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<tbody>
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<td></td>
<td>Machine and Cross</td>
<td>Machine and Cross</td>
</tr>
<tr>
<td></td>
<td>Direction (lb./ft.)</td>
<td>Direction (lb./ft.)</td>
</tr>
<tr>
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<td>800</td>
</tr>
<tr>
<td>3</td>
<td>2100</td>
<td>1200</td>
</tr>
</tbody>
</table>
PART 3 - EXECUTION

3.1 PROOFROLLING

A. Areas throughout slopes and beneath and 10'-0" beyond new building and covered areas, and beneath and 5'-0" beyond new pavement areas (back-of-curb or other paving edge termination) shall be designated as “controlled areas.” Prior to placement of fill earth and following removal of cut earth, the controlled areas shall be proofrolled. Areas to be filled shall be proofrolled prior to any fill placement and again after fill is placed in the building controlled area; cut areas shall be proofrolled after they are brought to subgrade level. Proofrolling shall be performed with a partially loaded truck with a rear single axle weight of 8 to 10 tons, or similarly weighted construction equipment. The proofroller shall make at least two passes over each section in perpendicular directions over the “controlled areas”. In confined locations, use of a steel probe rod or dynamic cone penetrometer (DCP) may be recommended by the Geotechnical Engineer in lieu of proofrolling. Soft, organic, or excessively wet soils found during the proofrolling operations shall be excavated and replaced with suitable compacted fill. The exposed subgrade must be well drained to prevent the accumulation of water.

1. Proofrolling shall be conducted in the presence of testing lab’s Geotechnical Engineer or representative.
2. Do not proofroll when the ground surface is frozen, wet or saturated with water.

3.2 EXCAVATION:

A. Excavation includes removal of pavements and other obstructions visible on surface; underground structures, utilities, and other items indicated to be demolished and removed; together with earth and other materials encountered that are not classified as structures, foundations, or unauthorized excavation.

B. Perform excavation by hand within 5'-0" of existing buildings and structures to remain.

1. Do not under-mine or excavate below footings and/or foundations which are to remain.
2. Refer to “Definitions” paragraph above for any “mud footings” required.

C. Blasting and/or pneumatic hammering will likely be required for excavation to remove zones of rock.

D. The Contractor is responsible for performing his/her own quantity take-off. However, do not assume that the cut to fill quantities on this site balance.

E. Some areas of poorly compacted fill, debris laden fill, and soft native soils may exist on the site and may be considered unsuitable by the Owner’s Geotechnical Engineer. Unsuitable material is not to be placed in the structural fill mass and is to be discarded, hauled off site and legally disposed of, or placed in areas designated by the Owner.
3.3 STABILITY OF EXCAVATIONS:

A. General: Comply with local codes, ordinances, and requirements of agencies having jurisdiction.

B. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling.

C. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces, in good serviceable condition. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Extend shoring and bracing as excavation progresses.

3.4 STORAGE OF EXCAVATED MATERIALS:

A. Stockpile excavated materials acceptable for backfill and fill where directed. Stockpiles are not allowed within the flood way. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain.

3.5 EXCAVATION FOR STRUCTURES:

A. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, and other construction and for inspection.

B. Within the “Building Controlled Area”, excavate and remove unsuitable material as acceptable to Geotechnical Engineer.

C. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed. Trim bottoms to required lines and grades and compact exposed soils to leave solid base to receive other work.

D. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Structures: Conform to elevations and dimensions indicated within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, and other construction and for inspection. Do not disturb bottom of excavations, intended for bearing surface.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS (if any):

A. Cut surface under pavements to comply with cross sections, elevations and grades as indicated.

1. Within all controlled areas other than the building, excavate in place unsuitable material as directed by the Owner’s Geotechnical Engineer.
3.7 TRENCH EXCAVATION FOR PIPES AND CONDUIT:

A. Excavate trenches to uniform width, sufficiently wide to provide ample working room and a minimum of 6-inches to 9-inches of clearance on both sides of pipe or conduit.

1. More clearance may be required to achieve required compaction. This is a minimum.

B. Excavate trenches and conduit to depth indicated or required to establish indicated slope and invert elevations and to support bottom of pipe or conduit on minimum of 4-inches of compacted “select fill” bedding. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

C. Except as otherwise indicated, excavate for exterior water-bearing piping (water, steam, condensate, drainage, etc.) so top of piping is not less than 3'-0" below finished grade and/or paving.

D. Where rock or concrete is encountered, carry excavation 6" below required elevation and backfill with a 6" layer of graded aggregate, prior to installation of pipe. This is to be considered base bid except in the case of additional work.

3.8 COLD WEATHER PROTECTION

A. Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.

3.9 BACKFILL AND FILL:

A. General: Place soil material in layers to required subgrade elevations, for each area classification listed below, using materials specified in Part 2 of this Section.

1. Under all areas, use satisfactory material. Refer to Owner’s “Report of Geotechnical Exploration,” and this Section 31 20 00, for minimum testing requirements.

   a. Previously placed debris laden fill may be present on this site and may be considered unsuitable by the Owner’s Geotechnical Engineer. Unsuitable material is not to be placed in the structural fill mass and is to be discarded, hauled off site and legally disposed of.

2. Under building slabs, use drainage fill material of compacted and finished depth indicated, or if not indicated, at least 4-inches compacted and completed thickness.

3. Backfill trenches with concrete where trench excavations pass within 18-inches of column or wall footings and that are carried below bottom of such footings or that pass under wall footings. Place concrete to level of bottom of adjacent footing.

   a. Concrete is specified in Division 3.
   b. Do not backfill trenches until inspections and any required testing have been made and backfilling is authorized by Engineer based on test results. Use care in backfilling to avoid damage or displacement of pipe systems.
c. Utility trenches shall be backfilled with acceptable borrow or graded crushed stone in 6” loose lifts compacted with mechanical piston tampers to the project requirements.

B. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, etc.
2. Inspections, testing, approval, and recording locations of underground utilities have been performed and recorded.
3. Removal of concrete formwork, if any.
4. Removal of shoring and bracing, and backfilling of voids with satisfactory materials.

a. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure or utilities, or leave in place if required.

5. Removal of trash and debris from excavation.
6. Permanent or temporary horizontal bracing is in place on horizontally supported walls, where necessary.

3.10 PLACEMENT AND COMPACTION:

A. Ground Surface Preparation:

1. Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow strip, or break up sloped surfaces steeper than 1-vertical to 5-horizontal so that fill material will bond with existing surface.
2. Where new fill is placed against sloped surfaces steeper than 1 -vertical to 5 -horizontal, the existing slope shall be benched. Benching shall commence at the toe of the proposed fill and proceed upwards as fill is placed at a maximum of 4 vertical feet. Benches shall be at least 6 feet wide.
3. Prior to placement of fill earth and following removal of cut earth, the controlled areas shall be proofrolled. Areas to be filled shall be proofrolled prior to any fill placement and again after fill is placed in the building controlled area; cut areas shall be proofrolled after they are brought to subgrade. Proofrolling shall be performed with a partially loaded truck with a rear single axle weight of 8 to 10 tons, or similarly weighted construction equipment. The proofroller shall make at least two passes over each section in perpendicular directions over the “controlled areas”. Soft, organic, or excessively wet soils found during the proofrolling operations shall be excavated and replaced with suitable compacted fill. The exposed subgrade must be well drained to prevent the accumulation of water.

B. Place backfill and fill materials in layers not more than 8-inches in loose depth for material compacted by heavy compaction equipment, and not more than 4-inches in loose depth for material compacted by hand operated tampers.

C. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry
density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

D. Place backfill and fill materials evenly adjacent to structures, piping, or conduit to required elevations. Prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping, or conduit to approximately same elevation in each lift.

E. General Fill Embankment Construction

1. Embankment construction shall commence at the toe of the proposed slope and continue upwards as additional fill is placed. The engineered fill placed shall be benched into the natural slopes.

2. The embankment is to be overfilled and then cut back to the required geometry to remove the uncompacted material that is usually present on the face of fill slopes.

3. The face of slopes shall be promptly vegetated according to the Erosion Control Plan, the CBMPP and Section 31 25 00 Erosion Control to prevent erosion after construction. Prior to vegetation 4” minimum topsoil is to be placed and tracked in by a dozer moving up and down the slope to create horizontal track lines.

F. Rock Fill:

1. Rock Fill is not to be used unless acceptable to the Owner’s Geotechnical Engineer. Break larger particles down to 3 inches or less and treat as soil fill.

G. Control soil and fill compaction, providing minimum percentage of density specified for each area classification indicated below. Correct improperly compacted areas or lifts as directed by testing lab’s Geotechnical Engineer if soil density tests indicate inadequate compaction.

1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density, in accordance with ASTM D 698:

   a. Under structures, building foundations and slabs, and 10’ beyond those perimeters, compact full depth of fill placement to at least 98% standard Proctor maximum dry density.

      1) Refer to paragraph 1.2 above for areas where additional depth(s) of preparation and compaction of exposed subgrade are or may be required.

   b. Under steps, covered areas, sidewalks, mechanical/utility and in all other “controlled areas”, compact full depth of fill placement to at least 98 percent standard Proctor maximum dry density.

      1) Refer to paragraph 1.2 above for areas where additional depth(s) of preparation and compaction of exposed subgrade are or may be required.

   c. Under pavements and at least 5-feet beyond (measured from back-of-curb or edge of paving, where occurs), compact full depth of fill placement to at least 98-percent standard Proctor maximum density.
d. Under lawn or unpaved areas beyond “controlled areas”, compact each layer of backfill or fill material to at least 95-percent standard Proctor maximum dry density.

e. On-site Borrow (where allowed): 98-percent standard Proctor maximum dry density.

f. Select and/or Structural Fill: 98-percent standard Proctor maximum dry density.

g. Porous Fill (drainage course): 98-percent standard Proctor maximum dry density.

2. Moisture Control:

a. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations.

b. Remove and replace, or scarify and moisture condition, soil material that is too wet to permit compaction to specified density.

c. Stockpile or spread soil material that has been removed because it is too wet to permit compaction. Assist moisture conditioning by discing, harrowing, or pulverizing until moisture content is reduced to a satisfactory value.

d. At the time of densification, the moisture content of “engineered fill”, “structural fill”, and “select fill” should within -3 and +3 percentage points of the materials ASTM-698 optimum moisture content.

e. Structural fill areas exposed to excessive wetting, drying or otherwise disturbed by the construction following acceptance for moisture and density should be retested followed by the correction of deficient areas just prior to the installation of additional fill or structures.

f. In no instance should placement of structural fill or ground supported structures be permitted if the ground surface soils contain a moisture content in excess of 3 percentage points of the materials optimum moisture content.

g. In no case shall porous drainage backfill (except as specifically indicated at foundation drains only) or masonry sand material be used adjacent to foundations. Care shall be taken to prevent masonry brick/block debris from falling or being pushed into foundation excavations.

3.11 GRADING:

A. General: Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated or between such points and existing grades.

B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes and as follows:

1. Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 0.10-foot above-or-below required subgrade elevations.

2. Walks: Shape surface of areas under walks to line, grade, and cross section, with finish surface not more than 0.10-foot above-or-below required subgrade elevation.
3. Pavements: Shape surface of areas under pavement to line, grade, and cross section, with finish surface not more than 1/2-inch above or below required subgrade elevation.
4. Connection of Existing and New Work: Provide flush transition, unless specifically indicated otherwise.

C. Grading Surface of Fill under Building Slabs and “Building Control Areas”: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/2-inch when tested with a 10-foot straightedge.

D. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.

3.12 FIELD QUALITY CONTROL

A. Quality Control Testing During Construction:

1. Allow testing agency to inspect and approve each subgrade and fill layer before further backfill or construction work is performed.
2. Perform field density tests in accordance with applicable ASTM testing method.
3. New Footing Subgrade: All foundation excavations shall be observed by the geotechnical engineer or his representative to verify required design bearing capacities of the bearing soils.
4. Perform at least 3 field density tests of subgrade for each lift of fill placed or 1 test per 5,000 square feet in building areas and 1 test per 10,000 square feet in other areas, whichever is more.
5. Foundation Wall Backfill: Perform at least 1-field density test for every 50-linear feet for each 8 inches of vertical thickness of fill placed at locations and elevations as directed.
6. Trenches: Perform at least one field density test for every 50-linear feet for each 8 inches of vertical thickness of fill placed in utility or similar trenches, which extend through the “controlled areas”.
   a. Retaining walls, if any, same as for “Trenches”, as indicated above.
7. A laboratory soil particle size, Atterberg limit, and Proctor density test shall be performed on each different type of fill soil used in the “controlled areas”.
8. Based on the Project Geotechnical Engineer’s testing reports, inspections, and recommendations, subgrade or fills that are below specified density, additional earthwork, compaction, and/or other operations, and re-testing, shall be performed until specified density is obtained. If additional trips are required for re-testing, re-testing will be paid for by the contractor.

3.13 EROSION CONTROL:

A. Provide erosion control methods in accordance with the BMP plan and the requirements of authorities having jurisdiction and per drawings.
3.14 MAINTENANCE:

A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

B. Repair and reestablish grades in settled, eroded, and rutted areas to specified tolerances.

C. Repair edges of existing pavements, sidewalks, etc., and other existing and/or new improvements flush with and to match existing materials and thicknesses, subject to acceptance by Owner and Engineer.

D. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.

E. Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn, or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.15 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Remove excess and waste materials, including unacceptable excavated materials, trash and debris, and legally dispose of off Owner's property.

END OF SECTION 31 20 00
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SECTION 31 25 00 - EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Construction Entrance/Exits
   2. Diversion Channels.
   3. PAM
   4. Rock Energy Dissipator.
   5. Rock Barriers.
   6. Sediment Control: including silt fences, inlet protection, etc.
   7. Sediment Ponds.
   8. Sediment Traps.
   9. Silt Fences

B. Related Sections:
   1. Section 03 30 00 Cast-In-Place Concrete.
   2. Section 05 50 00 Metal Fabrications.
   3. Section 31 05 16 Aggregates for Earthwork.
   4. Section 31 20 00 Earthmoving.
   5. Section 32 13 13 Concrete Paving.
   6. Section 32 91 13 Soil Preparation
   7. Section 32 92 00 Turf and Grasses.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

B. American Concrete Institute:
   1. ACI 301 - Specifications for Structural Concrete.

C. ASTM International:
   1. ASTM C127 - Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
   2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³).
3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft³ (2,700 kN-m/m³).
5. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

D. Precast/Prestressed Concrete Institute:
   1. PCI MNL-116S - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.

E. Alabama Department of Transportation Standard Specifications for Highway Construction.

F. Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas

1.3 SUBMITTALS
   A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
   B. Product Data: Product Data: Submit data on joint filler, joint sealer, admixtures, curing compounds, and geotextiles.
   C. Submit proposed mix design of each class of concrete for review prior to commencement of Work.
   D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

1.5 QUALITY ASSURANCE
   A. Perform Work according to State of Alabama Highways standards.

1.6 PRE-INSTALLATION MEETINGS
   A. Convene minimum one week prior to commencing work of this section.

PART 2 - PRODUCTS

2.1 ROCK AND GEOTEXTILE MATERIALS
   A. Furnish materials according to State of Alabama Department of Transportation standards.
B. Rock: As specified in Section 31 05 16 Aggregates for Earthwork. Furnish according to State of Alabama Highways standards.

C. Geotextile Fabric: Furnish according to State of Alabama Highways standards.

2.2 CONCRETE MATERIALS AND REINFORCEMENT

A. Cement: As specified in Section 03 30 00 Concrete.

2.3 PLANTING MATERIALS

A. Seeding and Soil Supplements: As specified in Section 32 91 13 Soil Preparation.

B. Turf and Grasses: As specified in Section 32 92 00 Turf and Grasses.

2.4 POLYACRYLAMIDE (PAM)

A. Only the anionic form of PAM shall be used. PAM and PAM mixtures shall be environmentally benign, harmless to fish, wildlife, and plants.

B. Anionic PAM in pure form shall have less than or equal to 0.05% acrylamide monomer by weight, as established by the FDA and US EPA.

2.5 Mats and Blankets (ECB’s)

A. 3:1 Slopes and flatter
   1. ECB must be rated for shear stresses up to 1.5 lbs/sq ft, must weigh at least 0.50 lbs/yd2, and the netting made of biodegradable polypropylene or FibreNet™ material

B. 1.5:1 to 3:1 Slopes
   1. ECB must be rated for shear stresses up to 1.2 lbs/sq ft, must weigh at least 0.73 lbs/yd2, and the netting made of biodegradable polypropylene or FibreNet™ material

C. Acceptable manufacturer
   1. American Excelsior Company, Arlington, TX
   2. Or approved equal

D. Inlet Protection Products
   1. Drop Inlets
      a. Silt Savers
      b. Dandy Sacks
   2. Curb Inlet
a. Dandy Curb  
b. Gutter Eel

3. The filter shall be a weighted sediment tube filter with a diameter of 9.5-inches at the ends and tapering to 5 inches in the center. Lengths shall be 6 to 9 feet with a build-in triangular overflow for relief during high-intensity storm events.

a. Unit Weight: 13 lbs/ft  
b. Interior Filter  
c. Materials: Shredded, recycled tire rubber particles with less than 2% metal and the rubber shall be washed during manufacturing.  
d. Particle Size: ½ inch to ¾ inch particle size  
e. Geotextile Bag  
   1) Percent Open Area: 8%  
   2) Apparent Opening Size: 30 U.S. Sieve  
   3) Grab Tensile Strength: 400 lbs  
   4) Flow Rate: 115 gal/min/ft²  
   5) Puncture Strength: 125 lbs

E. Fiber Rolls  
1. Fiber rolls should be prefabricated rolls or rolled tubes of geotextile fabric. When rolling the tubes, make sure each tube is at least 8 inches in diameter. Bind the rolls at each end and every 4 feet along the length of the roll with jute-type twine

F. Silt Fence  
1. The height of a silt fence shall not exceed 36 inches. Storage height and ponding height shall never exceed 18 inches.  
2. The standard-strength filter fabric shall be stapled or wired to the fence, and 12 inches of the fabric shall extend into the trench.  
3. Type A Silt Fence  
   a. A wire mesh support fence shall be fastened securely to the upslope side of the posts (between the posts and fabric) using heavy duty wire staples at least ½” long and ¾” wide, tie wires or hog rings. The wire shall extend into the trench a minimum of 6 inches and shall not extend more than 36 inches above the original ground surface.  
   b. Posts shall be 4’ long steel that each weigh at least 5.2 lbs.  
4. Type B Silt Fence  
   a. The spacing between posts shall be a maximum of 6’, and the filter fabric shall be stapled or wired directly to the posts.  
   b. Posts may be soft wood 2x4, oak 2x2, or steel as indicated for Type A Silt Fence

2.6 PIPE MATERIALS

A. Pipe: Corrugated steel, as specified in the State Highways standards.
2.7 ACCESSORIES
   A. Trash Rack: Bars welded to angles and at each intersection of bars, as specified in Section 05 12 00 Structural Steel.

2.8 SOURCE QUALITY CONTROL (AND TESTS)
   A. Section 01 40 00 - Quality Requirements: Testing, inspection and analysis requirements.
   B. Perform tests on cement, aggregates, and mixes to ensure conformance with specified requirements.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Verify compacted stabilized soil is acceptable and ready to support devices and imposed loads.
   B. Verify gradients and elevations of base or foundation for other work are correct.

3.2 DIVERSION CHANNELS
   A. Windrow excavated material on low side of channel.
   B. Compact to 95 percent maximum density.
   C. On entire channel area, apply soil supplements and sow seed as specified in Section 32 92 00.
   D. Mulch seeded areas with hay as specified in Section 32 92 00.

3.3 POLYACRYLAMIDE (PAM)
   A. The maximum application rate of PAM in pure form shall not exceed 200 lbs/ace/year. Over application of PAM can lower infiltration rates or suspend solids in water, and, therefore, over application should be avoided.
   B. Users of PAM shall obtain and follow all MSDS requirements.
   C. The manufacturer or supplier shall provide written application methods for PAM and PAM mixtures. The application shall provide uniform coverage to the target area.

3.4 MATS AND BLANKETS
   A. After the site has been shaped and graded to the approved design, prepare a seedbed free from clods and rocks more than 1 inch in diameter, and any foreign matter that will prevent the contact of the mat with the soil surface.
B. Lime, fertilizer, and seed shall be applied in accordance with seeding or other type of planting plan as suggested by the ENGINEER.

C. Erosion control blanket products should be installed in accordance with the manufacturer’s recommendations and specifications, including check slots and stapling materials.

D. Anchor product so that a continuous, firm contact with the soil surface/seed bed is maintained. This is best accomplished on slopes by working from the bottom to the top.

3.5 SEDIMENT CONTROL

A. Filter Ring/Rock Filter Ring
   1. Mechanical or hand placement of fiber rolls/straw wattles/stone shall be required to uniformly surround the structure to be supplemented.
   2. The filter ring may be constructed on natural ground surface, excavated surface, or on machine compacted fill.
   3. When placed below a storm drain outlet, it shall be constructed so that it does not allow water to back up into the storm drain.

B. Inlet Protection Products
   1. For information on installation, refer to the manufacturers’ drawings provided by the distributor. Strict adherence to the manufacturers’ suggested installation procedures is required for proper inlet protection.

C. Fiber Rolls
   1. On slopes, install fiber rolls along the contour with a slight downward angle at the end of each row to prevent ponding at the midsection. Turn the ends of each fiber roll upslope to prevent runoff from flowing around the roll. Install fiber rolls in shallow trenches dug 3 to 5 inches deep for soft, loamy soils and 2 to 3 inches deep for hard, rocky soils.
   2. Determine the vertical spacing for slope installations on the basis of the slope gradient and soil type. A good rule of thumb is:
      a. 1:1 slopes = 10 feet apart
      b. 2:1 slopes = 20 feet apart
      c. 3:1 slopes = 30 feet apart
      d. 4:1 slopes = 40 feet apart
   3. For soft, loamy soils, place the rows closer together. For hard, rocky soils, place the rows farther apart. Stake fiber rolls securely into the ground and orient them perpendicular to the slope. Drive the stakes through the middle of the fiber roll and deep enough into the ground to anchor the roll in place. About 3 to 5 inches of the stake should stick out above the roll, and the stakes should be spaced 3 to 4 feet apart. A 24-inch stake is recommended for use on soft, loamy soils. An 18-inch stake is recommended for use on hard, rocky soils.

D. Rock Filter Dam
1. The center of the rock dam should be at least 6” lower than the outer edges of the dam at the channel banks. Side slopes shall be 2:1 or flatter. The top width of the dam should be at least 6’.
2. The dam should not be higher than the channel banks or the elevation of the upstream property line.
3. Set a marker stake to indicate the clean out elevation.

3.6 CONSTRUCTION ENTRANCE/EXIT

A. The entrance/exit must be excavated to a depth of 3” and cleared of all vegetation and roots.

B. The entrance/exit course aggregate should be ALDOT coarse aggregate gradation No. 1 and be a minimum of 6” think and a minimum 50’ long and 20’ wide.

C. If the action of the vehicle travelling over the gravel pad does not sufficiently remove the mud, the tires should be washed prior to entrance onto public rights-of-way. When washing is necessary, it should be done on an area stabilized with crushed stone.

D. A geotextile fabric underliner should be placed the full length and width of the entrance.

3.7 ROCK ENERGY DISSIPATOR

A. Excavate to indicated depth of rock lining or nominal placement thickness as follows. Remove loose, unsuitable material below bottom of rock lining, then replace with suitable material. Thoroughly compact and finish entire foundation area to firm, even surface.

1. Nominal Placement Thickness per NCSA Class:
   a. R7: 36 Inches
   b. R6: 30 Inches
   c. R5: 24 Inches
   d. R4: 18 Inches
   e. R3: 12 Inches

B. Lay and overlay geotextile fabric over substrate. Lay fabric parallel to flow from upstream to downstream. Overlap edges upstream over downstream and upslope over downslope. Provide a minimum overlap of 1.5 feet. Cover fabric as soon as possible and in no case leave fabric exposed more than 4 weeks.

C. Carefully place rock on geotextile fabric to produce an even distribution of pieces, with minimum of voids and without tearing geotextile.

D. Unless indicated otherwise, place full course thickness in one operation to prevent segregation and to avoid displacement of underlying material. Arrange individual rocks for uniform distribution.
3.8 ROCK BARRIER

A. Determine length required for ditch or depression slope and excavate, compact and foundation area to firm, even surface.

B. Produce an even distribution of rock pieces, with minimum voids to the indicated shape, height and slope.

C. Construct coarse aggregate filter blanket against upstream face of rock barrier to the indicated thickness.

3.9 SEDIMENTATION POND

A. Clear and grub storage area and embankment foundation area site as indicated and specified.

B. Excavate key trench for full length of dam. Excavate emergency spillway in natural ground.

C. Install pipe spillway, with anti-seep collar attached, at location indicated.

D. Place forms, and reinforcing for concrete footing at bottom of riser pipe with trash rack and anti-vortex device. Construction of embankment and trench prior to placing pipe is not required.

E. Mix, place, finish, and cure concrete, as specified in Section 03 30 00.

F. Do not use coarse aggregate as backfill material around pipe. Backfill pipe with suitable embankment material to prevent dam leakage along pipe.

G. Construct rock basin at outlet end of pipe. Place embankment material, as specified.

H. On entire sedimentation pond area, apply soil supplements and sow seed as specified in Section 32 92 00.

I. Mulch seeded areas with hay.

J. Apply PAM.

3.10 SEDIMENT TRAPS

A. Clear site, as indicated.

B. Construct trap by excavating and forming embankments as indicated in the drawings.

C. Place coarse aggregate or rock at outlet as indicated on Drawings.

D. Place geotextile fabric, as specified for rock energy dissipator.

E. When required, obtain borrow excavation for formation of embankment.

F. On entire sediment trap area, apply soil supplements and sow seed as specified in Section 32 91 13.
3.11 SITE STABILIZATION

A. Incorporate erosion control devices indicated on the Drawings into the Project at the earliest practicable time.

B. Construct, stabilize and activate erosion controls before site disturbance within tributary areas of those controls.

C. Stockpile and waste pile heights shall not exceed 35 feet. Slope stockpile sides at 2:1 or flatter.

D. Stabilize any disturbed area of affected erosion control devices on which activity has ceased and which will remain exposed for more than 14 days.

E. Stabilize diversion channels, sediment traps, and stockpiles immediately.

3.12 FIELD QUALITY CONTROL & INSPECTIONS

A. Section 01 40 00 - Quality Requirements and 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect erosion and sediment control devices after each storm event greater than or equal to 3/4” or at a minimum of once per month. Make necessary repairs to ensure erosion and sediment controls are in good working order.

C. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

D. The Contractor may contact Evan Reid at Goodwyn, Mills, & Cawood (251-460-4006) in Mobile, Alabama for assistance with stormwater permitting, inspection, and BMP plan.

E. CONTRACTOR is responsible for continually maintaining all temporary erosion control measures until permanent measures are properly installed and performing as required.

3.13 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. When sediment accumulation in sedimentation structures has reached a point one-third depth of sediment structure or device, remove and dispose of sediment.

C. Do not damage structure or device during cleaning operations.

D. Do not permit sediment to erode into construction or site areas or natural waterways.

E. Clean channels when depth of sediment reaches approximately one half channel depth.
3.14 PROTECTION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Immediately after placement, protect paving from premature drying, excessive hot or cold temperatures, and mechanical injury.

C. Protect paving from elements, flowing water, or other disturbance until curing is completed.

END OF SECTION 31 25 00
SECTION 32 91 13 - SOIL PREPARATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes planting soils and layered soil assemblies specified by composition of the mixes.
B. Related Requirements:
   1. Division 31 - Earthwork
   2. Section 32 92 00 "Turf and Grasses" for placing planting soil for turf and grasses.

1.3 DEFINITIONS
B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.
C. CEC: Cation exchange capacity.
D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.
E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
F. Imported Soil: Soil that is transported to Project site for use.
G. Layered Soil Assembly: A designed series of planting soils, layered on each other that together produce an environment for plant growth.
H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.
I. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.
J. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."

K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.


M. SSSA: Soil Science Society of America.

N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

O. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

P. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.


1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include recommendations for application and use.
2. Include test data substantiating that products comply with requirements.
3. Include sieve analyses for aggregate materials.
4. Material Certificates: For each type of imported soil and soil amendment and fertilizer before delivery to the site, according to the following:
   a. Manufacturer's qualified testing agency's certified analysis of standard products.
   b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
   c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.
1.6 INFORMATIONAL SUBMITTALS

A. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.

B. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Owner will engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil.

1. Notify Engineer seven days in advance of the dates and times when the contractor requests samples will be taken.

B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.

1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.9 SOIL-SAMPLING REQUIREMENTS

A. General: Extract soil samples according to requirements in this article.

B. Sample Collection and Labeling: Have samples taken and labeled by Contractor in presence of Engineer under the direction of the testing agency.

1. Number and Location of Samples: Minimum of three representative soil samples from varied locations for each soil to be used or amended for landscaping purposes.

2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."

3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.

4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.10 TESTING REQUIREMENTS

A. General: Perform tests on soil samples according to requirements in this article.
B. Physical Testing:

1. Soil Texture: Soil-particle, size-distribution analysis by one of the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":
   a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.

2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."


C. Chemical Testing:

1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."

2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1- Physical and Mineralogical Methods."

D. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of SSSA NAPT SERA-6, including the following:

1. Percentage of organic matter.
2. CEC, calcium percent of CEC, and magnesium percent of CEC.
3. Soil reaction (acidity/alkalinity pH value).
4. Buffered acidity or alkalinity.
6. Phosphorous ppm.
7. Potassium ppm.
8. Manganese ppm.
10. Zinc ppm.
11. Zinc availability ppm.
12. Copper ppm.
13. Sodium ppm.
15. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
16. Other deleterious materials, including their characteristics and content of each.

F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.

1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. for 6-inch depth of soil.
2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. for 6-inch depth of soil.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Do not move or handle materials when they are wet or frozen.
4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.1 PLANTING SOILS SPECIFIED BY COMPOSITION

A. General: Soil amendments, fertilizers, and rates of application specified in this article are guidelines that may need revision based on testing laboratory's recommendations after preconstruction soil analyses are performed.

B. Planting-Soil Type: Provide offsite topsoil or amend existing, on-site surface soil, with the duff layer, if any, retained; modified to produce viable planting soil. Blend existing, on-site surface soil with the soil amendments and fertilizers required for the topsoil to have the following qualities or provide from offsite as follows:

1. Fertile, friable, naturally occurring. Free of stones, clay, lumps, hardpan, roots, stumps, branches, sticks and other debris larger than one inches in any dimension; free of noxious weeds, grasses, seeds, plants, extraneous matter and any substance harmful to plant growth. Topsoil from open fields will not be accepted.
2. Ph: 5.0 to 7.0
3. Organic Matter: 5% to 10%
4. Sand: 50% to 70%
5. Silt: less than 30%
6. Clay: 10% to 25%
7. Permeability Rate of $5 \times 10^{-3}$ centimeters or greater at 85% compaction.
8. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches deep, not from bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass.
9. Unacceptable Properties: Clean soil of the following:
   a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
   1. Class: T, with a minimum of 99 percent passing through a No. 8 sieve and a minimum of 75 percent passing through a No. 60 sieve.
   2. Class: O, with a minimum of 95 percent passing through a No. 8 sieve and a minimum of 55 percent passing through a No. 60 sieve.
   3. Form: Provide lime in form of ground dolomitic limestone or calcitic limestone.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Perlite: Horticultural perlite, soil amendment grade.

E. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 sieve.

F. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C 33.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC’s "Seal of Testing Assurance," and as follows:
   1. Feedstock: May include sewage sludge.
   2. Reaction: pH of 5.5 to 8.
3. Moisture Content: 35 to 55 percent by weight.
4. Particle Size: Minimum of 98 percent passing through a 1-inch sieve.

B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture with 100 percent passing through a 1/2-inch sieve, a pH of 3.4 to 4.8, and a soluble-salt content measured by electrical conductivity of maximum 5 dS/m.

C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture with 100 percent passing through a 1/2-inch sieve, a pH of 6 to 7.5, a soluble-salt content measured by electrical conductivity of maximum 5 dS/m, having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.

D. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.4 FERTILIZERS

A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

D. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

PART 3 - EXECUTION

3.1 GENERAL

A. Place planting soil and fertilizers according to requirements in other Specification Sections.
B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

C. Proceed with placement only after unsatisfactory conditions have been corrected.

3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

A. Excavation: Excavate soil from designated area(s) to a depth of 6 inches and stockpile until amended.

B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

C. Unsuitable Materials: Clean soil to contain a maximum of 5 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.

D. Screening: Pass unamended soil through a 2-inch sieve to remove large materials.

3.3 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 6. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply, add soil amendments, and mix approximately half the thickness of unamended soil over prepared, loosened subgrade according to "Mixing" Paragraph below. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil.

C. Mixing: Spread unamended soil to total depth of 4 inches, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

1. Amendments: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.
   a. Mix lime with dry soil before mixing fertilizer.
   b. Mix fertilizer with planting soil no more than seven days before planting.

2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 8 inches in loose depth for material compacted by compaction equipment, and not more than in loose depth for material compacted by hand-operated tampers.
D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698 and tested in-place except where a different compaction value is required due to use or as directed by the Engineer.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.4 PLACING MANUFACTURED PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply manufactured soil on-site in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 6 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply approximately half the thickness of planting soil over prepared, loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil.

C. Application: Spread planting soil to total depth of 4 inches, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

1. Lifts: Apply planting soil in lifts not exceeding 8 inches in loose depth for material compacted by compaction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698 and tested in-place except where a different compaction value is required due to use or as directed by the Engineer.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.5 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

A. Application: Apply compost component of planting-soil mix 4 inches of compost to surface of in-place planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
B. Perform the following tests and inspections:

1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D 698. Space tests at no less than one for each 2000 sq. ft. of in-place soil or part thereof.

C. Soil will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

3.7 PROTECTION

A. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Vehicle traffic.
4. Foot traffic.
5. Erection of sheds or structures.
6. Impoundment of water.
7. Excavation or other digging unless otherwise indicated.

B. If planting soil or subgrade is overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Engineer and replace contaminated planting soil with new planting soil.

3.8 CLEANING

A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.

B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.

1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION 32 91 13
SECTION 32 92 00 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Seeding.
   2. Hydroyeeding.
   4. Erosion-control material(s).

B. Related Requirements:
   1. Section 32 91 13 “Soil Preparation”

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 32 91 13 "Soil Preparation."

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for grass and seeds. Include identification of source and name and telephone number of supplier.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.

1. Experience: Three years' experience in turf installation in addition to requirements in Section 01 40 00 "Quality Requirements."

2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.


1.8 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

C. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

3. Accompany each delivery of bulk materials with appropriate certificates.

1.9 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the periods indicated in the seeding and grassing chart or as advised by the turf provider. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species:
   1. Quality: State-certified seed of grass species as listed.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
   2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.2 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   1. Organic Matter Content: 50 to 60 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

2.3 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.4 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

C. Erosion-Control Mats: Cellular, nonbiodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of 3-inch nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Invisible Structures, Inc.

b. Presto Products Company.

c. Tenax Corporation - USA.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel,
paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Engineer and replace with new planting soil.

3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and mix planting soil according to Section 32 91 13 "Soil Preparation."

B. Placing Planting Soil: Place and mix planting soil in place over exposed subgrade.
1. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Before planting, obtain Engineer’s acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Turf Area Preparation" Article.

B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.

C. Fill cells of erosion-control mat with planting soil and compact before planting.
D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
   1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
   2. Do not use wet seed or seed that is moldy or otherwise damaged.
   3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of 3 to 4 lb/1000 sq. ft. or as indicated by the ALDOT guidelines.

C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets installed and stapled according to manufacturer's written instructions.

E. Protect seeded areas with erosion-control mats where indicated on Drawings; install and anchor according to manufacturer's written instructions.

F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
   1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

G. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch planting soil within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

3.6 HYDROSEEDING

A. Hydroseeding: Mix specified seed, commercial fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
   1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.
   2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.
3.7 SODDING

A. Lay sod within 24 hours of harvesting unless a suitable preservation method is accepted by Engineer prior to delivery time. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than two anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.8 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.

2. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Owner shall mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet.

D. Turf Postfertilization: Apply commercial fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.
3.9 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Engineer:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.

B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.10 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.11 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove non-degradable erosion-control measures after grass establishment period.

END OF SECTION 32 92 00
SECTION 33 05 16.13 - PRECAST CONCRETE UTILITY STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Precast concrete utility structures
   2. Frames and covers
   3. Access hatches

B. Related Requirements:
   1. Section 03 30 00 - Cast-in-Place Concrete
   2. Division 31 – Earthwork
   3. Division 33 – Utilities

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:
   1. AASHTO HB-17 - Standard Specifications for Highway Bridges.

B. American Concrete Institute:
   2. ACI 211.2 - Standard Practice for Selecting Proportions for Structural Lightweight Concrete.
   3. ACI 318 - Building Code Requirements for Structural Concrete and Commentary.

C. ASTM International:
   3. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
   5. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
   6. ASTM A496 - Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
8. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
9. ASTM A767 - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
13. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
16. ASTM C138 - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
20. ASTM C192 - Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
21. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
27. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
29. ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
36. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
38. ASTM C1433 - Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers.

D. American Welding Society:
   1. AWS D1.1 - Structural Welding Code - Steel.
   2. AWS D1.4 - Structural Welding Code - Reinforced Steel.

E. National Precast Concrete Association:
   1. NPCA Plant Certification Program.
   2. NPCA Quality Control Manual for Precast and Prestressed Concrete Plants.

1.3 SUBMITTALS

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

B. Product Data:
   1. Submit data for frames and covers, steps, component construction, features, configuration, and dimensions.

C. Shop Drawings:
   1. Indicate structure locations, elevations, sections, equipment supports, piping, conduit, sizes and elevations of penetrations, and block-outs/knockouts.
   2. Indicate design, construction and installation details, typical reinforcement and additional reinforcement at openings.

D. Submit concrete mix design for each different mix.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for custom fabrications.

G. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

H. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

I. Qualifications Statements:
   1. Submit qualifications for manufacturer.
1.4 QUALITY ASSURANCE

A. Obtain precast concrete utility structures from single source.

B. Perform structural design according to ACI 318.

C. Perform Work according to NPCA Quality Control Manual for Precast and Prestressed Concrete Plants.

D. Conform to following material and fabrication requirements:
   2. Other Structures: ASTM C913.

E. Perform welding according to following:
   2. Reinforcing Steel: AWS D1.4

F. Perform Work according to National Precast Concrete Association (NPCA) standards.

G. Design precast concrete members under direct supervision of a Professional Structural Engineer experienced in design of precast concrete. Drawings shall bear the stamp of the P.E.

1.5 QUALIFICATIONS

A. Manufacturer: Certified by NPCA Plant Certification Program prior to and during Work of this Section.

B. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' documented experience.

C. Welders and Welding Procedures: AWS qualified within previous 12 months for employed weld types.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Do not deliver products until concrete has cured 5 days or has attained minimum 75 percent of specified 28-day compressive strength.

C. Inspection: Accept precast structures on Site in manufacturer's original packaging and inspect for damage.

D. Comply with precast concrete manufacturer instructions for unloading, storing, and moving precast structures.

E. Lift structures from designated lifting points.
F. Storage:

1. Store precast concrete manholes and drainage structures to prevent damage to Owner's property or other public or private property.
2. Repair property damaged from materials storage.

PART 2 - PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Design structures for minimum loads conforming to ASTM C857 and ASTM C890.

B. Roof Live Load: Comply with following loading conditions, including impact load:

1. Heavy Traffic:
   a. ASTM C857, A-16.
   b. Maximum 16,000 lb. each wheel.

2. Medium Traffic:
   b. Maximum 12,000 lb. each wheel.

3. Light Traffic:
   b. Maximum 8,000 lb. each wheel.

4. Walkway Traffic:
   a. ASTM C857, A-0.3.
   b. Maximum 300 psf.

2.2 PRECAST CONCRETE UTILITY STRUCTURES

A. Manufacturers:

   1. Foley Products
   2. Hanson Pipe and Precast
   3. Manarch Products, Inc.
   4. Old Castle Precast, Inc.
   5. Or Approved Equal

B. Precast Concrete Utility Structures: Reinforced precast concrete.

   1. As shown on the drawings
2.3 FRAMES AND COVERS

A. Manufacturers:
   1. Barry Pattern & Foundry Company
   2. EJ Iron Works
   5. Or Approved Equal

B. Description:
   1. Construction: ASTM A48, Class 30B cast iron or other material as shown on the plan drawings.
   2. Frame for cover: Shall be cast in place by the precast concrete manufacture or blocked-out for field installation of frame per dimensions required for the opening.

2.4 ACCESS HATCHES

A. Manufacturers:
   1. Halliday Products
   2. The Bilco Company
   3. U.S.F. Fabrication
   4. Or Approved Equal

B. Access Hatch:
   1. All access hatches shall be double or single leaf as shown on the drawings. Automatic doors shall be equipped with a minimum of two stainless steel hinges with stainless steel pins. Each door leaf shall also have spring operators with a positive hold open arm that engages automatically in full open position, and a non-corrosive release handle. Doors shall open with a maximum lift force of 9 lbs. When closed, doors shall not protrude above the operating surface in which they are installed. Include slam lock feature with removable key.
   2. When subject to vehicular traffic, cover shall be reinforced to support an AASHTO H-20 wheel load with a maximum deflection of 1/150th of the span.
   3. Door leaves shall be 1/4-inch aluminum checkered plate reinforced with structural aluminum channels, capable of withstanding 300 pounds per square foot uniform load with minimal deflection for non-vehicular loading service. When subject to vehicular traffic, cover shall be reinforced to support an AASHTO H-20 wheel load with a maximum deflection of 1/150th of the span.
   4. The gutter frame provided shall be of 1/4-inch aluminum with an anchor flange around the perimeter. Frame shall incorporate a 1 ½” threaded drain fitting and neoprene gasket.
   5. The drain coupling shall be located in an appropriate corner of each channel frame away from the access steps. Contractor shall attach and route Sch 80 PVC pipe from drain port to daylight away from structure. If daylight is not ready accessible within 10-ft, then contractor shall terminate piping into ½ cubic yard of #57 stone wrapped with filter fabric. Piping shall project through walls with sleeve and Link-Seal in a water-tight (leak-proof) installation.
6. Factory finish shall be mill finish.
7. Hardware shall be stainless steel.
8. Any surface or portion of the frame contacting concrete shall receive a bituminous coating.
9. The door shall open to 90 degrees and lock automatically in that position. A vinyl grip handle shall be provided to release and close the cover with one hand.
10. Doors, which are to receive flooring, shall be smooth plate. Doors which will not receive flooring shall be checkered plate

2.5 MATERIALS
A. Concrete: As specified in Section 03 30 00 – Cast-In-Place Concrete.
B. Admixtures: As specified in Section 03 30 00 – Cast-In-Place Concrete.
C. Concrete Reinforcement: As specified in Section 03 30 00 – Cast-In-Place Concrete.

2.6 FABRICATION
A. Fabricate precast concrete utility structures conforming to ACI 318 and NPCA Quality Control Manual for Precast and Prestressed Concrete Plants.
B. Fabricate precast concrete utility structures with knock-out panels, embedded items (frames, etc.), and openings to size and configuration as indicated on Drawings.
C. Construct forms to provide uniform precast concrete units with consistent dimensions.
D. Clean forms after each use.
E. Reinforcing:
   1. Install reinforcement by tying or welding to form rigid assemblies.
   2. Position reinforcement to maintain minimum ½ inch cover.
   3. Secure reinforcement to prevent displacement while placing concrete.
F. Position and secure embedded items to prevent displacement while placing concrete.
G. Deposit concrete in forms and consolidate concrete without segregating aggregate.
H. Provide initial curing by retaining moisture using one of following methods:
   1. Cover with polyethylene sheets.
   2. Cover with burlap or other absorptive material and keep continually moist.
   3. Apply curing compound according to manufacturer instructions.
I. Provide final curing according to manufacturer's standard.
J. Remove forms without damaging concrete.
K. Tension reinforcement tendons as required to achieve design load criteria.
L. Exposed Ends at Stressing Tendons: Fill recess with non-shrink grout, trowel flush.

2.7 MIXES
A. Concrete:
   1. Design Mix shall be as specified in Section 03 30 00 – Cast-In-Place Concrete.

2.8 FINISHES
A. Reinforcing Steel, Wire and Wire Fabric, Concrete and Steel shall be as specified in Section 03 30 00 – Cast-In-Place Concrete.

2.9 ACCESSORIES
A. Membrane Curing Compound: ASTM C309, Type 2, Class A.
B. Steps:
   1. Formed steel-reinforced polypropylene rungs.
   3. Width: 10 inches, minimum.
   4. Spacing: 15 inches o.c. vertically or as indicated on Drawings.
C. Inserted and Embedded Items:
   1. Structural Steel Sections:
      a. Comply with ASTM A36.
      b. Finish: As shown or called for on the plans or in related specification sections
D. Bearing Pads:
   1. High density plastic, Vulcanized elastomeric compound molded to size, Neoprene (Chloroprene), or Tetrafluoroethylene (TFE); Shore A Durometer; 1/8 inch (3 mm) thick, smooth both sides.
E. Joint Sealants and Joint Gaskets:
   1. Gasket Joints for Circular Concrete Pipe:
      a. ASTM C443.
      b. Gaskets: Oil-resistant rubber.
   2. External Sealing Bands:
      a. Comply with ASTM C877.
      b. Material: Type I, rubber and mastic.
3. Preformed Joint Sealants for Concrete Pipe and Box Sections: Comply with ASTM C990
4. Elastomeric Joint Sealants:
   a. Comply with ASTM C920.
   b. Material: Polyurethane.
   c. Grade NS, Class 35.

F. Pipe Entry Connectors: Comply with ASTM C923.

G. Grout:
   1. Cement Grout: Portland cement, sand, and water mixture with stiff consistency to suit intended purpose.
   2. Non-Shrink Grout:
      a. Description: Premixed compound consisting of non-metallic aggregate, cement, and water-reducing and plasticizing agents.
      b. Conform to ASTM C1107.
      c. Minimum Compressive Strength: 2,400 psi in 48 hours, and 7,000 psi in 28 days.

H. Bituminous Coating:
   1. Manufacturers:
      a. Carboline Company; a subsidiary of RPM International
      b. Duron, Inc.
      c. Laurence, C.R. Co., Inc.
      d. Or Approved Equal
   2. Description: Provide damproofing on the exterior side of structures in the field where structure will be below grade. Coating shall be a two-component, self-priming, chemically cured, coal tar epoxy protective coating.

I. Touch-Up Primer for Galvanized Surfaces:
   1. As specified in Section 09 96 00 – High-Performance Coatings

2.10 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Testing:
   1. Perform following tests for each 100 cu. yd. of concrete placed with minimum one set of tests each week:
      a. Slump: Comply with ASTM C143.
      c. Air Content: Comply with ASTM C231 or ASTM C173.
      d. Unit Weight: Comply with ASTM C138.
2. Make test results available to Engineer/Owner upon request.

C. Inspection:
   1. Visually inspect completed precast structures for defects.
   2. Repair defects on surfaces exposed to view to achieve uniform appearance.
   3. Repair honeycomb by removing loose material and applying grout to produce smooth surface flush with adjacent surface.
   4. Repair of major defects not allowed

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
   B. Verify that items provided by other Sections of Work are properly sized and located.
   C. Verify correct size and elevation of excavation.
   D. Verify that subgrade and bedding are properly prepared, compacted, and ready to receive Work of this Section.

3.2 PREPARATION
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
   B. Mark each precast structure by indentation or using waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers shown on Drawings to indicate its intended use.
   C. Coordinate placement of inlet and outlet pipe or duct sleeves required by other Sections.
   D. Do not install structures if Site conditions induce loads exceeding weight capacity of structures.
   E. Inspect precast concrete structures immediately prior to placement in excavation to verify that they are internally clean and free from damage; remove and replace damaged units.

3.3 INSTALLATION
   A. Install underground precast utility structures according to ASTM C891.
   B. Lift precast concrete structures at lifting points designated by manufacturer.
   C. When lowering structures into excavations and joining pipe to units, take precautions to ensure that interior of pipeline and structure remains clean.
D. Install precast concrete base to elevation and alignment as indicated on Drawings.

E. Install precast concrete utility structures to elevation and alignment as indicated on Drawings.

F. Erect members without damage to structural capacity, shape, or finish. Replace or repair damaged members.

G. Maintain temporary bracing in place until final support is provided. Protect members from staining.

H. Provide temporary lateral support to prevent bowing, twisting, or warping of members.

I. Adjust differential camber between precast members to tolerance before final attachment.

J. Install bearing pads.

K. Level differential elevation of adjoining horizontal members with grout to maximum slope of 1:12.

L. Assembly of Multi-section Structures:
   1. Lower each section into excavation.
   2. Clean joint surfaces.
   3. Install watertight joint seals according to manufacturer instructions using gasket joints, external sealing bands, preformed joint sealants, elastomeric joint sealants, grout, as required.

M. Remove knockouts or cut structure to receive piping without creating openings larger than required to fit pipe; fill annular space with grout.

N. Pipe Connections:
   1. Connect pipe to structure and seal watertight.
   2. Cut pipe flush with interior of structure.

O. Base/Foundation slab:
   1. Grout to achieve slope to exit piping.
   2. Trowel smooth.
   3. Contour to form continuous drainage channel as indicated on Drawings.

P. Paint exterior with two coats of bituminous interior coating at rate of per coating manufacturer for each coat.

Q. Frame and Cover and Access Hatch:
   1. Set level, without tipping, to elevations as indicated on Drawings.
   2. Set cover and access hatch 3 inches above finished grade for structures located within unpaved areas to allow area to be graded away from cover beginning 1 inch below top surface of frame.
   3. Connect drain from access hatch frame to storm drainage system.
R. Touch up damaged galvanized coatings.

S. Backfill excavations for structures as specified in Division 31.

3.4 ERECTION TOLERANCES

A. Erect members level and plumb within allowable tolerances

B. Conform to PCI MNL-116S.

C. Design and erect to the following tolerances:

1. Maximum Variation from Plane or Location Indicated on Drawings: 1/4 inch/10 feet and 3/8 inch in 100 feet, non-cumulative.

2. Maximum Offset from True Alignment between Members: 1/4 inch.


D. Exposed Joint Dimension: 3/8 inch plus or minus 1/4 inch.

E. When members cannot be adjusted to conform to design or tolerance criteria, cease work and advise. Execute modifications as directed.

3.5 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Perform vacuum test and exfiltration test as specified in Division 33.

END OF SECTION 33 05 16.13
SECTION 334713 - POND AND RESERVOIR LINERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Impermeable geomembrane liners for ponds and reservoirs

B. Related Requirements:
   1. Division 31 - Earthwork

1.2 REFERENCE STANDARDS

A. ASTM International:
   4. ASTM D1204 - Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.

B. South Coast Air Quality Management District:
   1. SCAQMD Rule 1168 - Adhesive and Sealant Applications.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information on liner.

C. Shop Drawings: Indicate joining details and special details.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Qualifications Statements:
   1. Submit qualifications for manufacturer and installer.
   2. Submit manufacturer's approval of installer.

1.4 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of pipe penetrations.

1.5 QUALITY ASSURANCE

A. Perform Work according to applicable standards.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 10 years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum 10 years' documented experience and approved by manufacturer.

1.7 DELIVERY, STORAGE AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Transport and handle liner with equipment designed to protect liner from damage.

C. Storage:
   1. Store materials according to manufacturer instructions.

D. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.
1.8 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

1.9 WARRANTY

A. Furnish 1-year manufacturer's warranty for repair or replacement of liners that leak or fail in materials and workmanship or that deteriorate under conditions of normal weather.

B. The product shall be warranted for 20 years to withstand normal weathering and environmental degradation.

PART 2 - PRODUCTS

2.1 LINERS

A. Manufacturers:
   1. Intertape Polymer Corporation (ArmorLiner™ 30SFL)
   2. Or Pre-Approved Equal

B. Approved Installers
   1. Erosion Control Systems
   2. Or Pre-Approved Equal

C. Product Description
   1. Heavyweight fabric incorporating a special weave pattern to enhance thickness, flatness, and tear properties.
   2. Nominal thickness: 30 mils
   3. Weave: Woven black HDPE scrim
   4. Coating: 24 mil
   5. Film: 5.5 mil
   6. Weight: 14.7 oz/yd³

D. Material
   1. Weave: Woven black HDPE scrim
   2. Coating: 24 mil

E. Comply with ASTM D7176.

F. Performance Properties
1. Grab Tensile: MD 410 lb (ASTM D7004)
2. Strip Tensile: MD 260 lb/in (ASTM D7003)
3. Tongue Tear-large scale: MD 79 lb (ASTM D5884)
4. Mullen Burst: 622 psi (ASTM D751)
5. MVTR: 0.05 perms (ASTM E96 Proc. BW)
6. Hydraulic Conductivity: $2.06 \times 10^{-12}$ cm/s
7. Hydrostatic Resistance: 635 psi (ASTM D751)
8. Puncture Resistance: 195 lb (ASTM D4833)
9. CBR Static Puncture: 1272 lb (ASTM D6241)
10. Carbon Black Content: 3% (ASTM D4218)
11. Accelerated UV Weathering: >90% strength retention after 10,000 light hours

2.2 FABRICATION

A. Fabricate liner panels from sheets in sizes as large as possible, with factory-sealed seams and consistent with limitations of weight and installation procedures.

B. Minimize field seaming.

2.3 ACCESSORIES

A. Adhesives and Solvents:

1. Type: As recommended by liner manufacturer for sealing seams in geomembrane, and for sealing projections through liner.
2. Do not use adhesive exposed to temperatures of 40 degrees F for more than 24 hours.

B. Penetration Assemblies: Manufacturer's standard factory-fabricated assemblies for sealing penetrations for utilities and structures.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that anchor trench excavation, where liner is to be secured, is in correct location and configuration.

C. Verify that subgrade and anchor trench excavation is free from angular rocks, rubble, roots, vegetation, debris, voids, protrusions, groundwater, and other conditions that may affect liner performance.
3.2 PREPARATION

A. Conduct operations as not to interfere with, interrupt, damage, destroy, or endanger integrity of surface or subsurface structures or utilities, and landscape in immediate or adjacent areas.

B. Side Slopes:
   1. The Contractor shall prepare slopes to receive liner as shown on the Drawings.
   2. Shape slopes to even surface and to required depth and section, as indicated on Drawings and according to liner manufacturer instructions.

C. Remove sharp sticks, stones, and trash from bottom and sides of excavation subgrade that may puncture liner.

D. Contractor shall prepare perimeter anchoring trench as indicated on Drawings.

3.3 INSTALLATION

A. Installation shall be by a pre-qualified installer approved by the liner manufacturer.

3.4 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Equipment Acceptance:
   1. Before initial filling of pond, or placement of earth or other cover, inspect seams and repaired areas to ensure tight and continuously bonded installation.
   2. Repair damaged liner and seams and reinspect repaired Work.
   3. Make final adjustments to liners under direction of manufacturer's representative.

C. Furnish installation certificate from equipment manufacturer's representative attesting that liner has been properly installed and is ready for startup and testing.

3.5 PROTECTION

A. Section 017000 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect installed liner according to liner manufacturer instructions.

END OF SECTION 334713
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SECTION 40 05 06 - COUPLINGS, ADAPTERS, AND SPECIALS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe penetrations.
   2. Restrained joints.
   4. Expansion joints.
   5. Expansion loops.
   7. Wall sleeve.

B. Related Requirements:
   1. Section 05 50 00 - Metal Fabrications
   2. Section 09 96 00 – High-Performance Coatings
   3. Division 40 – Process Integration

C. Conform to the requirements of Section 40 05 13 – Common Requirements for Process Piping

1.2 REFERENCE STANDARDS

A. American Water Works Association:
   1. AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe.
   2. AWWA C227 Bolted, Split-Sleeve Restrained and Nonrestrained Couplings for Plain-End Pipe.

B. American Welding Society:
   1. AWS D1.1/D1.1M - Structural Welding Code - Steel.

C. ASME International:
   2. ASME B31.3 - Process Piping.
   3. ASME B31.9 - Building Services Piping.
   4. ASME Boiler and Pressure Vessel Code (BPVC), Section IX - Welding, Brazing, and Fusing Qualifications.

D. ASTM International:
1. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.

E. Expansion Joint Manufacturers Association, Inc.:
1. EJMA Standards.

F. NSF International:
1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

G. UL:
2. UL 1479 - Fire Tests of Through-Penetration Firestops.

PART 2 - PRODUCTS

2.1 PIPE PENETRATIONS

A. Flashing:
1. Metal Flashing:
   b. Thickness: 26 gage.
2. Metal Counterflashing:
   b. Thickness: 22 gage.
3. Flexible Flashing Materials:
   a. Material: Butyl sheet, PVC sheet, or Compatible with service conditions.
   b. Thickness: 47 mils.
4. Caps:
   b. Minimum Thickness: 22 gage, and 16 gage at fire-resistive elements.

B. Sleeves:
1. Sleeves for Pipes through Non-fire-rated Floors:
   b. Thickness: 0.0625 inch minimum
2. Sealant:
   a. As specified in Section 07 92 00 - Joint Sealants.

C. Mechanical Sleeve Seals:

1. Manufacturers:
   a. Flexicraft Industries, PipeSeal
   b. GPT (Link-Seal)
   c. Or Approval Equal

2. Description:
   a. Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve.
   b. Connection: Bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.2 RESTRAINED JOINTS

A. Flange Adapter (Set Screws)

1. Manufacturer:
   a. EZ Flange Adapter (EBAA Iron, Inc.)
   b. Uni-Flange, series 400 (OR series 420)
   c. Ford Meter Box Company, Inc. (Nappco, Inc.)
   d. Star Pipe Series 400
   e. Or Approved Equal.

2. Description:
   a. The uniflange assembly shall be used only in instances shown on the drawings. If the CONTRACTOR proposes to use uniflanges at other locations, he shall first obtain approval from the ENGINEER.
   b. The uniflange shall consist of a Ductile Iron ASTM A536 Grade 65-45-12 flange with ANSI B16.1 Class 125 & 250 or ANSI B16.5 Class 150 & 300 drillings.
   c. The standard gasket of Buna S for water and wastewater shall be supplied.
   d. The uniflange class shall be suitable for the pressure service. (2”-12” = 250 psi, 14”-24” = 150 psi, >24” = 100 psi)

B. Flange Adapter-Restrained

1. Manufacturer:
   a. SERIES 2100 MEGAFLANGE adapter, as produced by EBAA Iron, Inc.,
   b. StarFlange Series 3200
   c. Or Approved Equal.

2. Description:
   a. Restrained flange adapters may be used in lieu of threaded, or welded, flanged spool pieces. Flange adapters shall be made of ductile iron conforming to ASTM A536 and have flange bolt circles that are compatible with ANSI/AWWA C110/A21.10.
   b. Restraint for the flange adapter shall consist of a plurality of individual actuated gripping wedges to maximize restraint capability. Torque limiting actuating screws shall be used to insure proper initial set of gripping wedges.
c. The flange adapter shall be capable of deflection during assembly, or permit lengths of pipe to be field cut, to allow a minimum of 0.6” gap between the end of the pipe and the mating flange without affecting the integrity of the seal.

d. Flange Adapters shall be fully restrained and shall incorporate a wedge style grip.

e. Allowable working pressures shall have a minimum as follows: 3”-16” = 350psi, 18”-24” = 250 psi, 30”-48” = 150psi.

C. Adapter with Wedge Restraints for Mechanical Joint pipe.

1. Manufacturer:
   a. Uni-Flange Series 1400, by Ford Meter Box Company
   b. StarGrip 3000 by Star Pipe Products
   c. Megalug Series 1100 by EBBA Iron Sales, Inc.
   d. Or Approved Equal.

2. Description:
   a. Restraint for standardized mechanical joints shall be incorporated into the design of the follower gland and shall impart multiple points of wedge action against the pipe, increasing its resistance as the pressure increases.
   b. The restrained joint shall incorporate a wedge style restraint system. Restraints with set screws will not be acceptable.
   c. The assembled joint shall maintain its flexibility after burial and shall maintain its integrity by a controlled and limited expansion of each joint during the wedging action.
   d. Restraining glands shall be manufactured of high strength ductile iron conforming to the requirements of ASTM A536, Grade 65-45-12.
   e. Wedges shall be contoured to properly fit on the pipe, and shall be manufactured of ductile iron, heat treated to a minimum hardness of 370 BHN. Dimensions of the glands shall be such that they can be used with the standardized mechanical joint bell and tee head bolts conforming to the requirements of ANSI/AWWA C111/A21.11 and ANSI/AWWA C153/A21.53 of latest revision.
   f. Twist-off heads shall be incorporated in the design of the wedge actuating screws to ensure proper torque.
   g. The mechanical joint restraining device shall have a water working pressure rating of 250 psi minimum with a safety factor of at least 2:1 against separation when tested in a dead-end situation.
   h. Allowable working pressures shall be as follows: 3”-16” = 350psi, 18”-36” = 250psi.

2.3 BRAIDED FLEXIBLE CONNECTIONS

A. Manufacturers:

1. Flexicraft Industries
2. Flex-Weld, Inc.
3. Hyspan Precision Products, Inc.
4. Or Approved Equal.

B. Steel or Stainless Steel Piping:
1. Inner Hose: Corrugated stainless steel as indicated.
2. Exterior Sleeve: Braided or stainless steel as indicated.
3. Pressure Rating: Minimum 150 psig at 50 degrees F and sufficient for service condition.
4. Fittings: Flanged, unless otherwise noted.
5. Size: Use pipe-sized units.
6. Maximum Offset: 3/4 inch on each side of installed center line.

C. Copper Piping:
1. Inner Hose: Corrugated Bronze.
2. Exterior Sleeve: Braided bronze.
3. Pressure Rating: Minimum 150 psig at 70 degrees F and sufficient for service condition.
4. Fittings: Threaded with union, Soldered, or As specified for pipe joints.
5. Size: Use pipe-sized units.
6. Maximum Offset: 3/4 inch on each side of installed center line.

2.4 EXPANSION JOINTS

A. Manufacturers:
1. Flexicraft Industries
2. Flex-Weld, Inc.
3. Hyspan Precision Products, Inc.
4. Or Approved Equal

B. Performance and Design Criteria:
1. Bellow Design: According to Section C of EJMA Standards.

C. Stainless-Steel Compensator Type:
1. Pressure Rating: 50 psig WOG at 250 degrees F for aeration air piping, all others shall be 200 psig WOG at 250 degrees F.
4. Joint: Flanged, unless otherwise noted.
5. Size: Use pipe-sized units.
6. Application: Aeration air piping 4-inch and larger or steel piping 3 inches and smaller.

D. External Ring-Controlled Stainless-Steel Bellows Type:
1. Pressure Rating: 200 psig WOG at 250 degrees F.
8. Application: Steel piping 3 inches and larger.
E. Single-Arch Rubber Type:
   3. Maximum Temperature: 200 degrees F.
   4. Maximum Compression: 1 inch.
   7. Maximum Angular Movement: 30 degrees.
   10. Accessories: Control rods.
   11. Application: Steel piping 2 inches and larger.

F. Bronze Compensator Type:
   1. Description: Bronze with anti-torque device, limit stops, and internal guides.
   2. Pressure Rating: 200 psig WOG at 250 degrees F.
   3. Maximum Compression: 3 inches.
   5. Size: Use pipe-sized units.
   6. Application: Copper piping.

2.5 EXPANSION LOOPS
   A. Provide expansion loops as indicated on Shop Drawings.

2.6 SLEEVE-TYPE COUPLINGS
   A. Manufacturers:
      1. Dresser Piping Specialties
      2. The Macomb Group
      3. US Pipe Fabrication
   B. Description:
      2. Middle Ring: Epoxy Coated Steel.
      3. Followers: Epoxy Coated Steel.
      4. Gaskets:
         a. Material: Buna-N, EPDM, or Compatible with service conditions.
      5. Bolts: AWWA C111, Epoxy Coated Steel.
2.7 WALL SLEEVE

A. Manufacturers:
   1. Sigma – Omni-Sleeve.
   2. American
   3. Or Approved Equal.

B. Description:
   1. Wall and floor pipe penetrations of ductile iron piping systems shall be made by means of a sleeve capable of being bolted directly to the formwork to prevent misalignment. Seal of annular space shall be by means of a confined rubber gasket, so as not to be affected by vibration and capable of withstanding up to 100 psig. Sleeve shall be manufactured from Ductile Iron with an integrally cast water stop.

2.8 FINISHES

A. Prepare ferrous metal piping appurtenances for field finishes as specified in Section 09 96 00 – High-Performance Coatings.

2.9 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.
   1. Provide shop inspection and testing of completed assemblies.

B. Certificate of Compliance:
   1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
   2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that field dimensions are as indicated on Shop Drawings.

C. Inspect existing flanges for nonstandard bolthole configurations or design and verify that new pipe and flanges mate properly.

D. Verify that openings are ready to receive sleeves.
E. Verify that pipe plain ends to receive sleeve-type couplings or flange adapters are smooth and round for 12 inches from pipe ends.

F. Verify that pipe outside diameter conforms to sleeve manufacturer's requirements.

3.2 PREPARATION
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
B. Cleaning: Thoroughly clean end connections before installation.
C. Close pipe and equipment openings with caps or plugs during installation.
D. Surface Preparation: Clean surfaces to remove foreign substances.

3.3 INSTALLATION
A. According to ASME B31.3 for process piping and ASME B31.9 for building services piping.
B. Coating: Finish ferrous metal piping appurtenances as specified in Section 09 96 00 – High-Performance Coatings for service conditions.
C. Pipe Penetrations:
   1. Flashing:
      a. Provide flexible flashing and metal counterflushing where piping penetrates weatherproofed or waterproofed walls, floors, and roofs.
      b. Flash floor drains with topping over finished areas with lead, 10 inches clear on sides, with minimum 36-by-36-inch sheet size.
      c. Fasten flashing to drain clamp device.
   2. Sleeves:
      a. Exterior Watertight Entries: Seal with mechanical sleeve seals.
      b. Set sleeves in position in forms and provide reinforcement around sleeves.
      c. Size sleeves large enough to allow for movement due to expansion and contraction and provide for continuous insulation wrapping.
      d. Extend sleeves through floors 1/2 inches above finished floor level and calk sleeves.
      e. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent Work with insulation and calk airtight.
      f. Provide close-fitting metal collar or escutcheon covers at both sides of penetration.
      g. Install stainless-steel escutcheons at finished surfaces.
D. Firestopping:
   1. Placement: Place intumescent coating in sufficient coats to achieve rating required.
   2. Fire-Rated Surfaces:
a. Seal opening at floor, wall, partition, ceiling and roof.
b. Install sleeve through opening and extend beyond minimum of 1 inch on both sides of building element.
c. Size sleeve, allowing minimum of 1 inch void between sleeve and building element.
d. Pack void with backing material.
e. Seal ends of sleeve with UL-listed, fire-resistive silicone compound to meet fire rating of structure penetrated.

3. Non-rated Surfaces:
   a. Seal opening through non-fire-rated floor, wall, partition, ceiling and roof.
   b. Install sleeve through opening and extend beyond minimum of 1 inch on both sides of building element.
   c. Size sleeve to allow minimum of 1 inch void between sleeve and building element.
   d. Install type of firestopping material recommended by manufacturer.
   e. Occupied Spaces:
      1) Install escutcheons, floor plates, or ceiling plates where conduit penetrates non-fire-rated surfaces in occupied spaces.
      2) Occupied spaces include rooms with finished ceilings and rooms where penetration occurs below finished ceiling.
   f. Exterior Wall Openings below Grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place according to manufacturer instructions.
   g. Interior Partitions:
      1) Seal pipe penetrations at where indicated.
      2) Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

E. Flexible Connections: Install flexible couplings at connections to equipment and where indicated on Shop Drawings.

F. Expansion Joints:
   1. Install flexible couplings and expansion joints at connections to equipment and where indicated on Drawings.
   2. If expansion joint is supplied with internal sleeve, indicate flow direction on outside of joint.

G. Air Release and Vacuum Breakers: Provide vacuum breakers on all tanks and process equipment.

H. Backflow Preventers:
   1. Install with nameplate and test cock accessible.
   2. Install according to local code requirements.
   3. Do not install in vertical position.

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.
B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. After installation, inspect for proper supports and interferences.

D. Repair damaged coatings with material equal to original coating.

3.5 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Keep equipment interior clean as installation progresses.

END OF SECTION 40 05 06
SECTION 40 05 07 - HANGERS AND SUPPORTS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe hangers and supports.
   2. Hanger rods.
   3. Structural attachments.
   4. Pipe guides.
   5. Guides
   6. Anchors
   7. Elbow and Flange Supports

B. Related Requirements:
   1. List other Sections directly related to or affecting Work of this Section. Include Sections specifying information expected to be found in this Section, as well as Sections required to describe complete system or assembly requirements.
   2. Section 03 30 00 - Cast-in-Place Concrete
   3. Division 05 – Metals
   4. Section 07 92 00 – Joint Sealants
   5. Section 09 96 00 – High-Performance Coatings
   6. Division 40 – Process Interconnections

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:
   1. ASME B31.1 - Power Piping.
   2. ASME B31.9 - Building Services Piping.

B. ASTM International:

C. American Welding Society:
D. Manufacturers Standardization Society of the Valve and Fittings Industry:

1.3 COORDINATION

A. Section 01 31 00 – Project Management and Coordination

B. Coordinate Work of this Section with piping and equipment connections specified in other Sections and indicated on Drawings.

1.4 PREINSTALLATION MEETINGS

A. Section 01 31 00 – Project Management and Coordination

1.5 SUBMITTALS

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

B. Product Data: Submit manufacturer's catalog data including load capacity.

C. Shop Drawings: Indicate system layout with location - including critical dimensions, sizes, and pipe hanger and support locations - and detail of trapeze hangers, anchors, and guides.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Welders' Certificate: Submit welders' certification of compliance with ASME Section IX or AWS D1.1, verifying qualification within previous 12 months.

F. Delegated Design Submittals:
   1. Submit signed and sealed Shop Drawings with design calculations and assumptions for load carrying capacity of trapeze, multiple pipe, and riser support hangers.
   2. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.
   3. Submit sizing methods or calculations sealed by a registered professional engineer.

G. Manufacturers' Instructions: Submit special procedures and assembly of components.

H. Qualifications Statements:
   1. Submit qualifications for manufacturer, fabricator, installer, and licensed professional.
   2. Submit manufacturer's approval of installer.
1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Spare Parts:
   1. Furnish one set of manufacturer's recommended spare parts.

1.7 QUALITY ASSURANCE

A. Perform Work according to applicable authority and/or AWS D1.1 for welding hanger and support attachments to building structure.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum five years' documented experience.

B. Fabricator: Company specializing in fabricating products specified in this Section with minimum five years' documented experience.

C. Installer: Company specializing in performing Work of this Section with minimum five years' documented experience and approved by manufacturer.

D. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of South Carolina.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on-Site in original factory packaging, labeled with manufacturer's identification.

C. Protect products from weather and construction traffic, dirt, water, chemical, and damage by storing in original packaging.

1.10 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls

B. Provide ventilation in areas receiving solvent-cured materials.
1.11 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

1.12 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish five-year manufacturer's warranty for pipe hangers and supports.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Description:

1. HORIZONTAL-PIPING HANGERS AND SUPPORTS
   a. General: Except as otherwise indicated, provide factory-fabricated horizontal piping hangers and supports of MSS type and size indicated, bolts (if any) and washers; comply with MSS SP-58 and manufacturer's published product information. Where MSS type or size is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with MSS SP-69 and manufacturer's published product information; size hangers and supports properly for piping including insulation (if any). Provide copper-plated hangers and supports for uninsulated copper-piping systems. Provide 304 stainless steel supports and hangers for stainless steel piping systems.

2. VERTICAL-PIPING CLAMPS
   a. General: Except as otherwise indicated, provide factory-fabricated vertical piping clamps of MSS type and size indicated; comply with MSS SP-58 and manufacturer's published product information. Where MSS type or size is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with MSS SP-69 and manufacturer's published product information. Size clamps properly for piping, including insulation (if any). Provide copper-plated clamps for copper-piping systems. Provide 304 stainless steel supports and hangers for stainless steel piping systems.

3. HANGER-ROD ATTACHMENTS
   a. General: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments of MSS type and size indicated; comply with MSS SP-58 and manufacturer's published product information. Where MSS type or size is not indicated, provide proper selection determined by Installer for installation requirements, and comply with MSS SP-69 and manufacturer's published product information. Size attachments properly for piping, including insulation (if any). Provide copper-plated hanger-rod attachments for uninsulated copper-piping systems. Provide 304 stainless steel supports and hangers for stainless steel piping systems.

4. STRUCTURAL ATTACHMENTS
a. General: Except as otherwise indicated, provide factory-fabricated building attachments of MSS type and load-rating indicated; comply with MSS SP-58 and manufacturer's published product information. Where MSS type or load-rating is not indicated, provide proper selection determined by Installer for installation requirements, and comply with MSS SP-69 and manufacturer's published product information. Size units properly for the piping loading.

B. Performance and Design Criteria:

1. General
   a. Design, size and locate piping support systems throughout facility, whether shown or not.
   b. Piping smaller than 30 inches: Supports are shown only where specific types and locations are required; additional pipe supports may be required.
   c. Piping 30 inches and Larger: N/A
   d. Meet requirements of MSS SP 58 and ASME B31.1 or as modified by this Section.

2. Pipe Support Systems
   a. Design pipe support systems for gravity and thrust loads imposed by weight of pipes or internal pressures, including insulation and weight of fluid in pipes.
   b. Maximum Support Spacing and Minimum Rod Size: In accordance MSS SP 58 Table 3 and Table 4.

3. Anchoring Devices: Design, size and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

4. Vertical Sway Bracing: 10-foot maximum centers or as shown.

5. Existing Support Systems: Use existing supports systems to support new piping only if Contractor can show they are adequate for additional load, or if they are strengthened to support additional load. Allow for expansion and contraction of piping while eliminating undue stress on piping appurtenances and equipment.

6. Provide linkage to permit lateral or axial movement where anticipated.

7. Where horizontal pipe movement is greater than ½ inch, or where hanger rod deflection from the vertical is greater than 4 degrees from cold to hot position of pipe, hanger rod and structural attachment shall be offset to maintain rod vertical in hot position.

8. Heat Transmission: Design supports, hangers, anchors, and guides to prevent excessive heat from being transmitted to building structure, equipment, or piping appurtenances.


10. Point Loads:
   a. Support plastic piping containing meters, valves, appurtenances, and other point loads on both sides.
   b. Avoid point loads on plastic piping by providing extra wide pipe saddles or galvanized steel shields.

2.2 HANGERS

A. Clevis: MSS SP 58, Type 1

1. Shall be used for the suspension of non-insulated pipe or insulated with B3151 shield or Anvil ISS
   a. Shall be used for the suspension of non-insulated pipe or insulated with B3151 shield or Anvil ISS
1) B-Line; Figure B3100, 1/2 inch to 30 inches
2) Anvil: Figure 260 for steel pipe and Figure 590, 1/2 inch to 30 inches
3) Insulated Steel Pipe; B-Line; Figure B3100 with B3151 shield, 1/2 inch through 16 inches
4) Insulated Steel Pipe; Anvil; Figure 260 with insulated saddle system (ISS), 1/2 inch through 12 inches
5) Or Approved Equal

b. Adjustable Swivel Split-Ring Pipe Clamp: MSS SP 58, Type 6
a. Shall be used for suspension of non-insulated stationary pipe
1) B-Line; Figure B3171, : 3/4 inch through 8 inches
2) Anvil; Figure 104, : 3/4 inch through 8 inches
3) Or Approved Equal

c. Steel Yoke Pipe Rolls and Roller Supports: MSS SP 58, Type 41 or Type 43
a. Shall be used to support pipe where movement may occur due to thermal expansion
1) B-Line; Figure B3110 for sizes 2 inches through 24 inches and Figure B3114 for 30 inches.
2) Anvil; Figure 181 for sizes 2-1/2 inches through 24 inches and Figure 171 for sizes 1 inch through 30 inches
3) Or Approved Equal

d. Pipe Rollers and Supports: MSS SP 58, Type 44
a. Shall be used to support pipe where movement may occur due to thermal expansion when ceiling suspension is impractical
1) B-Line; Figure B3120, sizes 2 inches through 24 inches
2) Anvil; Figure 175, sizes 2 inches through 30 inches
3) Or Approved Equal

2.2 HANGER RODS

A. Hanger Rods:

1. ASTM A576, steel.
2. Threaded both ends or Threaded one end or All-thread.
3. Diameter: ASME B31.1; as indicated on Drawings.

2.3 STRUCTURAL ATTACHMENTS

A. Welded Steel Wall Bracket: MSS SP 58, Type 33 (heavy duty)

1. Anvil; Figure 199, 3,000-pound rating.
2. B-Line; Figure B3067, 3,000-pound rating.
3. Or Approved Equal

B. Adjustable “J” hanger MSS SP 58, Type 5:

1. Anvil; Figure 67, sizes ½ inch through 8 inches.
2. B-Line; Figure B3690, sizes ½ inch through 8 inches.
3. Or Approved Equal
C. Channel Type

1. General Use
   a. Unistrut
   b. Anvil: Power Strut
   c. B-Line; Strut System
   d. Or Approved Equal

2.4 PIPE SADDLES

A. Provide 90-degree to 120-degree pipe saddle for pipe 6 inches and larger with baseplates drilled for anchors bolts.

1. Sizes 20 inches through 60 inches, Piping Technology & Products, Inc.; Figure 2000.
2. Or Approved Equal

B. Saddle Supports, Pedestal Type

1. Minimum standard weight pipe stanchion, saddle, and anchoring flange.
2. Nonadjustable Saddle: MSS SP, Type 37 with U-bolt
   a. B-Line; Figure B3090, sizes 3/4 inch through 36 inches with B3088S base
   b. Anvil: Figure 259; sizes 4 inch through 36 inches with Figure 63C base
   c. Or Approved Equal
3. Adjustable Saddle: MSS SP 58, Type 38 without clamp
   a. B-Line; Figure B3093, sizes 1 inch through 36 inches with Figure B3088S base.
   b. Anvil: Figure 264, sizes 2-1/2 inch through 36 inches with Figure 62C base.
   c. Or Approved Equal

2.5 CHANNEL TYPE SUPPORT SYSTEMS

A. Channel Size: 12-gauge, 1-5/8-inch wide minimum steel, or 1-1/2-inch wide, minimum FRP.

B. Members and Connections: Design for loads using one-half of manufacturer’s allowable loads.

C. Fasteners: Vinyl ester fiber, polyurethane base composite nuts and bolts, or encapsulated steel fasteners.

D. Manufacturers and Products:

1. General Use
   a. B-Line; Strut System.
   b. Unistrut
   c. Anvil; Power-Strut.
   d. Or Approved Equal

2.6 CLAMPS AND BEAM ATTACHMENTS

A. Beam Clamps:
1. Shall be used for suspending hanger rod from flanged beam and shall distribute the load equally on both sides of the beam.

2. MSS SP-58 Type 21, Type 28, Type 30

3. ASTM A36, steel or ASTM A181, forged steel.

4. Clamp Size: Based on load to be supported and load configuration.

5. Anchoring: Locknuts and cup-point set screws.

6. Reversible top or bottom flange.

7. Manufacturers:
   a. B-Line;
   b. Anvil;
   c. Or Approved Equal

B. Offset Clamps:

1. Shall be used to support pipe offset from the floor or wall.

2. Double leg, two-piece.
   a. B-Line; B3148; sizes ¼ inch through 12 inches
   b. Anvil; Figure 103; sizes ¾ inch through 8 inches
   c. Or Approved Equal

C. Welded Beam Attachment: MSS SP 58, Type 22

1. B-Line; Figure B3083, sizes 3/8”-16 through 2”-4 ½ rod

2. Anvil: Figure 66, sizes 3/8 inch through 3-1/2 inch

2.7 ELBOW AND FLANGE SUPPORTS

A. Elbow and Adjustable Stanchion: Sizes 2 inches through 18 inches, Anvil; Figure 62C base or approved equal

B. Elbow with Nonadjustable Stanchion: Sizes 2-1/2 inches through 42 inches, Anvil; Figure 63A or 63B base or approved equal.

C. Flange Support with Adjustable Base: Sizes 2 inches through 24 inches, Standon; Model S89 or approved equal.

2.8 PIPE GUIDES

A. Intermediate Guides:

1. Type: Hold down pipe guide
   a. Shall prevent longitudinal or lateral movement of pipe
      a. B-Line; Figure B3256 sizes 2 inch through 30 inches
      b. Or Approved Equal
   b. Type: U-bolts with 4 hex nuts to provide nominal 1/8 inch to ¼ inch clearance around pipe; MSS SP 58 Type 24
      a. Shall be used for support, anchor, or guide of pipe
         a. B-Line; Figure B3188 and Figure B3188NS, sizes ½ inch through 30 inches
b. Anvil; Figure 137 and Figure 137S, sizes ½ inch through 36 inches  
c. Or Approved Equal

B. Alignment Guides:

1. Type: Spider  
a. Shall direct thermal expansion of insulated or non-insulated pipe in direction permitted by expansion joints or loops  
b. Two or more guides shall be used on both sides of expansion joint or loop  
   a. B-Line; Figure B3281 through B 3287, sizes 1-1/2 inch through 24 inches  
   b. Anvil; Figure 255, sizes ½ inch through 24 inches  
   c. Or Approved Equal

2.9 PIPE ANCHORS

A. Type: Anchor chair with U-bolt strap  

1. Shall be used to anchor pipe to structure  
   a. B-Line; Figure 3147A and 3147B, sizes ½ inch through 24 inches  
   b. Or Approved Equal

2.10 ACCESSORIES

A. Anchor Bolts:

1. Size and Material: ½-inch minimum diameter, and as specified in Section 05500, Metal Fabrications.  
2. Bolt Length (Extension Above Top of Nut):  
   a. Minimum Length: Flush with top of nut preferred. If not flush, shall be no more than one thread recessed below top of nut.  
   b. Maximum Length: No more than a full nut depth above top of nut.

B. Dielectric Barriers:

1. Plastic coated hangers, isolation cushion, or tape.  
2. Manufacturer:  
   a. B-Line; B1999 Vibra Cushion.  
   b. B-Line;Iso Pipe, Isolation Tape.  
   c. Or Approved Equal

C. Insulation Shields:

1. Type: Galvanized steel or stainless steel, MSS SP 58, Type 40.  
2. Manufacturers:  
   a. B-Line; Figure B3151, sizes ½ inch through 24 inch.  
   b. Anvil; Figure 167, sizes ½ inch through 24 inches.  
   c. Or Approved Equal

D. Welding Insulation Saddles:
1. Type: MSS SP 58, Type 39.
2. Manufacturers:
   a. B-Line; Figure Series B3160, sizes ½ inch through 24 inches.
   b. Anvil; Figure Series 160, sizes 1 inch through 36 inches.
   c. Or Approved Equal

E. Plastic Pipe Support Channel:
1. Type: Continuous support for plastic pipe and to increase support spacing
2. Manufacturer
   a. B-Line; Figure Series B3106V, sizes ½ inch through 6 inches with Figure B3106 Vee bottom hanger.
   b. Or Approved Equal

F. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

G. Attachments:
1. Concrete Insert: MSS SP 58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.
2. Concrete Attachment Plates:
   a. B-Line; Figure B3084, Figure B3085, or Figure B3086 with B3201 to attach center lug.
   b. Anvil: Figure 47, Figure 49, or Figure 52.
   c. Or Approved Equal

PART 3 - EXECUTION

3.1 EXAMINATION
A. Section 01 31 00 – Project Management and Coordination.
B. Verify field dimensions as indicated on Drawings.

3.2 INSTALLATION
A. Obtain permission from Engineer before using powder-actuated anchors.
B. Obtain permission from Engineer before drilling or cutting structural members.
C. Inserts:
   1. Install inserts for placement in concrete forms.
   2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 in and larger.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of or recessed into and grouted flush with slab.

D. Pipe Hangers and Supports:

1. Install according to: MSS SP 58.
2. Support horizontal piping as indicated on Drawings.
3. Install hangers with minimum 1/2 in space between finished covering and adjacent Work.
4. Place hangers within 12 in of each horizontal elbow.
5. Use hangers with 1-1/2 in minimum vertical adjustment.
6. Support horizontal cast iron pipe adjacent to each hub, with 5 ft maximum spacing between hangers.
7. Support vertical piping at every other floor. Support vertical cast iron pipe at each floor at hub.
8. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
10. Provide copper-plated hangers and supports for copper piping or sheet lead packing between hanger or support and piping.
11. Design hangers for pipe movement without disengagement of supported pipe.
12. Support piping independently so that equipment is not stressed by piping weight or expansion in piping system.
13. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
14. Support no pipe from pipe above it.
15. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
16. Provide welded steel brackets where piping is to be run adjacent to building walls or columns.
17. Do not use adhesive anchors for attachment of supports to ceiling or walls.
18. Use beam clamps where piping is to be suspended from building steel.
19. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.
20. Install lateral supports for seismic loads at changes in direction.
21. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
22. Insulated Piping: Provide two bolted clamps designed to accommodate insulated piping.
23. Use offset clamps where pipes are indicated as offset from wall surfaces.
24. Repair mounting surfaces to original condition after attachments are completed.

E. Insulation:

1. Provide clearance in hangers and from structure and other equipment for installation of insulation.
2. Conform to 40 42 13 - Process Piping Insulation.

F. Equipment Bases and Supports:

1. Provide housekeeping pads as detailed on Drawings.
2. Using templates furnished with equipment, install anchor bolts and accessories for mounting and anchoring equipment.
3. Construct supports of steel members or formed steel channel. Brace and fasten with flanges bolted to structure.
4. Provide rigid anchors for pipes after vibration isolation components are installed. Comply with

G. Prime Coat:

1. Prime coat exposed steel hangers and supports.
2. Conform to Section 09 96 00 – High-Performance Coatings.
3. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.3 ATTACHMENTS

A. Standard Pipe Supports

1. Horizontal Suspended Piping:
   a. Single Pipes: Clevis hangers or adjustable swivel split-ring.
   b. Grouped Pipes: Trapeze hanger system.

2. Horizontal Piping Supported from Walls:
   a. Single Pipes: Wall brackets, or attached to wall, or to wall mounted framing with anchors.
   b. Stacked Piping: Wall mounted framing system and “J” hangers acceptable for pipe smaller than 3-inch.
   c. Pipe clamp that resists axial movement of pipe through support is not acceptable. Use pipe rollers supported from wall bracket.

3. Horizontal Piping Supported from Floors/Roof:
   a. Saddle Supports:
      a. Pedestal Type, elbow and flange.
      b. Provide minimum 1-1/2-inch grout beneath baseplate.
   b. Floor Mounted Channel Supports:
      a. Use for pipe smaller than 3-inch running along floors and in trenches at pipe elevations lower than can be accommodated using pedestal pipe supports.
      b. Attach channel framing to floors with baseplate on minimum 1-1/2-inch nonshrink grout and with anchor bolts.
      c. Attach pipe to channel with clips or pipe clamps.
   c. Concrete Cradles: Use for pipe larger than 3 inches along floor and in trenches at pipe elevations lower than can be accommodated using stanchion type.

4. Vertical Pipe: Support with wall bracket and elbow support, or riser clamp on floor penetration

B. Standard Attachments:

1. New Concrete Ceilings: Concrete inserts, concrete attachment plates, or concrete anchors as limited below:
   a. Single point attachment to ceiling allowed for only ¾-inch rod and smaller (8 inches and smaller pipe).
b. Where there is vibration or bending considerations, do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.

2. Existing Concrete Ceilings: Channel type support with minimum of two anchor points, concrete attachment plates or concrete anchors as limited below:
   a. Single point attachment to ceiling is allowed only for ¾-inch rod and smaller (8 inches and smaller pipe).
   b. Where there is a vibration or bending considerations do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.
      a. These lines include air operated diagram pumps and other lines.
   c. Steel Beams: I-beam clamp or welded attachments.
   d. Wooden Beams: Lag screws and angel clips to members not less than 2-1/2 inches thick
   e. Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.
   f. Concrete Beams: Concrete inserts, or if inserts are not used attach to vertical surface similar to concrete wall. Do not drill into beam bottom.

C. Saddles for Steel or Concrete Pipe: Provide 90-degree to 120-degree pipe saddle for pipe sizes 6 inches and larger when installed on top of steel or concrete beam or structure, pipe rack, trapeze, or where similar concentrated point supports would be encountered.

D. Intermediate and Pipe Alignment Guides:
   1. Provide pipe alignment guides, or pipe supports that provide same function, at expansion joints and loops.
   2. Guide pipe on each side of expansion joint or loop at 4 pipe and 14 pipe diameters from each joint or loop.
   3. Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.

E. Accessories:
   1. Insulation Shield: Install on insulated piping with oversize rollers and supports.
   2. Welding Insulation Saddle: Install on insulated steel pipe with oversize rollers and supports.
   3. Dielectric Barrier:
      a. Provide between painted and galvanized carbon steel members and copper or stainless-steel pipe or between stainless steel supports and nonstainless steel ferrous metal piping.
      b. Install rubber wrap between submerged metal pipe and oversized clamps.

F. Pipe Hanger Spacing:
   1. Pipe Material: Ductile Iron Pipe
      a. Size: 8 Inches and Under
      b. Maximum Hanger Spacing: Maximum span limited to that for standard weight steel pipe for water service.
         a. MSS SP 58 Table 3
      c. Hanger Rod Diameter: MSS SP 58 Table 4
2. Pipe Material: Ductile Iron Pipe  
   a. Size: 10 Inches and Larger  
   b. Maximum Hanger Spacing: Maximum span limited to 20 feet.  
      a. MSS SP 58 Table 3  
      c. Hanger Rod Diameter: MSS SP 58 Table 4  
3. Pipe Material: ABS.  
   a. Maximum Hanger Spacing: 4 feet.  
   a. Maximum Hanger Spacing: 10 feet.  
   b. Hanger Rod Diameter: 1/2 inch.  
5. Pipe Material: Cast iron.  
   a. Maximum Hanger Spacing: 5 feet.  
   a. Maximum Hanger Spacing: 10 feet.  
7. Pipe Material: CPVC.  
   a. Size: 1 inch and smaller.  
   b. Maximum Hanger Spacing: 3 feet.  
   c. Hanger Rod Diameter: 1/2 inch.  
8. Pipe Material: CPVC.  
   b. Maximum Hanger Spacing: 4 feet.  
   c. Hanger Rod Diameter: 1/2 inch.  
   b. Maximum Hanger Spacing: 6 feet.  
   c. Hanger Rod Diameter: 1/2 inch.  
    a. Size: 1-1/2 inches and larger.  
    b. Maximum Hanger Spacing: 10 feet.  
    c. Hanger Rod Diameter: 1/2 inch.  
    a. Maximum Hanger Spacing: 4 feet.  
    b. Hanger Rod Diameter: 1/2 inch.  
    a. Maximum Hanger Spacing: 2.7 feet.  
    a. Maximum Hanger Spacing: 4 feet.  
14. Pipe Material: PVC.  
    a. Maximum Hanger Spacing: 4 feet.  
15. Pipe Material: Steel.  
    a. Size: 3 inches and smaller.  
    b. Maximum Hanger Spacing: 12 feet.  
    c. Hanger Rod Diameter: 1/2 inch.
16. Pipe Material: Steel or Stainless Steel.
   a. Size: 4 inches and larger.
   b. Maximum Hanger Spacing: 12 feet.

END OF SECTION 40 05 07
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SECTION 40 05 13 - COMMON REQUIREMENTS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements common to pipe and tube of all material types used on the Project.
   2. Accessories.

B. Related Requirements:
   1. Section 09 96 00 – High-Performance Coatings
   2. Division 31 – Earthwork
   3. Division 40 – Process Interconnections

1.2 COORDINATION

A. Section 01 31 00 – Project Management and Coordination.

B. Coordinate Work of this Section with piping and equipment connections specified in other Sections and indicated on Drawings.

1.3 SUBMITTALS

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

B. Product Data: Submit manufacturer's catalog information on pipe materials and fittings.

C. Shop Drawings: Indicate layout of piping systems, including equipment, fittings, critical dimensions, sizes, and material lists.

D. Submit manufacturer’s certification and certified test reports that the pipe and linings and coatings were manufactured and tested in accordance with the ASTM and ANSI/AWWA Standards specified. Submittal shall be at least 7 days prior to each shipment of pipe.

E. Material Certificates

F. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for pipe sizing methods and calculations used.

G. Qualifications Statements:
   1. Submit qualifications for manufacturer, installer, and licensed professional.
   2. Submit manufacturer's approval of installer.
1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of piping, valves and other appurtenances, connections, invert and centerline elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.5 QUALITY ASSURANCE

A. Perform Work according to all applicable Federal, State and Local standards and these specifications.

B. Permanently mark each length of pipe with manufacturer's name or trademark and indicate conformance to standards.

C. Materials in Contact with Potable Water: Certified according to NSF 61 and NSF 372.

1.6 QUALIFICATIONS

A. Manufacturer: For each pipe material type, a company specializing in manufacturing products of the material shall be used. The manufacturer shall have successfully manufactured and delivered products of the diameters used in this project for a minimum of 15 projects over the past 5 years.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Deliver materials in manufacturer's packaging; include handling instructions.

C. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe or coatings. Under no circumstances shall the pipe be dropped or skidded against each other. Slings, hooks, or pipe tongs shall be padded and used in a manner as to prevent damage to the exterior surface or internal coating or lining of the pipe. If any part of the coating or lining is damaged, the repair shall be made by the Contractor.

D. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

E. Store piping and appurtenances according to manufacturer instructions.

F. Protect piping and appurtenances from oxidation by storing off ground.
G. Stored pipe shall be kept safe from damage and away from traveled ways. The interior of all pipe, fittings and other appurtenances shall be kept free from water, dirt, or foreign matter at all times.

1.8 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 Pipe Schedule

A. Unless otherwise shown on drawings, the following is a general pipe schedule for the work:

<table>
<thead>
<tr>
<th>Service</th>
<th>Location</th>
<th>Pipe Material</th>
<th>Fittings</th>
<th>Specification References</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Wastewater (RWW)</td>
<td>Buried</td>
<td>Ductile Iron (DI)</td>
<td>Mechanical Joint/Push-on Joint 40 05 19</td>
<td>Ceramic epoxy liner. Pressurized pipe shall be restrained.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exposed</td>
<td>Ductile Iron (DI)</td>
<td>Flanged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wastewater, Secondary Effluent (SE)</td>
<td>Buried</td>
<td>Ductile Iron (DI)</td>
<td>Mechanical Joint/Push-on Joint 40 05 19</td>
<td>Cement lined. Pressurized pipe shall be restrained.</td>
<td></td>
</tr>
<tr>
<td>Wastewater, Final Effluent (FE), Sludge (SL), Drain (D)</td>
<td>Exposed</td>
<td>Ductile Iron (DI)</td>
<td>Flanged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compressed Air (A)</td>
<td>Exposed/Buried</td>
<td>Copper</td>
<td>Soldered/Press Type       40 05 17</td>
<td>Type L or K</td>
<td></td>
</tr>
<tr>
<td>Water, Potable (PW)</td>
<td>Buried/exposed</td>
<td>Sch. 40 PVC</td>
<td>Solvent-Weld              40 05 31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polymer (POL)</td>
<td>Buried/exposed</td>
<td>Sch. 80 PVC</td>
<td>Solvent-Weld              40 05 31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical Feed Carrier Pipe (CFCP)</td>
<td>Buried/exposed</td>
<td>Sch. 40 PVC</td>
<td>Solvent-Weld              40 05 31</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.2 ACCESSORIES

1. Couplings, Adapters, Specials for Process Piping: As specified in Section 40 05 06 - Couplings, Adapters, Specials for Process Piping
2. Hangers and Supports for Process Piping: As specified in Section 40 05 07 - Hangers and Supports for Process Piping.

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.
B. All pipe and fittings to be installed under this Contract shall be of new manufacture.
C. The manufacturer is responsible for the performance of all inspection requirements as specified.
D. Owner Inspection:
   1. The manufacturer is responsible for performance of all inspection requirements as specified. All pipe and fittings to be installed under this Contract may be inspected at the plant for compliance with these Specifications by the Owner, by an independent testing laboratory selected by the Owner, or by other representative of the Owner.
E. Certificate of Compliance:
   1. If fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
   2. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
B. Verify that field dimensions are as indicated on the Drawings.
C. Inspect existing flanges for nonstandard bolt hole configurations or design, and verify that new pipe and flange mate properly.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
B. Ream ends of threaded pipes and file smooth.
C. Cleaning: Thoroughly clean pipe and fittings before installation.

D. Surface Preparation:
   1. Touch up shop-primed surfaces with primer as specified in Section 09 96 00 - High-Performance Coatings.
   2. Solvent-clean surfaces that are not shop primed.
   3. Clean surfaces of metallic pipe to remove loose rust, mill scale, and other foreign substances by power wire brushing or commercial sand blasting; SSPC SP 6/NACE No. 3. Do not sand blast or power wire brush thermoplastic pipe.
   4. Prime surface as specified in Section 09 96 00 – High-Performance Coating.

3.3 INSTALLATION

A. Buried Service: Install pipe as specified in the Section appropriate to the pipe material.

B. Exposed Service: Install according to ASME B31.3.

C. Provide required upstream and downstream clearances from devices as indicated.

D. Install piping with sufficient slopes for venting or drainage of liquids and condensate to low points.

E. Support piping as specified in Section 40 05 07 - Hangers and Supports for Process Piping.

F. Provide expansion joints as specified in Section 40 05 06 - Couplings, Adapters, and Specials for Process Piping and pipe guides as specified in Section 40 05 07 - Hangers and Supports for Process Piping to compensate for pipe expansion due to temperature differences.

G. Dielectric Fittings: Provide between dissimilar metals.

H. Field Cuts: According to pipe manufacturer's recommendations.

I. Finish primed surfaces according to Section 09 96 00 – High-Performance Coating.

J. Run pipelines straight and true, parallel to building lines with a minimum use of offsets and couplings. Provide only such offsets as may be required to provide necessary headroom or clearance and to provide necessary flexibility in pipe lines.

K. Changes in direction of pipelines shall be made only with fittings or pipe bends. Changes in size shall be made only with fittings. Miter fittings, face or flush bushings, or street elbows shall not be used. All fittings shall be of the long radius type, unless otherwise shown on the drawings or specified.

L. Provide flanges or unions at all final connections to equipment, traps and valves to facilitate dismantling. Arrange piping and piping connections so that equipment being served may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.

M. Use full and double lengths of pipe wherever possible.
N. Unless otherwise indicated, install all supply piping, including shut off valves and strainers, to coils, pumps and other equipment at line size with reduction in size being made only at inlet to control valve or pump. Install supply piping from outlet of control valve at full size to connection of equipment served.

O. All pipe shall be cut to exact measurement and installed without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings. Particular care shall be taken to avoid creating, even temporarily, undue loads, forces or strains on valves, equipment, or building elements with piping connections or piping supports.

3.4 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Requirements for tolerances.

B. Laying Tolerances: Unless otherwise specified, laying tolerances will be within 5/8”.

3.5 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Inspection:

1. Inspect for damage to pipe lining or coating and for other defects that may be detrimental as determined by Engineer.
2. Repair damaged piping or provide new, undamaged pipe.
3. After installation, inspect for proper supports and interferences.

D. Damage:

1. Inspect for damage to pipe lining or coating, or other defects that may be detrimental as determined by Engineer.
2. Repair damaged piping or provide new undamaged pipe.

E. Pressure Testing:

1. Unless otherwise specified or indicated on the drawings, all pipe shall be pressure tested prior to acceptance.
2. Conduct pressure testing in according to AWWA C600 and following:
   a. Test Pressure: Not less than 200 psig or 50 psi in excess of maximum static pressure, whichever is greater.
   b. Conduct hydrostatic test for at least two hours.
   c. Slowly fill with water section to be tested; expel air from piping at high points. Install corporation cocks at high points. Close air vents and corporation cocks after air is expelled. Raise pressure to specified test pressure.
d. Observe joints, fittings, and valves under test. Remove and renew cracked pipe, joints, fittings, and valves showing visible leakage. Retest.

e. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate. Maintain pressure within plus or minus 5 psi of test pressure. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.

f. Compute maximum allowable leakage by following formula:

1) \( L = SD \times \sqrt{P}/C \).
2) \( L \) = testing allowance, in gph.
3) \( S \) = length of pipe tested, in feet.
4) \( D \) = nominal diameter of pipe, in inches.
5) \( P \) = average test pressure during hydrostatic test, in psig.
6) \( C = 148,000 \).
7) When pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.

g. When test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections, and retest until leakage is within allowable limits.

h. Correct visible leaks regardless of quantity of leakage.

F. After installation, inspect for proper supports and interferences.

3.6 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Keep pipe interior clean as installation progresses.

C. All piping shall be cleaned, flushed, and tested prior to use.

D. All water lines shall be flushed out under full treated water pressure; potable water piping shall be flushed with potable water; air piping shall be thoroughly blown out with air. All filters, control valves and gages shall be removed from lines or bypassed during the blowout period.

E. Following the blow through, all dirt legs and other low points in lines shall be disassembled and all residual material thoroughly removed. All stop valves shall be removed and cleaned.

F. The Contractor shall provide all water required for cleaning, and flushing at no additional cost to the Owner.

END OF SECTION 40 05 13
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SECTION 40 05 17 - COPPER PROCESS PIPE AND TUBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Copper pipe and fittings.
   2. Copper tube and fittings.
   3. Accessories.

B. Conform to the requirements of Section 40 05 13 – Common Requirements for Process Piping.

C. Related Requirements:
   1. Section 40 05 07 – Hangers and Supports for Process Piping
   2. Section 40 05 13 – Common Requirements for Process Piping
   3. Section 40 05 51 – Common Requirements for Process Valves

1.2 REFERENCE STANDARDS

A. American Welding Society:
   1. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding.

B. ASME International:
   1. ASME B1.1 - Unified Inch Screw Threads, UN and UNR Thread Form.
   2. ASME B1.20.1 - Pipe Threads, General Purpose, Inch.
   4. ASME B16.15 - Cast Copper Alloy Threaded Fittings: Classes 125 and 250.
   5. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
   7. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
   8. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
   9. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings: DWV.
   10. ASME B16.24 - Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500.
   11. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
   12. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings - DWV.
   13. ASME B31.3 - Process Piping.

C. ASTM International:
5. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
7. ASTM B98/B98M - Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes.

D. Manufacturers Standardization Society:


E. NSF International:

1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

PART 2 - PRODUCTS

2.1 COPPER PIPE, TUBE, AND FITTINGS

A. Pipe:

1. Material: Seamless copper.
2. Comply with ASTM B42 for water service, B306 for drainage and vent.
4. Type: L-above ground, K-below ground.

B. Tube:

1. Material: Seamless copper alloy.
2. Comply with ASTM B88.
3. Type: L-above ground, K-below ground.
4. Temper: Annealed.

C. Fittings:
1. Material: Copper alloy.
2. Temper: Comply with ASTM B61
4. Flared Fittings: Comply with ASME B16.26 and AWWA C800.
5. Threaded Fittings:
   a. Material: Cast bronze.
   b. Comply with ASME B16.15.
   c. Threads: Comply with ASME B1.20.1.
6. Flanges and Flanged Fittings:
   b. Class 150
   c. Gaskets:
      1) Material: Neoprene.
      2) Comply with ASME B16.5 and ASME B16.20.
      3) Thickness: 1/16 inch.
7. Seals:
   a. Material: EPDM.
   b. Factory installed.
8. Tubing Compression Fittings:
   a. Material: Forged brass alloy.
   b. Comply with ASTM B124/B124M.
   d. Press Fittings:
      1) Material: Copper
      2) Comply with ASME B16.18.

D. Pipe Joints:

1. Type:
   a. Threaded or Soldered.
   b. Connections to Equipment: Flanged or Threaded.

E. Tube Joints:

1. Type: Solder, or Flared.

A. Solder:

1. Comply with ASTM B32.

B. Piping Supports:

1. As specified in Specification Section 40 05 07 - Hangers and Supports for Process Piping.
PART 3 - EXECUTION

3.1 INSTALLATION

A. According to ASME B31.3 and Section 40 05 13 – Common Requirements for Process Piping.

3.2 JOINING OF PIPE

A. Threaded Joints

1. Ream pipe ends and remove all burrs and chips after cutting and threading. Protect pipe thread during assembly. Apply Teflon tape to male threads.

B. Solder Joints

1. Cut copper tubing so ends are perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to soldering. Apply flux evenly, but sparingly, over all surfaces to be joined. Heat joints uniformly to proper soldering temperature so solder will flow to all mated surfaces. Wipe excess solder, leaving a uniform fillet around cup of fitting.

3.3 DISINFECTION OF POTABLE WATERLINES

A. Following the testing procedure and after all corrections and adjustments have been made, all potable waterlines, both hot and cold water systems, shall be disinfected in strict accordance with the following procedure:

1. Water shall be introduced with a chlorine concentration of at least 50 mg/L. Chlorine shall be added with either a solution feed chlorinator or a hypochlorite feeder. Chlorine application shall continue until the system is filled with the chlorine solution.

2. The chlorinated water shall remain in the system for a minimum of 24 hr while all valves along the system are operated to insure their disinfection. Following the 24 hr period, a residual chlorine test shall be conducted on a fresh sample taken at a point farthest from the point the solution was introduced. If less than 25 mg/L of chlorine is indicated, the system shall be drained and the disinfection procedure repeated.

3. After a chlorine residual of at least 25 mg/L is obtained, the system shall be flushed until the chlorine concentration is equal to or less than 1 mg/L.

4. Disinfection shall conform to ANSI/AWWA C-651, latest revision. The ENGINEER and OWNER shall be notified 48 hr in advance of the disinfection procedure. Also, the flushed solution shall be disposed of as directed by the ENGINEER and OWNER.

END OF SECTION 40 05 17
SECTION 40 05 19 - DUCTILE IRON PROCESS PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ductile-iron pipe and fittings.
   2. Accessories.

B. Conform to the requirements of Section 40 05 13 – Common Requirements for Process Piping

C. Related Requirements:
   1. Section 09 96 00 – High-Performance Coating
   2. Division 40 – Process Integration

1.2 REFERENCE STANDARDS

A. American Water Works Association:
   1. AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
   2. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
   8. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.

B. ASME International:
   2. ASME B31.3 - Process Piping.

C. ASTM International:

D. SSPC - The Society for Protective Coatings:
   1. SSPC SP 6/NACE No. 3 - Commercial Blast Cleaning.
PART 2 - PRODUCTS

2.1 DUCTILE-IRON PIPE AND FITTINGS

A. Manufacturers:
   1. US Pipe.
   3. Or Approved Equal.

B. Piping:
   1. Comply with AWWA C151.
   2. Diameter and Class: As indicated below:

<table>
<thead>
<tr>
<th>Pipe Size (in)</th>
<th>Pressure Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>12” and Smaller</td>
<td>350</td>
</tr>
<tr>
<td>14” – 24”</td>
<td>250</td>
</tr>
<tr>
<td>30” and Larger</td>
<td>150</td>
</tr>
</tbody>
</table>

C. Joints:
   1. Pressure Rating: Same as that of connected piping.
   2. Mechanical:
      a. Comply with AWWA C110 and AWWA C111.
      b. Glands: Ductile iron with asphaltic coating.
      c. Use Tee-head or non-hex head bolts and head nuts for joint makeup and gasket seating. Bolts & Nuts shall be carbon steel coated with corrosion inhibiting fluoropolymer composite material.
      d. Mechanical joint fittings shall be furnished with sufficient quantities of accessories as required for each joint.
      e. All mechanical joints shall be restrained.
   4. Flanged: Comply with AWWA C115 with gaskets and bolts conforming to AWWA C115, Appendix A.
   5. Gaskets for mechanical and push-on type joints shall conform to ANSI A21.11 and AWWA C111, Gaskets shall be SBR, neoprene, or EPDM.
   6. Gaskets for flange joints shall conform to ANSI A21.15 and AWWA C115. Gaskets shall be neoprene or EPDM.
   7. Gaskets for joints above 250 psi shall be Toruseal gaskets as manufactured by American specially designed for a working pressure of 350 psi.

D. Fittings:
   1. Comply with AWWA C153, ductile iron.
2.2 FINISHES

A. Interior Coating
   1. Cement-mortar lining, AWWA C104; standard thickness.
   2. Glass-lined SR-14 or equal for grit and scum piping.
   3. Ceramic epoxy for gravity and pumped raw wastewater.
   4. Ductile Iron Pipe and Fittings used for air service shall be unlined pipe.

B. Outside Coating:
   2. Exposed: As specified in Section 09 96 00 - High-Performance Coatings.

2.3 ACCESSORIES

A. Jackets:
   1. AWWA C105, polyethylene jacket.
   2. All buried ductile iron pipe shall receive polyethylene jacketing.

B. Dielectric Fittings: Provide between dissimilar metals.

C. Pipe Identification Labels
   1. Identification for Process Piping: As specified in Section 40 05 53 - Identification for Process Piping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. As specified in Section 40 05 13 – Common Requirements for Process Piping

3.2 INSTALLATION

A. Buried Service: Install pipe as specified in:
   1. Section 40 05 13 – Common Requirements for Process Piping.
   2. AWWA C600 – Installation of Ductile Iron Water Mains and their Appurtenances.

B. Exposed Service: Install pipe as specified in:
   1. Section 40 05 13 – Common Requirements for Process Piping.
   2. Install according to ASME B31.3.
   3. Fittings:
      a. Clean gasket seats thoroughly and wipe gaskets clean prior to installation.
      b. Install fittings according to manufacturer instructions.
c. Tighten bolts progressively, drawing up bolts on opposite sides until bolts are uniformly tight; use torque wrench to tighten bolts to manufacturer recommendations.

4. Provide required upstream and downstream clearances from devices as indicated.

C. Tap ductile-iron piping only with service saddle, tapping boss of a fitting or valve body, or equipment casting.

D. At times when pipe laying is not in progress, the open ends of the pipe shall be closed by a watertight plug or other means acceptable to the Engineer.

E. The cutting of pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or lining so as to leave a smooth end at right angles to the axis of the pipe.

F. Where pipe is laid on a grade of ten (10) percent or greater, the laying shall start at the bottom and shall proceed upward with the bell ends of the pipe upgrade.

3.3 JOINING OF PIPE

A. Flanged Joints

1. Flanges conforming to AWWA C110 can be joined with Class 125 B16.1 flanges shown in ANSI B16.1 but not with Class 250 B16.1 flanges.
2. Flange joints should be fitted so that the contact faces bear uniformly on the gasket. The joint should be made with relatively uniform bolt stress.
3. Set flange bolts beyond finger tightness with an indicating torque wrench to insure equal tension in all bolts. Tighten bolts such that those 180 degrees apart or directly opposite are torqued in sequence.

B. Push-On Joint

1. Push-on joints shall be made in strict accordance with the manufacturer’s instructions. Pipe shall be laid with bell ends upstream.
2. Pipe 8 inches in diameter and larger shall be socketed by fork tools or jacks.
3. Pipe cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. The spigot ends of field cut pipe shall be tapered back 1/8 inch at an angle of about 30 degrees to the barrel of the pipe with a coarse file or portable grinder. All sharp or rough edges that may injure the rubber gasket shall be removed in this operation.
4. Whenever it is desirable to deflect push-on joint pipe, the amount of deflection shall not exceed the maximum limits according to Table 4 in AWWA C600.

C. Mechanical Joints:

1. Mechanical joints shall be in accordance with AWWA C600 and the manufacturer’s instructions.
2. Bell ends shall be laid upstream.
3. Bolts shall be tightened to the specified torque. Under no condition shall extension wrenches or pipe over handle of ordinary ratchet wrench be used to obtain greater leverage.
4. Final tightening of bolts shall be with a torque wrench to insure equal tension in all bolts.
5. Bolts shall not be over-stressed to compensate for poor assembly.

3.4 PLACEMENT OF FITTINGS

1. Pipeline fittings, plugs, and caps shall be furnished and installed of the type indicated and at the location shown on the Drawings or as directed by the Engineer. It shall be the responsibility of the Contractor to furnish and install all proper size pipe bends for both horizontal and vertical deflections that are required to construct the pipeline to the line and grade as shown on the construction drawings or as set by the Engineer.

3.5 POLYETHYLENE ENCASEMENT

A. The Contractor shall use Method A of ANSI/AWWA A21.5/C105 to install polyethylene encasement.

3.6 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.
B. Test Pipe (other than air lines) per Section 40 05 13 – Common Requirements for Process Piping.
C. Pressure Testing - Air

1. All pressure pipelines conveying process air, flume air or primary air shall be tested by the Contractor in a manner satisfactory to and witnessed by the Engineer.
2. The section under test shall be isolated by airtight plugs or valves from the air blowers and the diffuser headers which shall be tested separately.
3. The pressure and leakage test shall first consist of filling the test section with compressed air to a pressure of 12 psig. The air inlet point shall be sealed and with no further introduction of air, the pipeline shall maintain a pressure of 12 psig for one hour. A pressure gage supplied by the Contractor and scaled to twice the test pressure shall be used to indicate the pressure.
4. If the pipeline fails the above test, the Contractor shall locate and correct all leaks and retest the pipe section until it satisfactorily passes the test.

3.7 DISINFECTION OF POTABLE WATERLINES

A. Following the testing procedure and after all corrections and adjustments have been made, all potable waterlines, both hot and cold water systems, shall be disinfected in strict accordance with the following procedure:

1. Water shall be introduced with a chlorine concentration of at least 50 mg/L. Chlorine shall be added with either a solution feed chlorinator or a hypochlorite feeder. Chlorine application shall continue until the system is filled with the chlorine solution.
2. The chlorinated water shall remain in the system for a minimum of 24 hr while all valves along the system are operated to insure their disinfection. Following the 24 hr period, a residual chlorine test shall be conducted on a fresh sample taken at a point farthest from the point the solution was introduced. If less than 25 mg/L of chlorine is indicated, the system shall be drained and the disinfection procedure repeated.

3. After a chlorine residual of at least 25 mg/L is obtained, the system shall be flushed until the chlorine concentration is equal to or less than 1 mg/L.

4. Disinfection shall conform to ANSI/AWWA C-651, latest revision. The Engineer and Owner shall be notified 48 hr in advance of the disinfection procedure. Also, the flushed solution shall be disposed of as directed by the Engineer and Owner.

END OF SECTION 40 05 19
SECTION 40 05 31 - THERMOPLASTIC PROCESS PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. PVC pipe, tube, and fittings
2. High Density Polyethylene (HDPE) pipe, tube, and fittings
3. Accessories for plastic piping and fittings

B. Related Requirements:

1. Section 40 05 07 – Hangers and Supports for Process Piping
2. Section 40 05 13 – Common Requirements for Process Piping
3. Section 40 05 51 – Common Requirements for Process Valves

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

1. ASME B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form).
2. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
3. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800
4. ASME B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.
5. ASME B16.20 - Metallic Gaskets for Pipe Flanges.
6. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
7. ASME B31.3 - Process Piping Guide.

B. ASTM International:

1. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
2. ASTM A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.

C. American Water Works Association:
1. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution.
2. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service.
3. AWWA C905 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In.
4. AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,600 mm), for Water Distribution and Transmission.
D. NSF
   1. NSF / ANSI 14 – Plastic Piping and Components and Related Materials

E. PVC Pipe Association
   1. UNI-B-06-Recommended Low-Pressure Air Testing of Installed Sewer Pipe.

1.3 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Temperature: Do not install pipe when temperature is below 40 degrees F (4.4 degrees C) or above 90 degrees F (32.2 degrees C) if pipe is exposed to direct sunlight.

C. Ultraviolet (UV) Protection: Provide pipe installed above ground or outside with UV protection.

PART 2 - PRODUCTS

2.1 PVC PIPE, TUBE, AND FITTINGS

A. Manufacturers:
   1. Eslon Thermoplastics; Charlotte, NC
   2. R&G Sloane, Sun Valley, CA
   3. Harvel Plastics, Easton, PA
   4. LCP Chemicals & Plastics, Colfax, NC
   5. Bristol Corp., Bristol, IN.
   6. Or Approved Equal.

B. PVC Pipe and Fittings (for non-potable service):
   1. Pipe
      a. Rigid, Type I, Grade I
      b. Comply with ASTM D1785
      c. Schedule 80
   2. Fittings:
      a. Comply with ASTM D2467
      b. Joints: Socket type, solvent welded; comply with ASTM D2855
      c. Solvent Cement: Comply with ASTM D2564

1) For chemical piping, use PVC solvent Weld-On 724 as manufactured by IPS Corporation or equivalent.
C. PVC Pipe and Fittings (for potable service)
   1. Pipe:
      a. Comply with ASTM D1785
      b. Schedule 40
   2. Fittings:
      a. Comply with ASTM D2467
      b. Joints: Socket type, solvent welded; comply with ASTM D2855
      c. Solvent Cement: Comply with ASTM D2564

D. PVC Tube and Fittings:
   1. Tube:
      a. Clear.
      b. Size and Wall Thickness: schedule 80.
   2. Fittings: Compression type; materials suitable for application.

2.2HDPE PIPE, AND FITTINGS

A. Manufacturers:
   1. ISCO.
   2. JM Eagle.
   3. Or Approved Equal.

B. HDPE Pipe and Fittings:
   1. Pipe: ASTM F714 and ASTM D3035. DR 11
   2. Fittings: ASTM F2620/D3261, butt welded and fully pressure rated for the same service condition as the pipe.
   3. Joints: Butt fusion or electrofusion per ASTM F2620/D3261; threaded or flanged if later removal is required.
   4. Materials: ASTM D3350, manufactured from virgin resins PE4710 cell classification PE445474C.
   5. All HDPE pipe and fittings shall be of nominal DIPS (ductile iron pipe size) outside diameter.
   6. Pipe shall be legibly marked at intervals of no more than five feet with the manufacturer’s name, trademark, pipe size, HDPE cell classification, appropriate legend such as SDR 9, ASTM D3035, date of manufacture and point of origin.

2.3ACCESSORIES

A. Solvent Cement:
1. PVC Piping: ASTM D2564.


C. Tracer Wire: #12 AWG copper clad steel insulated wire, insulation color per pipe service.

D. Detectible Underground Marking Tape: underground marking tape shall be a minimum 3” width, detectable marking tape, with a minimum 5.0 mil overall thickness. Tape shall be manufactured using a 0.8 mil clear virgin polypropylene film, reverse printed and laminated to a 0.35 mil solid aluminum foil core, and then laminated to a 3.75 mil clear virgin polyethylene film. Tape shall be printed using a diagonally striped design for maximum visibility, and meet the APWA Color-Code standard for identification of buried utilities. Detectable marking tape shall be Pro-Line Safety Products or approved equal and made in the USA.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install piping and components according to the following:
   1. Section 40 05 13 – Common Requirements For Process Piping
   2. ASME B31.3 for above ground service
   3. AWWA C605 for potable water service
   4. ASTM D2774 for non-potable underground pressure service
   5. ASTM D2321 for non-potable underground gravity service

B. Joining:
   1. HDPE pipe sections shall be joined on the jobsite above ground into continuous lengths by the Butt-Fusion Method in accordance with ASTM F2620, and in strict accordance with the Manufacturer’s Recommendations. Maximum joined drag length is 600-ft.
   2. HDPE pipe shall be joined to ductile iron valves and fittings with a DIPS size MJ Adapter Kit. Pipe Stiffeners shall be used to maintain roundness of the pipe. MJ adapter and stiffeners shall be installed in strict accordance with the manufacturer’s instructions.
   3. Perform heat joining according to ASTM D2657.
   4. Perform electrofusion joining according to ASTM F1290.

C. Tracer Wire shall be installed on all non-metallic lines. The contractor shall perform a continuity test on all tracer wire in the presence of the engineer. Tracer wire shall be run along the top of the pipe and secured at intervals of 10’ with wire or tape. The tracer wire shall be brought up into all valve and meter boxes so as to be readily accessible to system operators. All wire splices and connections shall be tied and tightly taped with insulated electrical tape.

3.2 A detectable marking tape shall be installed over all nonmetallic lines by the Contractor. Care will be taken to ensure that the buried marking tape will bear the words "CAUTION-PIPE LINE
BURIED BELOW." The detectable marking tape will be buried 4 to 6 in. below finish grade. The tape should be placed into backfill and allowed to settle into place in the backfill.

3.3 TESTING:

A. Clean lines by flushing or other means before testing begins.

B. Testing may be dangerous if a line is improperly prepared. The Contractor shall develop and put in place proper safety procedures when performing testing.

C. PE and HDPE pipe for pressure service will be tested in accordance with ASTM F2164-13.

D. PVC pipe for pressure service will be tested in accordance with AWWA C600.

E. Tests for Gravity Service shall include:

1. Infiltration Test:
   a. All lines below the water table shall be checked for infiltration
   b. If at any time prior to expiration of the correction period stipulated in the General Condition, infiltration exists, that is any inflow, and the pipe fails.
   c. The Contractor shall locate the leaks and make repairs as necessary to remove the infiltration.

2. Deflection Testing
   a. Conduct deflection test prior to low-pressure air test.
   b. Perform deflection testing after the final backfill and compaction has been in place at least thirty (30) calendar days and prior to placing lines into operation.
   c. Each reach of pipe shall be checked for excessive deflection by pulling a mandrel through the pipe. The mandrel shall be cylindrical in shape and constructed with 9 evenly spaced arms. The critical dimensions of the mandrel shall have a +/- 0.01 inch tolerance.
   d. Deflection shall not exceed 5% of initial diameter
   e. Pipe failing the deflection test shall be uncovered, and the bedding and backfill replaced to prevent excessive deflection. Repaired pipe shall be retested.

3. Low Pressure Air Testing
   a. Test each reach with maximum 5 psi
   b. The time elapsed for a 0.5 psi drop in air pressure shall be not less than 10 minutes or as specified in ASTM F1417 or UNI B-6-90 whichever is greater.

4. Joint Testing
   a. For pipes large enough to enter (27” in diameter or larger), individual joints may be pressure tested with a portable tester to 5 psi maximum, with air or water in lieu of low pressure air testing.
   b. Joint Testing shall be performed in accordance with ASTM C1103.
END OF SECTION 40 05 31
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40 05 51 - COMMON REQUIREMENTS FOR PROCESS VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Valves
   2. Valve actuators

B. Related Requirements:
   1. Section 03 30 00 – Cast-in-Place Concrete
   2. Section 05 50 00 – Metal Fabrications
   3. Section 09 96 00 – High-Performance Coatings
   4. Division 40 – Process Interconnections

1.2 REFERENCE STANDARDS

A. American Water Works Association:
   1. AWWA C541 - Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
   2. AWWA C542 - Electric Motor Actuators for Valves and Slide Gates.
   3. AWWA C550 - Protective Interior Coatings for Valves and Hydrants.

B. ASTM International:
   1. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

C. Manufacturers Standardization Society:
   1. MSS SP-25 - Standard Marking System for Valves, Fittings, Flanges, and Unions.

D. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. NFPA:
   1. NFPA 70 - National Electrical Code (NEC).

F. NSF International:
   1. NSF 61 - Drinking Water System Components - Health Effects.
2. NSF 372 - Drinking Water System Components - Lead Content.

G. UL:
1. Equipment Directory.

1.3 COORDINATION
A. Section 01 31 00 – Project Management and Coordination.
B. Coordinate Work of this Section with piping, equipment, and appurtenances.

1.4 SUBMITTALS
A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data:
   1. Submit manufacturer information for actuator with model number and size indicated.
   2. Submit valve cavitation limits.
C. Shop Drawings: Indicate parts list, materials, sizes, position indicators, limit switches, control system, actuator mounting, wiring diagrams, and control system schematics.
D. Valve Schedule: Indicating the service, size, and connections, make, model number and any special features such as chain wheel operators, etc.
E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
F. Certification of Valves Larger than 12 Inches: Furnish certified copies of hydrostatic factory tests, indicating compliance with applicable standards.
G. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for sizing of control valves.
H. Manufacturer Instructions: Submit installation instructions and special requirements.
I. Source Quality-Control Submittals: Indicate results of shop/factory tests and inspections.
J. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections, including factory-applied coatings.
K. Qualifications Statement:
   1. Submit qualifications for manufacturer and licensed professional.

1.5 CLOSEOUT SUBMITTALS
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
B. Project Record Documents: Record actual locations of valves and actuators.

1.6 QUALITY ASSURANCE

A. Maintain clearances as indicated on Drawings and Shop Drawings.

B. Ensure that materials of construction of wetted parts are compatible with process liquid.

C. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

D. The manufacturer shall be required to furnish at the time of delivery an affidavit of compliance stating the valve and all materials used conform in every respect to the applicable performance of the appropriate AWWA Standard, and these supplementary specifications and that all tests have been performed with test requirements having been met. Test requirements shall be performed and test records furnished to the engineer prior to shipment.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum twenty years' documented experience

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Prepare valves and accessories for shipment according to latest edition of AWWA C500, Section 31 and:

1. Seal valve ends to prevent entry of foreign matter into valve body.
2. Box, crate, completely enclose, and protect valves and accessories from accumulations of foreign matter.

D. Store materials according to manufacturer instructions.

E. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Protect valve ends from entry of foreign materials by providing temporary covers and plugs.
3. Provide additional protection according to manufacturer instructions.
1.9 **TOOLS AND SPARE PARTS**

A. Provide to the Owner, one operating wrench for every 10 valves of each type (but not less than 2 wrenches per type), not equipped with hand wheels or levers.

B. The manufacturer shall furnish any special tools necessary to disassemble, service, repair, and adjust the equipment.

1.10 **EXISTING CONDITIONS**

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.11 **WARRANTY**

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. The Manufacturer and Contractor shall furnish a warranty extending twelve (12) months after substantial completion date.

**PART 2 - PRODUCTS**

2.1 **VALVES**

A. Description: Valves, operator, actuator, handwheel, chainwheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and other accessories as required.

B. General:

1. All packing, gaskets, discs, seats, diaphragms, lubricants, etc., shall conform to recommendations of the valve manufacturer for the intended service.
2. All valves shall be manufacturer's standard of the design which the manufacturer recommends for the service intended.
3. Each valve shall bear the maker's name or trademark or reference symbol to indicate the service conditions for which it is guaranteed.
4. All valves for use with copper tubing shall have solder type connections.
5. All screw end valves shall be threaded according to the American Standard for Pipe Threads No. B2.1.
6. Flange end valves shall have connecting end flanges in accordance with the B16.1, Class 125 Series of the American Standards Association for type valves covered in the Standard, and in accordance with the Manufacturer's Standardization Society Standard Practice for bronze valves corresponding to the maximum pressure and service for which the valve is to be used.

C. Valve Ends: Compatible with adjacent piping system.
D. Operation:

1. Open by turning counterclockwise; close by turning clockwise.
2. Cast directional arrow on valve or actuator with OPEN and CLOSE cast on valve in appropriate location.

E. Valve Marking and Labeling:

1. Marking: Comply with MSS SP-25.
2. Labeling: As specified in Section 40 05 53 - Identification for Process Piping.

F. Valve Construction:

1. Bodies: Rated for maximum temperature and pressure to which valve will be subjected as specified in valve Sections.
2. Bonnets:
   a. Flanged to body and of same material and pressure rating as body.
   b. Furnish glands, packing nuts, or yokes as specified in valve Sections.
3. Stems and Stem Guides:
   a. Materials and Seals: As specified in valve Sections.
   c. Space stem guides 10 feet o.c.
   d. Submerged Stem Guides: Type 304 stainless steel.
4. Nuts and Bolts: As specified in Section 05 50 00 - Metal Fabrications.

G. Valve Type:

1. Plug Valves: As specified in Section 40 05 62 – Plug Valves.
2. Ball Valves: As specified in Section 40 05 63 – Ball Valves.
3. Swing and Disc Check Valves: As specified in Section 40 05 65 – Swing Check Valves.
4. Pressure-Regulating Valves: As specified in Section 40 05 66 – Pressure-Regulating Valves.
5. Pressure-Relief Valves: As specified in Section 40 05 67 – Pressure-Relief Valves.
6. Combination Air Valves for Wastewater Service: As specified in Section 40 05 78 – Combination Air Valves for Wastewater Service.

2.2 VALVE ACTUATORS

A. Description: Manual, pneumatic and electric motor actuators.

B. Provide actuators per specification Section 40 05 57 – Actuators for Process Valves and Gates

2.3 FINISHES

A. Valve lining and coating: Comply with AWWA C550.
B. Exposed Valves: As specified in Section 09 96 00 – High-Performance Coatings.

C. Do not coat flange faces of valves unless otherwise specified.

2.4 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Testing: Test valves according to manufacturer's standard testing protocol, including hydrostatic, seal, and performance testing.

C. Certificate of Compliance:

   1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
   2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 31 00 – Project Management and Coordination: Requirements for installation examination

B. Verify that piping system is ready for valve installation.

3.2 INSTALLATION

A. Install valves, actuators, extensions, valve boxes, and accessories according to manufacturer instructions.

B. Firmly support valves to avoid undue stresses on piping.

C. Valves shall be installed with the stems positioned in the horizontal or above the centerline of the pipe unless otherwise shown on the Drawings.

D. Operators shall be positioned so that they do not interfere with pedestrian traffic.

E. Valve operators which are 7’-0” or more above the operating floor or platform shall be chain wheel operated.

F. Where necessary for operations as described above, valves shall be bevel or spur gear operated. Plug valve 6 in. and larger shall be gear operated.

G. Coat studs, bolts and nuts with anti-seizing lubricant.

H. Clean field welds of slag and splatter to provide a smooth surface.
I. Install valves with stems upright or horizontal, not inverted.

J. Install brass male adapters on each side of valves in copper-piped system and solder adapters to pipe.

K. All buried valves shall have a 2” operating nut and handwheels for all exposed valves.

L. Install 3/4-inch ball valves with cap for drains at main shutoff valves, low points of piping, bases of vertical risers, and equipment.

M. Install valves with clearance for installation of insulation and to allow access.

N. Provide access where valves and fittings are not accessible.

O. Pipe Hangers and Supports: As specified in Section 40 05 07 - Hangers and Supports for Process Piping.

P. Comply with Division 40 - Process Interconnections for piping materials applying to various system types.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Valve Field Testing:
   1. Test for proper alignment.
   2. If specified by valve Section, field test equipment to demonstrate operation without undue noise, vibration, or overheating.

END OF SECTION 40 05 51
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SECTION 40 05 53 - IDENTIFICATION FOR PROCESS PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Nameplates.
   2. Tags.
   3. Stencils.
   4. Pipe markers.
   5. Ceiling tacks.
   7. Lockout devices.

B. Related Requirements:
   1. Section 09 96 00 – High-Performance Coatings
   2. Division 40 – Process Interconnections
   3. Division 43- Process Gas and Liquid Handling, Purification and Storage Equipment
   4. Division 46 – Water and Wastewater Equipment

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

1.3 SUBMITTALS

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

B. Product Data: Submit manufacturer's catalog literature for each product required.

C. Shop Drawings: Submit list of wording, symbols, letter size, and color-coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Samples: Submit one tag, label, and pipe markers for each size used on Project.

E. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

F. Manufacturer's Certificate: Certify that products meet or exceed specified requirement.

G. Qualifications Statement:
1. Submit qualifications for manufacturer.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Extra Stock Materials: Furnish one container of spray-on adhesive.

C. Tools: Furnish special tools and other devices required for Owner to reinstall tags.

1.6 QUALITY ASSURANCE

A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' documented experience.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:

1. Craftmark Pipe Markers
2. Kolbi Pipe Marker Co.
3. Seton Identification Products
4. Or Approved Equal

B. Description: Equipment nameplates shall be engraved or stamped on stainless steel and fastened to the equipment in an accessible location with oval head stainless steel screws or drive pins. Nameplates shall at a minimum contain manufacturers name and address, year of manufacture, serial number, speed (if applicable) and other applicable information.
2.2 TAGS

A. Plastic Tags:
   1. Manufacturers:
      a. Brady ID
      b. Craftmark Pipe Markers
      c. Kolbi Pipe Marker Co.
      d. Seton Identification Products
      e. Or Approved Equal
   2. Description:
      a. Laminated three-layer plastic with engraved black letters on light, contrasting background color.
      b. Minimum Tag Size and Configuration: 1-1/2 inches; diameter or square.

B. Metal Tags:
   1. Manufacturers:
      a. Brady ID
      b. Craftmark Pipe Markers
      c. Kolbi Pipe Marker Co.
      d. Seton Identification Products
      e. Or Approved Equal
   2. Description:
      a. Aluminum or Stainless-steel construction; stamped letters.
      b. Minimum Tag Size and Configuration: 1-1/2 inches; diameter or square with finished edges.

C. Information Tags:
   1. Manufacturers:
      a. Brady ID
      b. Craftmark Pipe Markers
      c. Kolbi Pipe Marker Co.
      d. Seton Identification Products
      e. Or Approved Equal
   2. Description:
      a. Clear plastic with printed DANGER, CAUTION, WARNING, and message.
      b. Minimum Tag Size: 3-1/4 by 5-5/8 inch.
      c. Furnish grommet and self-locking nylon ties.
3. Tag Chart: Typewritten, letter-size list of applied tags and location, in anodized aluminum frame.

2.3 STENCILS

A. Manufacturers:
   a. Kolbi Pipe Marker Co.
   b. Seton Identification Products
   c. Or Approved Equal

B. Description:
   1. Clean-cut symbols.
   2. Letters:
      a. Up to 2-inch Outside Diameter of Insulation or Pipe: 1/2-inch-high letters.
      b. 2-1/2- to 6-inch Outside Diameter of Insulation or Pipe: 1-inch-high letters.
      c. Over 6-inch Outside Diameter of Insulation or Pipe: 1-3/4-inch-high letters

C. Stencil Paint: As specified in 09 96 00 - High-Performance Coatings; semigloss enamel.

D. Color-Coding and Lettering Size: Conform to ASME A13.1.

2.4 PIPE MARKERS


B. Plastic Pipe Markers:
   1. Manufacturers:
      a. Brady ID
      b. Craftmark Pipe Markers
      c. Seton Identification Products
      d. Or Approved Equal

   2. Description:
      a. Factory-fabricated, flexible, semirigid plastic.
      b. Preformed to fit around pipe or pipe covering.
      c. Larger sizes may have maximum sheet size with spring fastener.

C. Plastic Tape Pipe Markers:
   1. Manufacturers:
      a. Brady ID
      b. Craftmark Pipe Markers
      c. Kolbi Pipe Marker Co.
d. Seton Identification Products  
e. Or Approved Equal

2. Description: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.

D. Plastic Underground Pipe Markers:
   1. Manufacturers:
      a. Kolbi Pipe Marker Co.  
b. Seton Identification Products  
c. Or Approved Equal
   2. Description:
      a. Brightly colored, continuously printed plastic ribbon tape.  
b. Minimum 6 inches wide by 4 mil thick.  
c. Manufactured for direct burial service.

2.5 LABELS
   A. Manufacturers:
      1. Brady ID  
      2. Seton Identification Products  
      3. Or Approved Equal
   B. Description:
      1. Aluminum or Laminated Mylar construction.  
      2. Minimum Size: 1.9 by 0.75 inches.  
      3. Adhesive backed, with printed identification and bar code.

2.6 LOCKOUT DEVICES
   A. Lockout Hasps:
      1. Manufacturers:
         a. Brady ID  
         b. Master Lock Company, LLC  
         c. Or Approved Equal
      2. Description:
         a. Anodized aluminum or reinforced nylon construction.  
         b. Furnish hasp with erasable label surface.  
         c. Minimum Size: 7-1/4 by 3 inches.
B. Valve Lockout Devices:

1. Manufacturers:
   a. Brady ID
   b. Master Lock Company, LLC
   c. Or Approved Equal

2. Description:
   a. Nylon or Steel construction.
   b. Furnish device preventing access to valve operator and accepting lock shackle.

PART 3 - EXECUTION

3.1 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Degrease and clean surfaces to receive adhesive for identification materials.

C. Prepare surfaces as specified in Section 09 96 00 – High-Performance Coatings for stencil painting.

3.2 INSTALLATION

A. Apply stencil painting as specified in Section 09 96 00 - High-Performance Coatings.

B. Install identifying devices after completion of coverings and painting.

C. Identify equipment with nameplates.

D. Identify inline pumps and other small devices with tags.

E. Identify control panels and major control components outside panels with plastic nameplates.

F. Install plastic nameplates with corrosion-resistant mechanical fasteners or adhesive.

G. Labels:
   1. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer.
   2. For unfinished covering, apply paint primer before applying labels.

H. Tags:
   1. Install tags using corrosion-resistant chain.
   2. Number tags consecutively by location.
I. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

J. Identify valves in main and branch piping with tags.

K. Piping:
   1. Identify piping, concealed or exposed, with plastic pipe markers, plastic tape pipe markers and/or stenciled painting.
   2. Use tags on piping 3/4-inch diameter and smaller.
   3. Identify service, flow direction, and pressure.
   4. Install in clear view and align with axis of piping.
   5. Locate identification not to exceed 20 feet on straight runs, including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

END OF SECTION 40 05 53
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SECTION 40 05 57 - ACTUATORS FOR PROCESS VALVES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   2. Electric motor actuators.

B. Related Requirements:
   1. Section 05 50 00 - Metal Fabrications
   2. Section 09 96 00 - High-Performance Coatings
   3. Division 40 - Process Interconnections

1.2 REFERENCE STANDARDS

A. American Bearing Manufacturers Association:
   1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. American Water Works Association:
   1. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service.
   2. AWWA C542 - Electric Motor Actuators for Valves and Slide Gates.

C. NFPA:
   1. NFPA 70 - National Electrical Code.

1.3 COORDINATION

A. Section 01 31 00 - Project Management and Coordination: Requirements for coordination.

B. Coordinate Work of this Section with installation of valves and accessories.

1.4 SUBMITTALS

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

B. Product Data: Submit manufacturer information for actuator with model number and size indicated.
C. Shop Drawings:
   1. Indicate parts list, materials, sizes, position indicators, limit switches, actuator mounting, wiring diagrams, control system, and control system schematics on assembly drawings.
   2. Submit actuator Shop Drawings with valve and gate submittal.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer Instructions: Submit special procedures and placement requirements.

F. Source Quality-Control Submittals: Indicate results of shop/factory tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Qualifications Statements:
   1. Submit qualifications for manufacturer and installer.
   2. Submit manufacturer's approval of installer.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations and types of actuators.

1.6 QUALITY ASSURANCE

A. Valve Actuators in NEC Class I, Group D, Division 1 for areas where flammable gases, vapors or liquids can exist all of the time or some of the time under normal operating conditions.

B. Valve Actuators in NEC Class I, Group D, Division 2 for areas where flammable gases, vapors or liquids are not likely to exist under normal operating conditions.

C. Locations: Comply with NFPA 70.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
   3. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. The Manufacturer and Contractor shall furnish a warranty extending twelve (12) months after substantial completion date.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Manufacturers:
   1. Dezurik
   2. Valmatic
   3. Beck
   4. EIM Limitorque
   5. Approved Equivalent

2.2 DESCRIPTION

A. Furnish gear and power actuators with position indicators.
2.3 MANUAL ACTUATORS

A. Gate Valves: Gate valves shall be fitted with cast iron hand wheels of suitable size or gear and hand wheel operators in accordance with AWWA C500.

B. Butterfly Valves: Butterfly valves 3 inches and smaller shall be lever and locking ratchet operated. Butterfly valves 4 inches and larger shall be equipped with gear and hand wheel operators. The operators shall be furnished by the manufacturer of the valve, in accordance with AWWA C504, who shall be responsible for the compatibility and adequacy of both the valve and operator. Valve operator shall be sized for the maximum torque developed by the maximum pressure in the pipeline in which the valve is to be used.

C. Plug and Ball Valves: Plug and ball valves 3 inches and smaller shall be lever and locking ratchet operated. Plug and ball valves 4 inches and larger shall be provided with gear and hand wheel operators.

D. Provide gear and power actuators with position indicators.

E. Gear-Assisted Manual Actuators:

1. Drive Type: Worm gear except where otherwise shown or specified
2. Provide totally enclosed gears.
3. Gearing: Designed for 100 percent overload.
4. Bearings:
   a. Type: Ball or Roller; comply with ABMA 9 or ABMA 11.
   b. Permanently lubricated bronze.
   c. Minimum L10 Life: 100,000 hours.
7. Packing: Accessible for adjustment without requiring removal of actuator from valve.

F. Chain Actuators:

1. Description:
   a. Chain actuators for shutoff valves mounted 7 feet and greater above operating floor level.
   b. Chain guides and hot-dip galvanized operating chain extending to 5-1/2 feet above operating floor level.
2. Chain Wheels: Sprocket rim type.
3. Furnish chain storage if chains may interfere with pedestrian traffic.

G. Buried Valves:

1. Comply with AWWA C500.
2. Floors:
a. Furnish extension stems to grade, and square nuts or floor stands with position indicators.
b. Cast-iron/Steel pipe extensions with valve boxes, covers, and operating keys.
c. Floor Boxes: Hot-dip galvanized cast iron or steel, with bronze cover.
d. Lid Inscription: An arrow at least 2" long showing direction of opening. The word OPEN shall also be cast on the flange.

3. Valve Boxes:
   a. Material: Cast iron.
   b. 12 Inch Diameter Valves and Smaller: Two-piece, screw type.
   c. Valves larger than 12 Inch Diameter: Three-piece, screw type.
   d. Lid Inscription: An arrow at least 2" long showing direction of opening. The word OPEN shall also be cast on the flange.

2.4 SOURCE QUALITY CONTROL
   A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.
   B. Provide shop inspection and testing of completed assemblies.
   C. Certificate of Compliance:
      1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
      2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
   B. Verify that field dimensions are as indicated on Shop Drawings.

3.2 INSTALLATION
   A. Securely mount actuators using brackets or hardware specifically designed for attachment to valves.
   B. Extend chain actuators to 5-1/2 feet above operating floor level.

3.3 FIELD QUALITY CONTROL
   A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.
B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. After installation, inspect for proper supports and interferences.

D. Repair damaged coatings with material equal to original coating as specified in Section 09 96 00 - High-Performance Coatings.

END OF SECTION 40 05 57
SECTION 40 05 62 - PLUG VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Eccentric plug valves.
B. Conform to the requirements of Section 40 05 51 - Common Requirements for Process Valves
C. Related Requirements:
   1. Division 40 – Process Interconnections

1.2 REFERENCE STANDARDS

A. American Water Works Association:
   1. AWWA C517 - Resilient-Seated Cast-Iron Eccentric Plug Valves.

B. ASME International:
   2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
   4. ASME B1.20.1 - Pipe Threads, General Purpose, Inch.

C. ASTM International:
   2. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

PART 2 - PRODUCTS

2.1 ECCENTRIC PLUG VALVES

A. Manufacturers:
   1. Dezurik
   2. Milliken; Henry Pratt Company
   3. Or approved equal

B. Description:
1. Type:
   a. Non-lubricated.
   b. Eccentric.
   c. 90 Degree Turn
   d. Resilient faced Plug

2. Working Pressure: 175 psig for valves through 12” and 150 psig for valves for 14” through 72”.

3. Ports:
   a. Configuration: Rectangular.
   b. Minimum Port Area: 100 percent of nominal pipe area for valves.


5. Stem Seals:
   a. Type: V-ring.
   b. Material: Neoprene.


7. End Connections:
   a. Flanged: Comply with ANSI 125/150 lb. Standard
   b. Mechanical Joint

C. Operation:

1. As specified in Section 40 05 57 Actuators for Process Valves and Gates.

D. Materials:

1. Body:
   a. Cast iron, ASTM A126 Class B.
   b. Lining: As recommended by valve manufacturer for service conditions.

2. Plug:
   a. Ductile iron, ASTM A126 Class B.
   b. Lining: Synthetic viton compound of a minimum of 70 durometer hardness.


4. Stem: Type 316 stainless steel.

5. Stem Bearings: Type 316L stainless steel.

6. Seals: Buna-N.

7. Connecting Hardware: Type 316 stainless steel.

E. Finishes: As specified in Section 40 05 51 - Common Requirements for Process Valves.
2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.
B. As specified in Section 40 05 51 - Common Requirements for Process Valves.

PART 3 - EXECUTION

3.1 EXAMINATION, INSTALLATION AND FIELD QUALITY CONTROL

A. As specified in Section 40 05 51 - Common Requirements for Process Valves
B. According to AWWA C517.
C. Horizontal Piping: Stem horizontal.
D. Vertical Piping: Plug at top when closed.
E. Plugs: On top when open and on pressure side when closed.

END OF SECTION 40 05 62
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SECTION 40 05 63 - BALL VALVES

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Rubber-seated ball valves
      2. Plastic ball valves
   B. Conform to requirements of Section 40 05 51 – Common Requirements for Process Valves
   C. Related Requirements:
      1. Division 40 – Process Interconnections

1.2 REFERENCE STANDARDS
   A. American Water Works Association:
      1. AWWA C507 - Ball Valves, 6 In. Through 60 In.
   B. ASME International:
      2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
   C. ASTM International:
   D. Manufacturers Standardization Society of the Valve and Fittings Industry:
      1. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
PART 2 - PRODUCTS

2.1 RUBBER-SEATED BALL VALVES

A. Manufacturers:

1. Henry Pratt Company; - Aurora, IL.
3. Apollo – Matthews, NC
4. Approved Equal.

B. Smaller Than 4 Inches:

1. Comply with MSS SP 110.
2. Working Pressure: 150 psig at 90 °F
3. Maximum Process Fluid Temperature: 90 °F
4. Body:
   a. Type: Two piece
   b. Material: Bronze
5. Ball: Stainless steel
6. Port: Regular
7. Seats: Buna-N
8. Stem: Blowout proof
9. End Connections: Threaded, with union
10. Operator: Hand lever
11. Finishes: As specified in Section 40 05 51 - Common Requirements for Process Valves.

2.2 PLASTIC BALL VALVES

A. Manufacturers:

1. Hayward
2. NIBCO
3. Asahi/American
4. Approved Equal

B. Description:

1. Working Pressure: 232 psig at 68 °F
2. Ports: Full size
3. End Connections:
   a. Socket Union
   b. Threaded Pipe Union

C. Operator: Manual unless otherwise specified or shown.
D. Materials:
   1. Body and Ball: PVC, CPVC, PP as specified, shown on drawings, or recommended by the manufacturer for the service conditions specified.
   2. Seats: PTFE

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.
B. As specified in Section 40 05 51 - Common Requirements for Process Valves.
C. Testing: Test ball valves according to AWWA C507.

PART 3 - EXECUTION

3.1 EXAMINATION, INSTALLATION AND FIELD QUALITY CONTROL

A. As specified in Section 40 05 51 - Common Requirements for Process Valves
B. According to AWWA C507

END OF SECTION 40 05 63
SECTION 40 05 65 - SWING AND DISC CHECK VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Swing check valves 3 inches and larger.
B. Conform to the requirements of Section 40 05 51 – Common Requirements for Process Valves
C. Related Requirements:
   1. Division 40 – Process Integration

1.2 REFERENCE STANDARDS

A. American Water Works Association:
   1. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm through 600-mm) NPS.

B. ASME International:
   2. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded.

C. ASTM International:
   3. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

PART 2 - PRODUCTS

2.1 STANDARD SWING CHECK VALVES

A. Manufacturers:
   1. DeZurik
   2. GA Industries, Inc.
   3. Henry Pratt Company
   4. Kennedy Valve Company
5. Crispin Valves; Berwick, PA
6. Or Approved Equal

B. Description:

1. Comply with AWWA C508
2. Minimum Working Pressure: 200 psig for 2” - 12” and 150 psig for 14” - 30”
3. Type: Swing, resilient seated with outside lever and adjustable weight.
4. Mounting: Horizontal or vertical.
5. End Connections: Integral flange ends shall be ANSI B16.1 Class 125, suitable for horizontal or vertical installation

C. Materials:

2. Disc, Disc Arm: Ductile iron, ASTM A536
3. Body Seat: Replaceable, Type 316 ASTM A276 with Buna-N renewable seat ring
4. Shaft: Type 303 Stainless Steel ASTM A582
5. Disc Seat: Buna-N
7. Hinge Pin and Key: Type 316 Stainless Steel
8. Rubber Components: Buna-N
9. Connecting Hardware: Type 304 stainless steel.

D. Finishes: As specified in Section 40 05 51 - Common Requirements for Process Valves.

2.2 SYNTHETIC DISC CHECK VALVE

A. Manufacturers:

1. Milliken; Henry Pratt Company, Aurora, IL
2. Or Approved Equal

B. Description:

1. Comply with AWWA C508
2. Minimum Working Pressure: 200 psig for 2” - 12” and 150 psig for 14” - 30”
3. Type: Swing, flexible disc check valve, full body flow type.
4. Mounting: Horizontal or vertical.
5. End Connections: Integral flange ends shall be ANSI B16.1 Class 125, suitable for horizontal or vertical installation

C. Materials:

2. Disc: Precision molded Buna-N ASTM D2000
3. Epoxy Coated Interior
4. Screw-Type Stainless Steel backflow actuator
5. Mechanical Position indicator
6. Open-Close position indicator limit switch
D. Finishes: As specified in Section 40 05 51 - Common Requirements for Process Valves.

2.3 SOURCE QUALITY CONTROL
A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.
B. Testing:
   1. Hydrostatically test check valves at twice rated pressure according to AWWA C508.
   2. Permitted Leakage at Indicated Working Pressure: None.

PART 3 - EXECUTION

3.1 EXAMINATION, INSTALLATION AND FIELD QUALITY CONTROL
A. As specified in Section 40 05 51 - Common Requirements for Process Valves
B. According to AWWA C508.

END OF SECTION 40 05 65
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SECTION 40 05 66 - PRESSURE-REGULATING VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pressure-reducing valves.
   2. Pressure-sustaining valves.

B. Conform to the requirements of Section 40 05 51 - Common Requirements for Process Valves

C. Related Requirements:
   1. Division 40 – Process Integration

1.2 REFERENCE STANDARDS

A. American Water Works Association:
   1. AWWA C530-12 – Pilot-Operated Control Valves

B. ASME International:
   1. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
   2. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.

C. ASTM International:
   4. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

D. American Water Works Association:
   1. AWWA C550 - Protective Interior Coatings for Valves and Hydrants.
PART 2 - PRODUCTS

2.1 PRESSURE-REDUCING VALVES

A. Manufacturers:

1. Cla-Val.
2. Singer Valve.
3. Flomatic Corporation.
4. Or Approved Equal.

B. Description:

1. Normally open or closed valves to maintain constant downstream pressure regardless of changing flow rate or varying inlet pressure, and to prevent backflow.
2. Type: Pilot operated.
3. Furnish V-ports for pressure control at low flows.
4. Indicator Rod: Attached to piston for visual position indication.

C. Pilot Valves:

1. Type: Globe or Angle
2. Body: Cast iron, Ductile iron, Steel, or Stainless steel.

D. End Connections:

1. Flanged, ASME B16.5 or B16.42, Class 150.

E. Performance and Design Criteria:

1. Flow Rate:
   a. As required by downstream device.
2. Upstream Pressure:
   b. Minimum: 60 psig.
3. Set Point Downstream Pressure:
   a. As indicated on Drawings or as required by downstream equipment.
   b. Range: Field adjustable from near zero to 110 percent.

F. Materials:

1. Body: Cast iron, ASTM A126, Class B or Ductile iron, ASTM A536
2. Disc and Diaphragm:
   a. Buna-N rubber.
   b. Disc Retainer and Diaphragm Washer: Cast iron or Cast steel or Bronze
3. Trim: Bronze or Stainless steel
4. Stem, Nut, and Spring: Stainless steel
5. Packing: PTFE
6. Control Piping: Brass or Bronze with stainless-steel wetted trim.
G. Interior Coating: Coat cast-iron and ductile-iron surfaces with epoxy coating according to AWWA C550.

H. Accessories:
   1. Externally mounted strainer with cocks.
   2. Isolation valve.
   3. Check valves.
   4. Low-flow bypass.

PART 3 - EXECUTION

3.1 EXAMINATION, INSTALLATION AND FIELD QUALITY CONTROL

   A. As specified in Section 40 05 51 - Common Requirements for Process Valves

   B. According to AWWA C530-12.

END OF SECTION 40 05 66
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SECTION 40 05 67 - PRESSURE-RELIEF VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Hydrostatic pressure-relief valves.

B. Conform to the requirements of Section 40 05 51 - Common Requirements for Process Valves

C. Related Requirements:
   1. Division 40 – Process Integration.

1.2 REFERENCE STANDARDS

A. ASME International:
   1. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.

B. ASTM International:

PART 2 - PRODUCTS

2.1 PRESSURE-RELIEF VALVES, HYDROSTATIC-FLOOR TYPE

A. Manufacturers:
   1. Clow Valve Company – Oskaloosa, Iowa
   2. M&H Valve Company – Anniston, Al
   3. Approved Equal.

B. Description:
   1. Size: 4 inches.
   2. Materials:
      a. Cover, Body and Grate: Cast iron, ASTM a-126, Class B.
b. Seat-Body: Machined Bronze, set in body.
c. Seat-Cover: Buna-N.

2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of completed assembly.

C. Certificate of Compliance:
   1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
   2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION, INSTALLATION AND FIELD QUALITY CONTROL

A. As specified in Section 40 05 51 - Common Requirements for Process Valves

END OF SECTION 40 05 67
SECTION 40 05 78 - COMBINATION AIR VALVES FOR WASTEWATER SERVICE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Combination air valves for wastewater treatment facilities.

B. Related Requirements:
   1. Section 09 96 00 - High Performance Coatings
   2. Division 40 - Process Interconnections

1.2 REFERENCE STANDARDS

A. American Water Works Association:

B. ASME International:

C. ASTM International:

D. International Organization for Standardization:

PART 2 - PRODUCTS

2.1 COMBINATION AIR VALVES FOR WASTEWATER SERVICE

A. Manufacturers:
   1. DeZurik.
   2. A.R.I
   3. H-TEC
   4. Approved Equivalent

B. Description:
1. Type:
   a. Automatic, float operated.

2. Comply with AWWA C512.
3. Size: As indicated on Drawings.
4. Suitable for sewage service.

C. Materials:
   1. Body and Cover: Stainless steel with stainless steel screws, unless indicated in the plan set.
   3. Seats: Buna-N.
   4. Seals: Buna-N.

D. End Connections - Single Body:
   1. Size 4 Inches and Smaller:
      a. Threaded, NPT.
      b. 1-Inch Valves: Furnish 2-inch inlet.


E. Valve Body Connections:
   1. Threaded, NPT.
   2. Cleanout: 2 inches.
   3. Drain: 1 inch.

F. Accessories:
   1. Backwash accessories, including inlet shutoff valve, blowoff valve, rubber supply hose, and quick-disconnect couplings.

2.2 INSULATION
   A. As specified in Section 40 42 13 - Process Piping Insulation.

2.3 FINISHES
   A. Prepare piping appurtenances for field finishes as specified in Section 09 96 00 - High-Performance Coatings.

2.4 SOURCE QUALITY CONTROL
   A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.
B. Provide shop inspection and testing of completed assembly.

C. Certificate of Compliance:
   1. If fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator’s facility conforms to Contract Documents.
   2. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
   B. Verify that field dimensions are as indicated on Shop Drawings.
   C. Inspect existing flanges for nonstandard bolt hole configurations or design and verify that new pipe and flanges mate properly.

3.2 PREPARATION
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
   B. Thoroughly clean end connections before installation.
   C. Close pipe and equipment openings with caps or plugs during installation.
   D. Cleaning: Clean surfaces to remove foreign substances.

3.3 INSTALLATION
   A. According to manufacturer instructions.
   B. Provide access for operation, removal, and maintenance, and to avoid discharge to occupied areas or other equipment.

3.4 FIELD QUALITY CONTROL
   A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.
   B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
   C. Inspect for interferences and proper supports.
D. Testing:
   1. As specified in Section 40 05 51 - Common Requirements for Process Valves.
   2. Demonstrate operation without undue noise or vibration.

E. Equipment Acceptance:
   1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
   2. Make final adjustments to equipment under direction of manufacturer's representative.
   3. Repair damaged coatings with material equal to original coating.

F. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.5 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Keep interior of air release valves clean as installation progresses.

END OF SECTION 40 05 78
SECTION 40 05 82 - SOLENOID VALVES FOR PROCESS SERVICE

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes: Solenoid valves for process applications.
   B. Related Requirements:
      1. Section 40 05 51 - Common Requirements for Process Valves: Basic materials and methods related to valves commonly used for process systems.

1.2 REFERENCE STANDARDS
   A. ASTM International:
      1. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
   B. National Electrical Manufacturers Association:
      1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS
   A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
   B. Product Data: Submit manufacturer information, indicating materials of construction and compliance with indicated standards.
   C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
   D. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

1.4 DELIVERY, STORAGE, AND HANDLING
   A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
   B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
   C. Store materials according to manufacturer instructions.
   D. Protection:
1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.5 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

1.6 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

PART 2 - PRODUCTS

2.1 SOLENOID VALVES

A. Manufacturers:
   1. Asco; Florham Park, NJ
   2. Or approved equal.

B. Description:
   1. Type: As indicated on Drawings.
   2. Working Pressure: 120 psig at 180 degrees F.
   3. Coil: Continuous duty.
   4. Operation: Fail close, energize to open unless noted otherwise.
   5. Enclosures: NEMA 250 rated according to area designation.
   6. Electrical Characteristics: As indicated on Drawings.

C. Materials:
   2. Trim and Spring: Stainless steel.
   3. Seals: Resilient, PTFE.

2.2 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.
PART 3 - EXECUTION

3.1 EXAMINATION
   A. As specified in Section 40 05 51 - Common Requirements for Process Valves.

3.2 INSTALLATION
   A. As specified in Section 40 05 51 - Common Requirements for Process Valves.

3.3 FIELD QUALITY CONTROL
   A. As specified in Section 40 05 51 - Common Requirements for Process Valves.

END OF SECTION 40 05 82
PART 1 - GENERAL

1.1 SUMMARY

A. The FMR10/20 free space radar is used for continuous, non-contact level measurement of liquids, pastes and slurries. The measurement is not affected by changing media, temperature changes, gas blankets or vapors. Setup, Programming and commissioning of this device is possible via 4-20mA/Hart or a remote display or wireless via app using Bluetooth.

1.2 SUBMITTALS

A. Furnish complete Product Data, Shop Drawings, Test Reports, Operating Manuals, Record Drawings, Manufacturer’s certifications, Manufacturer’s Field Reports.

B. Product Data:

1. Dimensional drawings.
   a. Transmitter housing
   b. Antenna or Horn
4. Range and range ability.
5. Enclosure Rating.
6. Classification Rating.
7. Power.
   a. Voltage
   b. Wattage
8. Output options.

1.3 QUALITY ASSURANCE


1.4 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the Manufacturer.
B. Any instruments that are not stored in strict conformance with the Manufacturer’s recommendation shall be replaced.

1.5 PROJECT OR SITE CONDITIONS

A. Provide instruments suitable for the installed site conditions including but not limited to material compatibility, site altitude, process and ambient temperature, and humidity conditions.

1.6 CALIBRATION AND WARRANTY

A. The meter shall have standard one year warranty from date of shipment and if the meter is commissioned by a factory certified technician, the warranty is extended to three years from the date of shipment.

B. Equipment shall be supplied with Bluetooth wireless technology which can be used for configuration, set-up and diagnosis of the transmitter using a smart Bluetooth enabled phone or smart pad.

1.7 MAINTENANCE

A. Provide all parts, materials, fluids, etc. necessary for maintenance and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

1.8 LIFECYCLE MANAGEMENT

A. Instrument documentation, like original calibration certificates, manuals and product status information shall be accessed via a web enabled system with a license. The instrument-specific information shall be accessed via its serial number. When services are provided by an authorized service provider the services information like subsequent field calibrations shall be archived and accessible via this web enabled system.

PART 2 - PRODUCTS

2.1 SYSTEMS/ASSEMBLIES

A. Manufacturer:
   1. Endress+Hauser- Micropilot FMR10 / FMR20
   2. Eastech Vantage 2210 may be used as an equal to the E&H FMR10/FMR20

2.2 MANUFACTURED UNITS

A. The pulsed time of flight radar transmitter shall operate at 26 GHz using 2-wire technology for level measurement and/or open channel flow measurement.
B. Accuracy shall be +/- 0.2” (FMR10) and +/- 0.08” (FMR20) by application.

C. Maximum measurement distance shall be 0-16ft (FMR10) and 0-66 ft (FMR20) by application.

D. The radar shall have CSA C/US General purpose approvals as required.

E. Process Temperature range is -40 to 176 degrees F and pressure range is from -14.5 to 43 psi.

F. The unit provides diagnosis information according to NAMUR NE107 with clear text messages to remedy.

G. It must be possible to view a graphical representation of the actual signal and envelope curve on the display.

H. The process connection shall be 1”NPT, 1.5”NPT, 2”NPT or 3”-6” ANSI flange connection by application. FMR10 series radar has 1”-1.5”NPT only and the FMR20 series radar has 1”,1.5” and 2”NPT and 3”-6” flange options available.

I. The radar output signal shall be 4-20 mA dc loop powered.

J. The radar device shall have Bluetooth wireless technology interface and can be operated and configured via this interface using the SmartBlue app. The range under reference conditions is 33ft. The Bluetooth shall have both encrypted communication and password encryption for security purposes. The Bluetooth wireless technology interface can be deactivated. The FMR10 must be configured via Bluetooth while the FMR20 may be configured with 4-20mA/Hart or a remote RIA 15 display or Bluetooth as options.

K. The radar signal on alarm shall be 22.5mA.

L. The radar shall have a linearization function with up to 32 value pairs entered allowing conversion of the measured value into any unit of length, weight, flow or volume.

M. The radar unit shall be rated for IP66 or NEMA 4x (FMR10) and IP66/68, NEMA4X/6P (FMR20) by application.

N. The radar sensor body material shall be made of PVDF.

O. The radar sensor must have hermetically sealed wiring and fully potted electronics eliminating water ingress.

2.3 ACCESSORIES

A. Weather protection cover in PVDF

B. Flooding Protection Tube

C. Adjustable Mounting Bracket in 316L
2.4 REQUIRED INSTRUMENTS
   A. New Influent Pump Station (LE1001)

2.5 SOURCE QUALITY CONTROL AND CALIBRATION
   A. Provide ISA data sheet ISA-TR20.00.01. Use the latest revision of form 20F2321. Complete the form with all known data, and dash out the inapplicable fields. Incomplete data sheets submitted will be result in a rejected submittal.

2.6 SAFETY
   A. All electrical equipment shall meet the requirements of ANSI/NFPA 70, National Electric Code latest addition.
   B. All devices shall be capable of being certified for use in hazardous areas: Class I, II, III, Div. 2, Groups A-G.
   C. All devices shall be suitable for use as non-incentive devices when used with appropriate non-incentive associated equipment. Devices with intrinsically safe ratings will normally be acceptable with vendor’s approval.
   D. Transmitter housing shall conform to NEMA 4x classification.
   E. Non-intrinsically safe electrical equipment shall be approved by a Nationally Recognized Testing Laboratory (NRTL) such as FM, UL, ETL, CSA, etc. for the specified electrical area classification.
   F. Electrical equipment specified as intrinsically safe shall qualify as “simple apparatus” or NTRL approved intrinsically safe equipment per ANSI/ISA-RP12.6 “Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations”, latest edition.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process conditions.
   B. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.2 INSTALLATION
   A. As shown on installation details and mechanical drawings.
   B. As recommended by the manufacturer’s installation and operation manual.
C. Specific attention should be given to the following technical requirements:

1. Verify the nozzle height, dimension, and location where the transmitter has been installed.

3.3 FIELD QUALITY CONTROL

A. Demonstrate the performance of all instruments to the Engineer before commissioning.

B. Engineer to witness all instrument calibration verification in the field.

C. Each instrument shall be tested before commissioning and the Engineer shall witness the response in the PLC control system and associated displays.

D. Manufacturer’s Field Services:

1. Manufacturer’s representative shall verify installation of all installed transmitters.
2. Notify the Engineer in writing of any problems or discrepancies and proposed solutions.

3.4 ADJUSTING

A. Verify set-up and configuration of all instruments in accordance with the Manufacturer’s instructions.

3.5 PROTECTION

1. All instruments shall be fully protected after installation and before commissioning. Replace any instruments damaged before commissioning.

   a. The Engineer shall be the sole party responsible for determining the corrective measures.
END OF SECTION 40 72 23
PART 1 - GENERAL

1.1 SUMMARY

A. A point level switch for use in hazardous areas with CE, CDA, SEMKO, NEMKO, and DEMKO approvals. The operation of the level switch shall not be adversely affected by flow, turbulence, bubbles, foam, vibration, bulk solids content or build-up.

1.2 SUBMITTALS

A. Furnish complete Product Manufacturer’s Technical Information, Operating and Maintenance

B. Product Data:

1. Dimensional drawings.
4. Range and range ability.
5. Enclosure Rating.
6. Classification Rating.
7. Power.
8. Output options.

1.3 QUALITY ASSURANCE


1.4 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the Manufacturer.

B. Any instruments that are not stored in strict conformance with the Manufacturer’s recommendation shall be replaced.

1.5 PROJECT OR SITE CONDITIONS

A. Provide instruments suitable for the installed site conditions including but not limited to material compatibility, site altitude, process and ambient temperature, and humidity conditions.
1.6  WARRANT
   A. The level switch shall have standard one year warranty from date of shipment and if the meter is
      commissioned by a factory certified technician, the warranty is extended to three years from the
data of shipment.

1.7  MAINTENANCE
   A. Provide all parts, materials, fluids, etc. necessary for maintenance and calibration purposes
      throughout the warranty period. Deliver all of these supplies before project substantial
      completion.

1.8  LIFECYCLE MANAGEMENT
   A. Instrument documentation, like original calibration certificates, manuals and product status
      information shall be accessed via a web enabled system with a license. The instrument-specific
      information shall be accessed via its serial number. When services are provided by an
      authorized service provider the services information like subsequent field calibrations shall be
      archived and accessible via this web enabled system.

PART 2 - PRODUCTS

2.1  LEVEL SWITCHES
   A. NON-MERCURY-FLOAT TYPE:
      1. Switch Description: Normally open (NO) non-mercury internal microswitch.
      2. Relays: Intrinsically safe.
      4. Housing: NEMA 250 Type 4X.
      5. Cable: Oil-resistant thermoplastic.
      6. Liquid Temperature: 0°C to 60°C
      7. Rated Voltage: AC 250V/3A(inductive); AC 250V/10A(resistive).
      8. Eccentric Weight: Level switch shall contain an eccentric weight positioned to insure that
         the switch tilts in the proper direction.

   B. REQUIRED INSTRUMENTS:
      1. LSH-1002
      2. LS-1003
      3. LSL-1004
      4. LSL-5101
      5. LS-5102
      6. LSH-5103
2.2 SOURCE QUALITY CONTROL AND CALIBRATION

A. A Certificate of Compliance shall be available from the manufacturer if required.

B. An application data sheet should be filled out, with all known data, and submitted to the manufacturer to ensure proper instrument choice

2.3 SAFETY

A. All electrical equipment shall meet the requirements of ANSI/NFPA 70, National Electric Code latest addition.

B. All devices shall be certified for use in the following hazardous areas:
   1. Explosion proof: Class I, Div. 1, Groups ABCD, Temperature rating T6 (Ta= 70°C)
   2. Intrinsically safe: Class I, II, III, Div. 1, Groups ABCDEF, Temperature rating T5 (Ta=70°C)
   3. Non-Incendive- Class I, Div. 2, Groups ABCD, Temperature rating T5 (Ta= 70°C)

C. All devices shall be suitable for use as non-incentive devices when used with appropriate non-incentive associated equipment. Devices with intrinsically safe ratings will normally be acceptable with vendor’s approval.

D. Electrical housing shall conform to NEMA 4x classification.

E. Non-intrinsically safe electrical equipment shall be approved by a Nationally Recognized Testing Laboratory (NRTL) such as FM, UL, ETL, CSA, etc. for the specified electrical area classification.


PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process conditions.

B. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.2 INSTALLATION

A. As shown on installation details and mechanical drawings.

B. As recommended by the manufacturer’s installation and operation manual.
3.3 FIELD QUALITY CONTROL

A. Demonstrate the performance of all instruments to the Engineer before commissioning.

B. Engineer to witness all instrument calibration verification in the field.

C. Each instrument shall be tested before commissioning and the Engineer shall witness the response in the PLC control system and associated displays.

D. Manufacturer’s Field Services:
   1. Manufacturer’s representative shall verify installation of all installed transmitters.
   2. Notify the Engineer in writing of any problems or discrepancies and proposed solutions.

3.4 ADJUSTING

A. Verify set-up and configuration of all instruments in accordance with the Manufacturer’s instructions.

3.5 PROTECTION

1. All instruments shall be fully protected after installation and before commissioning. Replace any instruments damaged before commissioning.
   a. The Engineer shall be the sole party responsible for determining the corrective measures.

END OF SECTION 40 72 76
SECTION 40 73 13 - PRESSURE AND DIFFERENTIAL PRESSURE GAUGES

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes: Pressure gauges.
   B. Related Requirements:
      1. Section 40 73 63 – Diaphragm Seals: Isolation of gages from process fluid.

1.2 REFERENCE STANDARDS
   A. ASME International:
      1. ASME B40.100 - Pressure Gauges and Gauge Attachments.
   B. NSF International:
      1. NSF 61 - Drinking Water System Components - Health Effects.
      2. NSF 372 - Drinking Water System Components - Lead Content.

1.3 SUBMITTALS
   A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
   B. Product Data: Submit manufacturer information for system materials and component equipment, including connection requirements.
   C. Shop Drawings:
      1. Indicate system materials and component equipment.
      2. Submit installation requirements and other details.
   D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
   E. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
   F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.4 CLOSEOUT SUBMITTALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
   B. Project Record Documents: Record actual locations of equipment and accessories.
1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Extra Stock Materials:
   1. Gages: Furnish 20 percent spare gages, with a minimum of one gage for each range used.

1.6 QUALITY ASSURANCE

A. Ensure that materials of construction of wetted parts are compatible with process liquid.

B. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.8 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish one-year manufacturer's warranty for pressure gages.

PART 2 - PRODUCTS

2.1 PRESSURE GAGES

A. Manufacturers:
   1. Ametek; Model Series 1550
   2. Wika; Model Series 716
   3. Ashcroft; Model Series 1010
B. Type: Differential - Compound.

C. Dials:
   1. Nominal Diameter: 4 inches.
   2. Face: White, laminated plastic dials with black graduations.
   3. Scale: Extend over arc not less than 270 degrees.
   4. Ranges and Graduation Units: As indicated on Drawings.

D. Cases:
   1. Liquid filled.
   2. Stainless Steel case and wetted parts.
   3. Windows:
      b. Thickness: 1/8 inch.
      c. Provide gasket.

E. Connection:
   1. Location: Bottom.
   2. Socket:
      a. 1/4-inch NPT male thread.
      b. Extend minimum 1-1/4 inches below gage cases.
      c. Provide wrench flats.

F. Measuring Element:
   1. Bourdon Tubes:
      a. Material: Stainless steel to brass socket.
      b. Provide welded, stress-relieved joints.
   2. Movement:
      a. Rotary.
      b. Material: Stainless steel.
   3. Accuracy:
      a. Comply with ASME B40.100.
      b. Plus and minus 0.5 percent of full-scale range.

G. Adjustment:
   1. Provide for zero-reading adjustment.
   2. Adjusting Screws: Accessible from rear of case without need for disassembly.
H. Accessories:
   1. Shutoff Cocks: Furnished by gage manufacturer.

2.2 SOURCE QUALITY CONTROL
   A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.
   B. Provide shop inspection and testing of completed assembly.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
   B. Verify that items provided by other Sections of Work are ready to receive Work of this Section.

3.2 INSTALLATION
   A. According to manufacturer instructions.
   B. Coordinate location and orientation of gages and seal assemblies with final piping and equipment installations.
   C. Ensure that gages are located to be easily read during operation and easily accessible for maintenance.

3.3 FIELD QUALITY CONTROL
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
   B. Equipment Acceptance:
      1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
      2. Make final adjustments to equipment under direction of manufacturer's representative.

3.4 DEMONSTRATION
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 40 73 13
SECTION 40 73 63 - DIAPHRAGM SEALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Diaphragm seals.

B. Related Requirements:
   1. Section 40 73 13 - Pressure and Differential Pressure Gauges

1.2 REFERENCE STANDARDS

A. NSF International:
   1. NSF 61 - Drinking Water System Components - Health Effects.
   2. NSF 372 - Drinking Water System Components - Lead Content.

1.3 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. Coordinate Work of this Section with piping work and pump installation.

1.4 SUBMITTALS

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

B. Product Data: Submit manufacturer information for system materials and component equipment, including connection requirements.

C. Shop Drawings:
   1. Indicate system materials and component equipment.
   2. Submit installation requirements and other details.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Qualifications Statement:
1. Submit qualifications for manufacturer.

1.5 CLOSEOUT SUBMITTALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
   B. Project Record Documents: Record actual locations of equipment and accessories.

1.6 QUALITY ASSURANCE
   A. Ensure that materials of construction of wetted parts are compatible with process liquid.
   B. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

1.7 QUALIFICATIONS
   A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years’ documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING
   A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
   B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
   C. Store materials according to manufacturer instructions.
   D. Protection:
      1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
      2. Provide additional protection according to manufacturer instructions.

1.9 WARRANTY
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
   B. Furnish one-year manufacturer's warranty for diaphragm seals.
PART 2 - PRODUCTS

2.1 DIAPHRAGM SEALS

A. Manufacturers:

1. Ashcroft Inc
2. Approved Equal

B. Description:

1. Mounting:
   a. Directly to pressure gage socket.

2. Wetted Parts and Bolt Materials: Corrosion resistant to process fluid.
3. Provide fill/bleed screw for filling of diaphragm seal.
5. Process Connection: NPT, 1/2 inch.
8. Calibration: Provide cleanout ring to be removed for recalibration or cleaning, without loss of filling liquid or change in calibration.

2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Diaphragm Seals:

1. Factory-assemble, fill, and calibrate entire assembly, including gage and switch, prior to shipment.
2. Field filling is not acceptable.

C. Provide shop inspection and testing of completed assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that items provided by other Sections of Work are ready to receive Work of this Section.
3.2 INSTALLATION

A. According to manufacturer instructions.

B. Mount only one pressure element per diaphragm seal.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Equipment Acceptance:
   1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
   2. Make final adjustments to equipment under direction of manufacturer's representative.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 40 73 63
SECTION 43 12 51 – COMPRESSED AIR SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rotary-screw air compressors
2. Air receivers
3. Compressed-air filters

B. The compressed air system shall be capable of delivering the required volume of air and drying the air to the specified dew point at the worst case ambient conditions.

1. The manufacturer shall be responsible for ensuring all accessories for the compressed air system are of sufficient capacity.
2. The air compressor system will be installed outdoors under a canopy.
3. The air compressor will provide air to the Dissolved Air Flotation System and the Air Diaphragm Sludge Pumps.

C. Related Requirements:

1. Section 01 30 00 – Administrative Requirements: Requirements for Coordination
2. Section 01 70 00 – Execution and Closeout Requirements: Requirements for Closeout
3. Section 03 30 00 – Cast-In-Place Concrete
4. Section 26 05 03 – Equipment Wiring Connections
5. Section 40 05 13 - Common Work Results for Process Piping

1.2 REFERENCE STANDARDS

A. American Society of Mechanical Engineers:

1. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
2. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
3. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
4. ASME B31.3 - Process Piping.
5. ASME - Boiler and Pressure Vessel Code (BPVC).

B. ASTM International:

6. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

C. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

D. National Science Foundation:
   1. NSF 61 - Drinking Water System Components - Health Effects.

1.3 COORDINATION
A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
   1. Coordinate Work of this Section with Work of other Sections.
   2. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.4 SCHEDULING
A. Section 013100 – Project Management and Coordination: Requirements for scheduling.

B. Schedule Work of this Section to install pumps prior to connecting piping Work.

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

B. Product data: For each type of product.
   1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Delegated Design Submittal: For compressed-air equipment mounting.
   1. Detail fabrication and assembly of supports.
   2. Include design calculations for selecting vibrations isolators and for designing vibration isolation bases.

D. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

E. Source Quality-Control Submittals: Indicate results of shop tests and inspections.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
G. Manufacturer Reports: Indicate that equipment has been installed according to manufacturer's instructions.

H. Qualifications Statements:
   1. Submit qualifications for manufacturer and installer.
   2. Submit manufacturer's approval of installer.

1.6 CLOSEOUT SUBMITTALS
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.
B. Project Record Documents: Record actual locations of compressors and components.
C. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.7 TOOLS AND SPARE PARTS
A. The compressed air system manufacturer shall provide one (1) set of recommended spare parts.
B. The compressed air system manufacturer shall provide a list of recommended spare parts.
C. The manufacturer shall furnish any special tools necessary to disassemble, service, repair, and adjust the equipment.

1.8 WARRANTY
A. Manufacturer shall provide a one (1) year warranty for all components of the compressed air system including, but not limited to, the compressor, dryer tanks, and controllers.
B. Warranty shall be in concurrence with the Contractor’s required warranty in Division 1.

PART 2 - PRODUCTS

2.1 ROTARY-SCREW AIR COMPRESSORS
A. Manufacturers:
   1. Quincy (QGD-15)
   2. Ingersoll Rand (R11i-125)
   3. Approved Equal
B. Description:
   1. Direct-drive, rotary-screw compressor with control panel.
2. Constant discharge pressure.
3. Lubrication Pump: Positive displacement; driven off rotor shaft.

C. Schedule
   1. COMP5200

D. Performance and Design Criteria:
   1. Capacity: >60 scfm
   2. Maximum Discharge Pressure: 125 psig
   3. Maximum Sound Level: 68 dBA, 3 feet from compressor unit.
   4. Static and Dynamic Balance: Eliminate vibration or noise transmission to occupied areas.

E. Operation:
   1. Electrical Characteristics: As specified in Section 260503 - Equipment Wiring Connections and following:
      a. 15 hp
      b. Voltage: 460 V, three phase, 60 Hz.
   2. Motors:
      a. TEFC
   3. Control Panels:
      a. Factory mounted.
      b. Cycle counter and hour meter for each compressor.
      c. Low- and high-pressure control.
      d. Hand-Off-Automatic Selector Switch in cover of control panel, plus pilot device for automatic control.

F. Accessories:
   1. High efficiency intake filter
   2. Moisture separator
   3. Discharge air pressure gauge
   4. Air filter maintenance indicator
   5. Discharge air and coolant temperature gauges

2.2 AIR RECEIVERS

A. Schedule
   1. T5200

B. Description:
   1. Integrated Horizontal
C. Performance and Design Criteria:
   1. Build to ASME BPVC Section VIII regulations for pressure rating at least as high as the discharge pressure of the connected compressor.

D. Fittings:
   1. Adjustable pressure regulator
   2. Safety relief valve
   3. Pressure gage
   4. ¾” outlet
   5. Automatic drain valve
   6. Automatic float-actuated condensate trap

E. Tank Finish: Shop primed

F. Size:
   1. Capacity: 120 gal

2.3 REFRIGERATED COMPRESSED-AIR DRYERS

A. Schedule:
   1. RAD5210

B. Manufacturers:
   1. Same as compressor

C. Description:
   1. Noncycling, air-cooled, electric-motor-driven unit with steel enclosure and capability to deliver 38°F air at dew point.
   2. Type: Self-contained mechanical refrigeration.
   3. Furnish heat exchanger, refrigeration compressor, automatic controls, moisture-removal trap, internal wiring and piping, and full refrigerant charge.

D. Air Connections:
   1. Furnish ½” NPT inlet and outlet connections.
   2. Factory insulated
   3. Electric drain valve

E. Capacity:
   1. Discharge Air Atmospheric Dew Point: 38 °F
   2. Rated Airflow Rate: Sufficient to provide the required dryness at the maximum ambient temperature and rated capacity of compressor.
   3. Max Operating Pressure: 203 psig
4. Max Inlet Temperature: 140 °F

F. Electrical Characteristics:
   1. 120 V, single phase, 60 Hz.

G. Dryer In Line Pre-Filter
   1. Filtration: remove solids at 0.1 micron, remove liquids at 0.03 ppm.

2.4 COMPRESSED AIR AFTERCOOLERS

   A. Manufacturers:
      1. Same as compressor

   B. Capacities and Characteristics
      1. Unit shall be sized to cool compressed air in compressor rated capacities to 38 °F dew point.
      2. Include moisture separator and automatic drain.
      3. Temperature calculations to be determined by manufacturer based on conditions in Evergreen, AL, and the specified compressor system.
      4. Load: <1/2 hp

   C. Electrical Characteristics
      1. 120 V, single phase, 60 Hz

   D. Control Panel
      1. Furnish integral control panel (LCP5200).
      2. Starter will be located in MCC-2.

PART 3 - EXECUTION

3.1 EXAMINATION

   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

3.2 INSTALLATION

   A. Inserts:
      1. Provide inserts for placement in concrete forms.
      2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Where inserts are omitted, drill through concrete slab from below and provide through bolt with recessed square steel plate and nut flush with top of slab.

B. Aboveground Piping Systems:

1. Install drip connections with valves at low points of piping system.
2. Install takeoff to outlets from top of main, with shutoff valve after takeoff; slope takeoff piping to outlets.
3. Install compressed-air couplings, female quick connectors, and pressure gages where outlets are indicated.
4. Install tees instead of elbows at changes in direction of piping; fit open end of each tee with plug.
5. Cut pipe and tubing accurately and install without springing or forcing.
7. Stainless-Steel Pipe with Press-Type Joints:
   a. Square-cut ends to plus or minus 0.030-inch tolerance.
   b. Remove burrs and clean ends.
   c. Fully insert tubing into fitting, and mark pipe ends to ensure full insertion into coupling or fitting during assembly.
   d. Press joint using manufacturer's tool with proper-sized jaw.
8. Copper Pipe with Press-Type Joints:
   a. Remove burrs and clean ends.
   b. Fully insert tubing into fitting, and mark pipe ends to ensure full insertion into coupling or fitting.
   c. Check alignment against mark to assure tubing is fully inserted.
   d. Press joint using manufacturer's tool.
9. Install pipe sleeves where pipes and tubing pass through walls, floors, roofs, and partitions, as specified in Section 40 05 13 - Common Work Results for Process Piping.
10. Except where indicated, install manual shutoff valves with stem vertical and accessible for operation and maintenance.
11. Install strainers on inlet side of pressure-reducing valves; install pressure-reducing valves with bypasses and isolation valves to allow maintenance without interruption of service.
12. Install strainers on inlet side of pressure regulators.

C. Equipment:

1. Install air compressor on concrete housekeeping pad, minimum 3-1/2 inches high and 6 inches larger than compressor base on each side, as specified in Section 03 30 00 - Cast-In-Place Concrete.
2. Install air compressor unit on vibration isolators; level and bolt in place.
3. Install air valve and drain connection on horizontal casing.
4. Install line-sized shutoff valve and check valve on compressor discharge.
5. Install replaceable cartridge-type filter-silencer for each compressor.
6. Install shutoff valve on water inlet to aftercooler; pipe drain to exterior of canopy.
7. Install condensate drain piping to exterior of canopy.
8. Install bypass with valves around air dryer; use factory-insulated inlet and outlet connections.
9. Provide bypass with valves around receivers.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than one (1) day on-Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment. The start-up of all components of the compressed air system shall be coordinated.

C. Equipment Acceptance:
   1. Adjust, repair, modify, or replace components failing to perform as specified, and rerun tests.
   2. Make final adjustments to equipment under direction of manufacturer's representative.

D. Furnish installation certificate from equipment manufacturer's representative attesting equipment has been properly installed and is ready for startup and testing.

3.4 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.

B. Check control functions and adjust as required.

3.5 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Blow systems clear of free moisture and foreign matter.

3.6 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 43 12 51
SECTION 43 23 40 – HORIZONTAL SELF-PRIMING CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes horizontal self-priming centrifugal pumps.

B. Related Requirements:
   1. Section 01 40 00 – Quality Requirements: Requirements for Inspecting and Testing
   2. Section 01 70 00 – Execution and Closeout Requirements
   3. Section 09 96 00 – High Performance Coatings
   4. Division 26 – Electrical
   5. Section 40 05 13 – Common Motor Requirements for Process Equipment

1.2 REFERENCE STANDARDS

A. American Bearing Manufacturers Association:
   1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. ASME International:

C. ASTM International:

1.3 COORDINATION

A. Section 01 31 00 – Project Management and Coordination

B. Coordinate installation and startup of Work of this Section with plant operations.

1.4 SCHEDULING

A. Section 013100 – Project Management and Coordination: Requirements for scheduling.

B. Schedule Work of this Section to install pumps prior to connecting piping Work.
1.5 SUBMITTALS

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

B. Product Data: Submit manufacturer information for materials of construction and fabrication.

C. Shop Drawings:
   1. Submit detailed dimensions for materials and equipment, including wiring and control diagrams, performance charts and curves, installation and anchoring requirements, fasteners, and other details.
   2. Include manufacturer's specified displacement tolerances for vibration at operational speed specified for pumps.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures, anchoring, and layout.

F. Source Quality-Control Submittals: Indicate results of factory non-witnessed performance tests and inspections.

G. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.7 TOOLS AND SPARE PARTS

A. The pump manufacturer shall provide one (1) set of recommended spare parts.

B. The pump manufacturer shall provide a list of recommended spare parts.

C. The manufacturer shall furnish any special tools necessary to disassemble, service, repair, and adjust the equipment.

1.8 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. All equipment, apparatus, and parts furnished shall be warranted for one (1) year, excepting only those items that are normally consumed in service, such as oils, grease, packing, gaskets, O
rings, etc. The pump manufacturer shall be solely responsible for warranty of the pump equipment and all components.

1.9 SHIPPING, HANDLING AND STORAGE

A. Follow manufacturer’s recommendations for handling and storage of equipment.

B. Contractor shall inspect all delivered equipment for any damage and shall note any damage. Contractor shall receive recommendations from Manufacturer for correcting damaged equipment.

C. Any damaged equipment shall be repaired or replaced prior to installation.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL PUMPS

A. Manufacturers:

1. Gorman Rupp
2. WEMCO
3. Approved Equal

B. Schedule:

1. P3210

C. Pump Design:

1. Pumps shall be horizontal, self-priming centrifugal type, designed specifically for handling raw, unscreened, domestic sanitary sewage.
2. The rotating assembly, which includes impeller, shaft, mechanical shaft seal, lip seals, bearings, sealplate and bearing housing, shall be removable as a single unit without disturbing the pump casing or piping.
D. Performance and Design Criteria:

<table>
<thead>
<tr>
<th>DESIGN PARAMETER</th>
<th>DESIGN VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Flow Rate: (gpm)</td>
<td>1000</td>
</tr>
<tr>
<td>Design Flow Total Dynamic Head: (feet).</td>
<td>28</td>
</tr>
<tr>
<td>Motor Horsepower</td>
<td>15</td>
</tr>
<tr>
<td>Service Liquid:</td>
<td>Wastewater Lagoon Effluent</td>
</tr>
</tbody>
</table>

E. Casing:
1. Material: ASTM A48, Cast or ductile iron
2. End Connections:
   a. Flanged.
   b. Comply with ASME B16.1, Class 125
3. Drain plug: 1-1/4” NPT

F. Coverplate
1. Coverplate shall incorporate the following maintenance features:
   a. Retained by hand nuts for complete access to pump interior. Coverplate removal must provide ample clearance for removal of stoppages, and allow service to the impeller, seal, wearplate or check valve without removing suction or discharge piping.
   b. A replaceable wearplate secured to the coverplate by weld studs and nuts shall be AISI 1015 HRS.
   c. In consideration for safety, a pressure relief valve shall be supplied in the coverplate. Relief valve shall open at 75-200 PSI.
   d. Two O-rings of Buna-N material shall seal coverplate to pump casing.
   e. Pusher bolt capability to assist in removal of coverplate. Pusher bolt threaded holes shall be sized to accept same retaining capscrews as used in rotating assembly.
   f. Easy-grip handle shall be mounted to face of coverplate.

G. Impeller:
1. Material: Ductile iron
2. Design to pass sand, grit, and solids normally encountered in a wastewater treatment plant without clogging and pass a maximum solid size of 3 inches.
3. Type: two-vane, semi-open, non-clog, with integral pump out vanes on the back shroud.
4. Threaded to pump shaft.
5. Statically and dynamically balanced after assembly.

H. Shaft:
1. Material: AISI 4140, steel
2. Key couplings to shaft.

I. Wearing Rings:
   1. Replaceable.
   2. Stainless steel in accordance with AISI 410 with a minimum hardness of 300 BHN

J. Bearings:
   1. Type: Anti-friction ball bearings
   2. Minimum L-10 Life: 100,000 hours at continuous maximum load and speed, according to AFBMA 9.
   3. Bearings shall be oil lubricated from a dedicated reservoir.

K. Seals:
   1. Mechanical seal
   2. Lubrication: oil from a dedicated reservoir

L. Sealplate and Bearing Housing:
   1. Sealplate and bearing housing shall be cast iron Class 30. Separate oil filled cavities, vented to atmosphere, shall be provided for shaft seal and bearings. Cavities shall be cooled by the liquid pumped. Three lip seals shall prevent leakage of oil.
   2. The bearing cavity shall have an oil level sight gauge and fill plug check valve. The clear sight gauge shall provide easy monitoring of the bearing cavity oil level and condition of oil without removal of the fill plug check valve. The check valve shall vent the cavity but prevent introduction of moist air to the bearings.
   3. The seal cavity shall have an oil level sight gauge and fill/vent plug. The clear sight gauge shall provide easy monitoring of the seal cavity oil level and condition of oil without removal of the fill/vent plug.
   4. Double lip seal shall provide an atmospheric path providing positive protection of bearings, with capability for external drainage monitoring.

M. Suction Check Valve:
   1. Suction check valve shall be molded Neoprene with integral steel and nylon reinforcement. A blow-out center shall protect pump casing from hydraulic shock or excessive pressure. Removal or installation of the check valve must be accomplished through the coverplate opening, without disturbing the suction piping. Sole function of check valve shall be to save energy by eliminating need to re-prime after each pumping cycle. Pumps requiring a suction check valve to assist re-prime will not be acceptable.

N. Spool Flanges
   1. Spool flanges shall be one-piece ductile iron, fitted to suction and/or discharge ports. Each spool shall have one 1-1/4" NPT and one 1/4" NPT tapped hole with pipe plugs for mounting gauges or other equipment.

O. Volute Casing Heater:
1. Each pump shall be provided with a thermostat mounted to the exterior of the volute casing, and a 750 watt 115 volt electric heater inserted into the interior of the volute by means of a dedicated port. The heater shall be energized at 43+/−3 degrees F to provide heat to the casing and eliminate the possibility of freezing. Heater probes that must be installed through a pump drain port shall not be acceptable.

P. Pump Base

1. Pump shall be mounted on a fabricated steel base consisting of pump, motor, V-belt drive unit, and belt guard.

Q. Re-prime Performance

1. Consideration shall be given to the sanitary sewage service anticipated, in which debris is expected to lodge between the suction check valve and its seat, resulting in the loss of the pump suction leg, and siphoning of liquid from the pump casing to the approximate center line of the impeller. Such occurrence shall be considered normal, and the pump must be capable of automatic, unattended operation with an air release line installed.
2. During unattended operation, the pump shall retain adequate liquid in the casing to insure automatic re-priming while operating at its rated speed in a completely open system. The need for a suction check valve, foot valve, or other external priming device shall not be required.
3. Pump must reprime > 8 vertical ft. at the specified speed and impeller diameter. Reprime lift is defined as the static height of the pump suction above the liquid, while operating with only one-half of the liquid remaining in the pump casing. The pump must reprime and deliver full capacity within five minutes after the pump is energized in the reprime condition.

R. Fabrication:

1. Shaft Guard: Enclose shaft and universal joint with enclosed-type metal shaft guard complying with OSHA standards.

S. Operation:

1. Electrical Characteristics: As specified in Division 26 – Electrical
   a. 460 V / 3ph / 60 Hz
2. Motors: As specified in Section 40 05 13 - Common Motor Requirements for Process Equipment.
3. Operation Sequences
   a. Pumps:
      1) The purpose of the DAF Influent Pumps is to convey secondary effluent from the polishing pond to the DAF unit.
      2) In automatic mode, the pumps shall run on a timer based on an operator input time interval.
T. Miscellaneous

1. Data Plates: Each pump shall be equipped with a data plate securely fastened to the pump that contains the manufacturer's name, pump size and type, serial number, pump speed, impeller data, capacity and head rating, and any other pertinent information.

2. Testing: The pump shall be factory non-witness performance tested in accordance with ANSI/HI 14.6 Acceptance Grade 2B. Test shall include, but not be limited to, checking the unit at its rated speed, capacity, head, efficiency, and brake horsepower at such conditions of head and capacity so as to properly establish the actual performance curve. Certified copies of the test reports shall be submitted for review prior to shipment. The Standards of the Hydraulic Institute shall govern the procedures and calculations for the prescribed testing.

3. Painting: All equipment above pump pad, including motor frame exterior, discharge head exterior and sole plate, shall be painted as specified in Section 09 96 00.

4. Fasteners: All pump fasteners shall be ASTM A276-00a Type 316 stainless steel.

5. Guarantee: All equipment supplied and installed under this section shall be guaranteed free of defects in material and workmanship for a period of one year from the date of shipment. Any defects which occur or become obvious within the above time shall be replaced or repaired at no expense to the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Contractor shall off-load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Immediately after off-loading, contractor shall inspect complete pump and appurtenances for shipping damage or missing parts. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all pump serial numbers and parts lists with shipping documentation. Notify the manufacturer’s representative of any unacceptable conditions noted with shipper.

3.2 INSTALLATION

A. Install pumps where indicated on Drawings and according to manufacturer instructions.

B. Install, level, align, and lubricate pump(s) as indicated on project drawings. Installation must be in accordance with written instructions supplied by the manufacturer at time of delivery.

C. Suction pipe connections shall vacuum tight. Fasteners at all pipe connections must be tight. Install pipe with supports and thrust blocks to prevent strain and vibration on pump piping. Install and secure all service lines (level control, air release valve or pump drain lines) as required in wet well.

D. Check motor and control data plates for compatibility to site voltage. Install and test the station ground prior to connecting line voltage to control panel.

E. Prior to applying electrical power to any motors or control equipment, check all wiring for tight connection. Verify that protective devices (fuses and circuit breakers) conform to project design.
documents. Manually operate circuit breakers and switches to ensure operation without binding. Open all circuit breakers and disconnects before connecting utility power. Verify line voltage, phase sequence and ground before actual start-up.

F. After all anchor bolts, piping and control connections are installed, completely fill the grout dam in the pump station base with non-shrink grout.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Prior to acceptance by owner, an operational test of all pumps, drives, and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

3.4 MANUFACTURER SERVICES

A. Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than two (2) 8-hour days on-Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.

END OF SECTION 43 23 31
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Submersible centrifugal pumps.
B. Related Requirements:

1. Section 01 33 00 – Submittal Procedures
2. Section 01 70 00 – Execution and Closeout Requirements
3. Division 26 – Electrical
4. Section 33 05 16 – Precast Concrete Utility Structures
5. Section 40 72 76 – Level Switches

1.2 REFERENCE STANDARDS

A. ASTM International:

B. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 COORDINATION

A. Section 013100 – Project Management and Coordination: Requirements for scheduling.
B. Coordinate installation and startup of Work of this Section with plant operations.

1.4 SCHEDULING

A. Section 013100 – Project Management and Coordination: Requirements for scheduling.
B. Schedule Work of this Section to install pumps prior to connecting piping Work.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data: Submit information concerning materials of construction, fabrication, and protective coatings.

C. Shop Drawings:
   1. Submit detailed dimensions for materials and equipment, including wiring and control diagrams, performance charts and curves, installation and anchoring requirements, fasteners, and other details.
   2. Include manufacturer's specified displacement tolerances for vibration at operational speed specified for pumps.

D. Manufacturer's Certificate: Certify that pump and accessories meet or exceed specified requirements.
   1. Certify installation is completed according to manufacturer's instructions.

E. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

F. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Manufacturer Reports: Indicate that equipment has been installed according to manufacturer's instructions.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.7 TOOLS AND SPARE PARTS

A. The pump manufacturer shall provide one (1) set of recommended spare parts.

B. The pump manufacturer shall provide a list of recommended spare parts.

C. The manufacturer shall furnish any special tools necessary to disassemble, service, repair, and adjust the equipment.

1.8 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish one-year manufacturer's warranty for pumps and components.
PART 2 - PRODUCTS

2.1 SUBMERSIBLE NON-CLOG CENTRIFUGAL PUMPS

A. Manufacturers:

1. Flygt
2. Or Approved Equal

B. Description:

1. Submersible non-clog pumps, each equipped with submersible electric motor.
2. Pump Station Name: Influent Pump Station
   a. Pump Designation:
      1) P-1010
      2) P-1020

C. Performance and Design Criteria:

1. Performance Table

<table>
<thead>
<tr>
<th>DESIGN PARAMETER</th>
<th>DESIGN VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Flow Rate: (gpm)</td>
<td>2200</td>
</tr>
<tr>
<td>Design Flow Total Dynamic Head: (feet)</td>
<td>29</td>
</tr>
<tr>
<td>Pump Efficiency at Design Flow Rate:</td>
<td>79</td>
</tr>
<tr>
<td>Motor Horsepower</td>
<td>35</td>
</tr>
<tr>
<td>Service Liquid:</td>
<td>RAW WASTEWATER (RWW)</td>
</tr>
<tr>
<td>Specific Gravity:</td>
<td>1.0</td>
</tr>
<tr>
<td>Temperature: (°F)</td>
<td>50-85</td>
</tr>
</tbody>
</table>

2. Discharge Connection Elbow: Permanently installed in chamber with discharge piping.
3. Connection: Automatic to discharge connection elbows when lowered into place, and easily removed for inspection or service.
4. Guide Bracket:
   a. Integral part of pump unit.
   b. Entire weight of pump unit guided by not less than two guide bars, and pressed tightly against discharge connection elbow with metal-to-metal contact.
5. Discharge Interface Seal: Diaphragm.
6. Do not permit any portion of pump to bear directly on floor of sump.
7. Capable of continuous submergence underwater without loss of watertight integrity to depth of 65 feet.

D. Impeller and Volute:

1. Impeller:
   a. Gray cast iron, ASTM A48, Class 30
   b. Dynamically balanced
   c. Double-shrouded, non-clogging design having long throughlet without acute turns.
   d. Semi-open, multi-vane design, capable of passing minimum 3-inch solid sphere.
   e. Capable of handling solids, fibrous materials, sludge, and other matter found in normal sewage applications.

2. Impeller and Shaft Fit: Sliding fit with one key, or impeller bolt.
3. Volute:
   a. Single piece, cast iron, ASTM A-48, Class 35B.
   b. Non-concentric, spiral design.
   c. Smooth fluid passages capable of passing solids through impeller.

E. Mechanical Seal System:

1. Shaft: AISI, Type 431 or ASTM A276, Type 420 stainless steel.
2. Shaft Seal: Tandem mechanical type.
   a. Upper Tandem Set of Seals:
      1) Operating in oil chamber located just below stator housing.
      2) One stationary tungsten-carbide ring and one positively driven rotating carbon ring.
   b. Lower Tandem Set of Seals: Stationary tungsten-carbide ring and positively driven rotating tungsten-carbide ring.

3. Oil Chamber for Shaft-Sealing System: Drain and inspection plug, with positive anti-leak seal, accessible from outside.

F. Bearings:

1. Rotate shaft on two permanently lubricated bearings with an L-10 bearing life of 50,000 hours when operating within any usable portion of the pump curve.

G. Cable Entry Seal:

1. Single cylindrical elastomer grommet, flanked by stainless-steel washers with close tolerance fit against cable outside diameter and entry inside diameter, and compressed by entry body containing strain-relief function, separate from function of sealing cable.
2. Bear assembly against shoulder in pump top.
3. Separate cable entry junction chamber and motor by stator-lead sealing gland or terminal board, which isolates motor interior from foreign material gaining access through pump top.

H. Electrical

1. Electrical Characteristics: As specified in Section 26 05 03 - Equipment Wiring Connections and following:
   a. Voltage: 460 V, three phase, 60 Hz.

2. Pump Motor: As specified in Section 26 05 13 - Common Motor Requirements for Water and Wastewater Equipment and following:
   a. Squirrel-cage.
   b. Induction.
   c. Shell-type design.
   d. Housed in air-filled, watertight chambers.
   e. Non-overloading throughout entire pump performance range based on 1.0 service factor.
   f. Continuous duty, capable of sustaining minimum of 10 starts per hour.
   g. Indefinite operation without overheating when unsubmerged and operating in air.
   h. Stators:
      1) Dipped and baked three times in Class F varnish.
      2) Heat-shrink-fitted into stator housings.
      3) Thermal sensors to monitor stator temperatures.
   i. Include three thermal switches embedded in end coils of stator winding, for one switch in each stator phase.
   j. Stator Windings and Leads: Insulated with moisture-resistant Class F insulation capable of resisting temperature of 311 °F.
   k. Cooling System:
      1) Water jacket encircling stator housing.
      2) Furnish cooling media channels.
   l. Junction Chamber:
      1) Terminal board.
      2) Sealed from motor by elastomeric compression seal (O ring).
      3) Connection cable conductors and stator leads with threaded, compressed-type binding post permanently affixed to terminal board.

3. Control Panel
   a. See Specification Section 26 30 00 - Duplex Control Panel
2.2 PUMP(S) CONTROLS

A. Control Description:

1. Each pump shall start and stop via signals from the radar level transducer (LE1001).
2. Alternatively, the float switches shall control the pump-on and pump-off sequence upon a fault condition of the radar level transducer. Reference the plan drawings for float switch elevations in the influent pump station wet well.
3. The pumps shall alternate run times automatically.

2.3 ACCESSORIES

A. Access Frame and Guides:

1. Complete with hinged and hasp-equipped covers, upper guide holder and protective grating panel.
2. Sufficient size to permit removal or replacement of the pumping equipment
3. Each door shall have a safety handle to maintain the door in the open position
4. Doors shall be of checkered aluminum plate
5. Cover guide bar holders shall be as required by the pump manufacturer
6. Cover shall include a protective grating panel with a 1-inch minimum depth aluminum “I” bar grating with Safety Orange powder-coated finish. Grating shall be hinged and shall be supplied with a positive latch to maintain unit in an upright position. Grating support 300 psf loading
7. Provide padlock hasp for owner-supplied padlock
8. Covers shall be delivered to the precast wetwell supplier for installation in the wetwell top slab as specified in Section 33 05 16 - Precast Concrete Utility Structures.

B. Lifting Chain

1. Minimum length equal to wetwell depths plus 5 feet.
2. Material: 304 Stainless Steel
3. Load Rating: Sufficient to permit raising and lowering the pump.

C. Float Switches

1. See Section 40 72 76 - Level Switches
2. Provide floats as listed below for back up in the event of radar level transducer fault:
   a. One (1) for pump start (LS1003)
   b. One (1) for pump shut-off (LSL1004)
   c. One (1) for high-level alarm (LSH1002)
3. Provide two (2) spare float switches with cable, not to be installed.

D. Detachable Mechanical Hoist

1. Furnish one (1) Detachable Mechanical Hoist to lift the pumps out of the wet well.
2. Manufacturer shall be responsible for sizing the hoist for the weights of the pumps supplied pumps.
3. Manufacturer shall furnish two (2) base mounts for the mechanical hoist.
4. Contractor is responsible for installing the base mounts on the precast top of the pump station.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify layout and orientation of pumps, accessories, and piping connections.

3.2 INSTALLATION

A. Install pumps and accessories where indicated on Drawings and according to manufacturer's instructions.

B. Provide and connect piping, accessories, and power and control conduit and wiring to make system operational, ready for startup.

C. Flush piping with clean water.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Pre-operational Checks:
   1. Check pump and motor alignment.
   2. Check for proper motor rotation.
   3. Check pump and drive units for proper lubrication.

C. Startup and Performance Testing:
   1. Operate pump using clean water at design point for continuous period of one hour, under supervision of manufacturer's representative and in presence of Engineer.

D. Verify pump performance by performing time-drawdown test or time-fill test.

E. Check pump and motor for high bearing temperature and excessive vibration.

F. Check for motor overload by taking ampere readings.

G. Equipment Acceptance:
1. Adjust, repair, modify, or replace system components that fail to perform as specified, and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.
3. Document adjustments, repairs, and replacements in manufacturer's field services certification.

H. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than two (2) 8-hour days on-Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.

I. Furnish installation certificate from equipment manufacturer's representative attesting equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 43 25 13
SECTION 43 26 50 – AIR OPERATED DOUBLE DIAPHRAGM PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes air operated double diaphragm pumps.

B. Related Requirements:
   1. Section 01 31 00 - Project Management and Coordination: Requirements for Scheduling
   2. Section 01 33 00 – Submittal Procedures: Requirements for Submittals
   3. Section 01 40 00 – Quality Requirements for Inspecting and Testing
   4. Section 01 70 00 – Execution and Closeout Requirements: Requirements for Submittals

1.2 COORDINATION

A. Section 013100 – Project Management and Coordination: Requirements for scheduling.

B. Coordinate installation and startup of Work of this Section with plant operations.

1.3 SCHEDULING

A. Section 013100 – Project Management and Coordination: Requirements for scheduling.

B. Schedule Work of this Section to install pumps prior to connecting piping Work.

1.4 SUBMITTALS

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

B. Manufacturer shall provide, at a minimum, the following information:
   1. Product information
   2. Shop drawings
   3. Installation information
   4. Parts lists
   5. Operational data

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.
1.5 CLOSEOUT SUBMITTALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
   B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.6 QUALITY ASSURANCE
   A. The manufacturer shall have air diaphragm pumps of the type specified herein successfully operating on similar waste streams (5% solids) for a minimum of ten (10) years in a minimum of five (5) facilities in the United States.
   B. Compliance with the performance requirements of the specifications shall not relieve the vendor of his responsibilities of supplying equipment having the specified structural, mechanical, corrosion resistance and operational features.

1.7 TOOLS AND SPARE PARTS
   A. The pump manufacturer shall provide one (1) set of recommended spare parts.
   B. The manufacturer shall furnish any special tools necessary to disassemble, service, repair, and adjust the equipment.

1.8 WARRANTY
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
   B. Manufacturer shall provide a one (1) year warranty on the equipment effective from substantial completion of the project, in addition to warranty requirements in Division 01.

1.9 SHIPPING, HANDLING AND STORAGE
   A. Follow manufacturer’s recommendations for off-loading, handling, and storage of equipment.
   B. Contractor shall inspect all delivered equipment for any damage and shall note any damage. Contractor shall receive recommendations from Manufacturer for correcting damaged equipment.
   C. Any damaged equipment shall be repaired or replaced prior to installation.
PART 2 - PRODUCTS

2.1 AIR OPERATED DOUBLE DIAPHRAGM PUMPS

A. Manufacturers:
   1. Versamatic
   2. Wilden
   3. Approved Equal

B. General

C. Performance and Design Criteria:
   1. Size: 2 inch
   2. Flow: 60 gpm
   3. Discharge head at 60 gpm: 25 ft.
   4. Min. suction lift: 9 ft
   5. Max expected solids content: 5%
   6. Maximum sphere to pass through: 1/4"
   7. Fluid to be pumped: Wastewater TSS Sludge, DAF waste (algae and duckweed)
   8. Max air usage: 25 cfm

D. Schedule:
   1. P5110
   2. P5120

E. Pump Construction Features:
   1. Material: cast iron
   2. Type: clamped
   3. Diaphragm: PTFE
   4. Wetted material: cast iron with stainless steel seat material.
   5. Pump shall be a bottom suction by top discharge design.
   6. Suction and discharge valves shall be of the ball valve design and have replaceable valve seats.
   7. Pumps shall be fitted with an air distribution system which shall include the main air directional valve and pilot valve both with a fully serviceable sleeve and spool design OR equal system.
   8. Pumps shall have a freestanding base for complete in-line serviceability of the main air valve. Pump to be painted on all external surfaces and be ATEX compliant and fully groundable with an all metallic muffler with all metal element.
   9. The pump shall be capable of running dry without damage.
   10. A surge dampener shall be provided to minimize unwanted pressure fluctuations by providing a supplementary pumping action to eliminate pressure variation and pulsation on the pumps. The equalizer shall automatically set and maintain the correct air pressure matching the variations in liquid flow or discharge pressure generated by the pump

F. Accessories
1. Each pump shall include electronic leak detectors, including necessary leads, PTFE probes and associated items. The detectors shall be provided in a watertight enclosure. The detectors shall be connected to the control panel for alarm. The control panel shall source the required power to the leak detection systems.

2. Solenoid valves
   a. SV5110
   b. SV5120

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Contractor shall off-load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Immediately after off-loading, contractor shall inspect complete pump and appurtenances for shipping damage or missing parts. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all pump serial numbers and parts lists with shipping documentation. Notify the manufacturer’s representative of any unacceptable conditions noted with shipper.

3.2 INSTALLATION
   A. Installation shall be in accordance with the manufacturer recommendations, installation instructions and assembly drawings.

3.3 FIELD QUALITY CONTROL
   A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.
   B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

3.4 STARTUP, TESTING, AND TRAINING
   A. Manufacturer shall furnish the services of a factory-trained service engineer for a minimum of one (1) trip and two (2) days to inspect the installation, carry-out the equipment start-up procedures, and provide training to the operators in how to effectively operate and maintain the equipment.
   B. The Service Representative shall be present for startup of the DAF system to ensure proper pumping of the representative sludge and to provide maintenance and preventative maintenance options to the Owner.
END OF SECTION 43 26 50
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SECTION 46 33 33 - POLYMER BLENDING AND FEED EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Polymer blending units and feed systems
   2. Booster and metering pumps
   3. Skid-mounted supports, frames, and floor stands
   4. Valves and piping appurtenances.
   5. System control panels
   6. Control features

B. Related Requirements:
   1. Section 26 05 83 - Wiring Connections: Electrical connections to equipment specified in this Section.
   2. Section 26 05 93 - Common Motor Requirements for Process Equipment: Common requirements for motors required under this Section.
   3. Section 26 43 13 - Surge Protection for Low-Voltage Electrical Power Circuits

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

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

B. Product Data: Submit manufacturer information, including system materials, component equipment, and performance characteristics.

C. Shop Drawings:
   1. Submit dimensional drawings and details.
   2. Indicate schedule of equipment components.
   3. Indicate materials of construction.
   4. Submit detailed wiring and control diagrams.
   5. Indicate installation and anchoring requirements, including fasteners and other details.
   6. Indicate mounting details, and location and elevation of electrical controls and panels.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
E. Manufacturer Instructions: Submit detailed instructions regarding installation requirements, including storage and handling procedures, special field procedures, anchoring, and layout.

F. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.

I. Qualifications Statements:
   1. Submit qualifications for manufacturer and installer.
   2. Submit manufacturer's approval of installer.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record installed locations and final orientation of equipment and accessories.

1.5 QUALITY ASSURANCE

A. Prior to shipment the system shall be inspected for quality of construction verifying all fasteners and fittings are tight, all wires are secure and connections whisker-free.

B. The complete system shall be fully factory tested prior to shipment. Testing shall include: setting and verification of all instrumentation and sensors per the design requirements of the application; pressure testing all plumbing systems for a minimum of one hour at 100 psi. If leaks are found they shall be fixed and a new test shall be conducted for one hour at 100 psi until the plumbing system is verified to be leak free; verification of system design flow rates, and; complete functional simulation of operation.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten (10) years' documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.
D. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.8 EXISTING CONDITIONS
A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

1.9 WARRANTY
A. Furnish one (1)-year manufacturer's warranty for polymer blending and feed equipment.
B. Mixing chamber shall be warranted for the life of the system against failure for plugging for any reason other than over pressure of freezing.

PART 2 - PRODUCTS

2.1 POLYMER BLENDING AND FEED EQUIPMENT
A. Manufacturers:
   1. Velodyne – Velocity Dynamics of Louisville, CO
   2. Prominent Fluid Controls
   3. Pre-Approved Equal

B. Description: Unit process capable of automatic metering, dilution, mixing, activation, and feeding of liquid polymer.
   1. The polymer dilution and feed system shall be capable of effectively activating and fully blending with water a homogenous polymer solution ranging from 0.1% to 1% concentration of emulsion polymers with active contents up to 75%.

C. Design Criteria
   1. Polymer type: Emulsion
   2. Polymer Activity (percent active): 30 to 75
   3. Solution Concentration Range: 0.1 to 2% based on neat polymer
   4. Solution Concentration Design Point: 0.5% based on neat polymer
   5. Neat Polymer Flow Range: 0.025 – 0.5 GPH
   6. Dilution Water Flow Range: 12 – 120 GPH

D. Equipment
1. Polymer Activation & Blending Chamber

a. Type: multi-stage, multi-zone, hydro-mechanical
b. Non-mechanical stage: The devices shall be capable of activating and blending polymer based on plant pressure alone at 30 psig or greater.

1) Polymer shall be injected directly into a water jet by means of an injection quill positioned such that the non-mechanical mixing energy is no way diminished prior to polymer and water contact. The non-mechanical zone shall be designed such that the velocity of the mixing energy-producing water jet is maintained or increases as flow decreases.

c. Hydro-mechanical mixing stage: In addition to the non-mechanical mixing stage the device shall be capable of producing its mixing energy independent of plant water pressure through a variable intensity, controllable stainless steel hydro-mechanical mixer.

1) The mixing impeller shall be fully controllable and capable of inducing ultra-high, non-damaging mixing energy at all flow rates. This shall be accomplished by controlling mixing intensity and preventing over exposure to, or damaging recirculation through the impeller.
2) The polymer mixing impeller shall be designed to produce both axial and radial flow to optimize mixing effectiveness and to effectively inducing high, non-damaging mixing energy over the systems full flow range.

d. Mixers that rely solely on plant water pressure and or flow for mixing energy will not be acceptable. Mixers where performance is affected by flow rate and therefore retention time resulting in under or over exposure to mixing energy, or which rely on constant speed impellers or that rely on close tolerances for blending will not be acceptable.

e. The mixing chamber shall maintain high velocity in the entire chamber in order to prevent polymer build up.

f. The motor shall be mounted horizontally or above the mixing chamber. Motors mounted under the mixing chamber where seal failure or leaks can damage the motor shall not be acceptable.

g. The mixer drive shaft shall be sealed by a mechanical seal which shall have an integrally mounted and factory plumbed seal flush. A drain port behind the seal shall be provided in the mixing chamber to drain the polymer solution in case of a seal failure. The seal shall be easily accessible for replacement. Systems without a seal flushing system shall not be considered.

1) All bearings shall be external from the mixing chamber. Internal bearings shall not be acceptable.

h. Both mechanical and non-mechanical mixing zones shall be clear polycarbonate to view the mixing action and blending effectiveness. Acrylic chambers prone to becoming brittle over time and cracking, or opaque pipe shall not be acceptable to meet this requirement. The clear cover shall have a stainless steel reinforced gusseted flange with a stainless steel discharge connection in order to handle maximum operating pressures.
i. The mixing chamber shall have a maximum rated pressure of 100 psi. Provide a pressure relief on the mixing chamber factory set at 75 psi.

j. Provide a neat polymer check valve specifically designed to isolate neat polymer from dilution water. The valve shall be designed with an open, unobstructed path to the valve seat. To minimize check valve plugging due to normally occurring polymer agglomerations, the minimum open area up to and including the valve seat shall be 3/16” without exception. The valve body shall be constructed of Teflon with Viton seals. The valve poppet and spring shall be stainless steel. The spring shall be outside of the polymer flow path to prevent build-up and plugging. The locking pin used to hold the valve in place shall be attached to the mixing chamber with a lanyard. The valve shall be readily accessible for cleaning and shall not require tools for removal, cleaning or replacement. Conventional check valves, valves that rely on ball seals, and or check valves that are installed inside the mixing chamber, or which require mixing chamber disassembly for servicing will not be accepted.

E. Progressive Cavity Neat Polymer Metering Pump

1. The unit shall have one (1) neat polymer metering pump integrally mounted on the system’s skid.

2. The pump shall be a positive displacement, progressive cavity type constructed of stainless steel and Viton. The shaft seal shall be a lip seal type riding on a ceramic sleeve. Mechanical seals shall not be used. A 90 VDC wash-down duty motor shall drive the pump. A gear reducer shall be provided to produce a maximum pump shaft speed of not more than 545 RPM. The motor shall be controlled by an SCR motor controller located in the system control panel.

3. Provide a calibration column with two full port PVC ball valves having Viton O-rings. The column shall be calibrated for a one minute draw-down at maximum pump rate and read in GPH and milliliters. The calibration column shall be rigidly mounted to the systems frame with a minimum of two heavy duty brackets. Mounting the calibration to the neat polymer inlet piping shall not be acceptable. Provide a breather plug in the top of the calibration column designed to allow adequate displacement of air during calibration while preventing water or other foreign material from entering the calibration column.

4. Provide a pressure relief on the discharge of the metering pump, adjustable between 25 and 100 psi. The valve shall be factory plumbed to the suction of the pump. The valve shall have a stainless steel or PVC body with stainless steel, Viton and Teflon internals. Brass pressure relief valves shall not be acceptable.

5. Provide a pressure gauge / switch assembly with stainless steel diaphragm isolator to monitor polymer line pressure.

F. Solution Discharge Assembly

1. Provide a 2-1/2” stainless steel liquid filled pressure gauge to monitor system discharge pressure.

2. Provide a swing type check valve to prevent back flow. The check valve shall be sized for the total solution flow of the system, constructed of PVC and Viton.

G. Dilution Water Assembly
1. The dilution water flow rate shall be monitored by a Rotameter flow meter. Unions shall be provided on the flow meter to allow easy removal for cleaning.
2. The unit shall have an electric solenoid valve for on/off control of total dilution water flow.
3. A differential pressure type low water differential pressure alarm shall be provided. The switch shall be adjustable between 9 and 60 psig. Static working pressure, 500 psi. Proof pressure shall be 2000 psi minimum. The pressure switch shall be as manufactured by Ashcroft.
4. Provide a 2-1/2” stainless steel liquid filled pressure gauge to monitor dilution water inlet pressure.

H. System Skid
1. The system's frame shall be of rugged 304 stainless steel construction. No mild steel shall be used. All piping shall be rigidly supported.
2. Under no circumstance shall the pump suction exceed 5” from the bottom of the skid for progressive cavity pumps.
3. The skid shall have an integral stainless steel drip pan located under the neat polymer metering pump. Provide one dozen absorbent pads designed for oil and sized to fit within the drip pan.

I. Electrical and Controls:
1. Motors: As specified in Section 40 05 93 - Common Motor Requirements for Process Equipment.
2. Power: 120 V, 1 ph, 60 hz
3. Provide a control panel integral to the system’s frame.
   a. Enclosure shall be rated NEMA 4X and constructed of FRP.
   b. Control panel shall consist of all controllers, digital displays, potentiometers, switches, lights, relays, and other control devices required for a complete operable system. The control panel and all components shall be industrial duty. All skid mounted electrical components interconnected to the control panel shall terminate at numbered and labeled terminal blocks. Wires shall be neatly run through wire race-way and numbered with shrink tubing type labels. Adhesive labels shall not be used. The control panel shall be positioned such that there are no obstructions in front of the control panel per related NFPA requirements.
   c. A circuit breaker on the main control circuit and on each motor shall be provided as manufactured by Allen Bradley or equal. Fuses shall not be used for circuit protection.
4. Controls:
   a. Operator Interface - Discrete Selector Switch:
      1) System ON / OFF(reset) / Remote
      2) One-Turn Potentiometer – Mixer Speed
      3) Ten-Turn Potentiometer – Progressive Cavity Metering Pump Control
   b. Status / Alarm Indicators:
1) Main Power ON
2) Display of Metering Pump Rate (diaphragm pump only: located on diaphragm metering pump face)
3) Low Water Differential Pressure Alarm
4) Low Polymer Flow Alarm

c. Inputs (signals by others):
   1) Remote Start / Stop (discrete dry contact)
   2) Pacing Signal Based on Process Flow (4-20mA)

d. Outputs:
   1) System Running (discrete dry contact)
   2) Remote Mode (discrete dry contact)
   3) Common Alarm (discrete dry contact)

J. Materials:
1. Frame and Skid: 304 stainless steel
2. Hardware: Type 18-8 stainless steel
3. Inlet and Outlet fittings: 304 stainless steel
4. Piping & pipe fittings: schedule 80 PVC
5. Tubing and tube fittings: polyethylene, polypropylene, stainless steel and Viton
6. Water solenoid valve: brass
7. Pressure gauges: stainless steel, liquid filled
8. Pressure switches: NEMA 4, brass connection
9. Flow meter: acrylic, stainless steel, PVC and or polypropylene
10. Water control valve: stainless steel with stainless steel seat
11. Mixing chamber body / flanges: stainless steel
12. Mixing chamber cover / chamber: clear polycarbonate
13. Mixing Chamber Discharge: stainless steel
15. Impeller shaft seal: Viton, stainless steel, ceramic, carbon
16. Mixing chamber pressure relief valve: brass, stainless steel or PVC
17. Metering pump wetted parts: stainless steel & Viton
18. Metering Pump Shaft Seals: Viton, stainless steel ceramic, carbon
19. Control enclosure: FRP

K. Spare Parts
1. As recommended by manufacturer.
2. Furnish any special tools required for assembly/disassembly of equipment for maintenance.

L. Accessories
1. Mixer for 55 gallon drums.
2. Drum dolly
PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that designated areas, clearances, structural requirements, piping, utility connections, and electronic signals are ready to receive equipment.

3.2 INSTALLATION

A. According to manufacturer instructions.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Manufacturer Services: Provide the services of a qualified field service technician to inspect and certify the installation, start-up the equipment, trouble shoot any problems that may arise and providing complete and thorough training of operator personnel. Field services shall consist of one (1) eight (8) hour day.

C. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

3.4 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, alarm condition responses, and emergency repair procedures to Owner's personnel.

END OF SECTION 46 33 33
SECTION 46 41 26 - FLOATING MECHANICAL AERATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Floating mechanical aerators.

B. Related Requirements:

1. Section 09 96 00: High Performance Coatings: Surface preparation and coating requirements.
2. Section 26 05 03 - Equipment Wiring Connections: Execution and product requirements for connecting equipment specified by this Section.
3. Section 26 05 13 - Common Motor Requirements for Water and Wastewater Equipment: Electric motors and accessories normally supplied as part of equipment assemblies.

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

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

B. Product Data:

1. Submit manufacturer's product information for system materials and component equipment.
2. Submit electrical characteristics and connection requirements.
3. Submit installation requirements and other details.

C. Shop Drawings:

1. Indicate size and configuration of aerator assembly, mountings, weights, and accessory connections.
2. Indicate system materials and component equipment.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1. Certify that installation is completed according to manufacturer's instructions.

E. Manufacturer's Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Source Quality-Control Submittals: Provide certified wet & dry testing of the complete unit at the manufacturer’s facility.
   1. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

H. Manufacturer Reports:
   1. Certify that equipment has been installed according to manufacturer's instructions.
   2. Indicate activities on Site, adverse findings, and recommendations.

1.4 COORDINATION
   A. Coordinate Work of this Section with Work of other Sections.

1.5 CLOSEOUT SUBMITTALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
   B. Project Record Documents: Record actual locations of installed aerators and components.

1.6 MAINTENANCE MATERIAL SUBMITTALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.
   B. Spare Parts:
      1. Furnish one set of manufacturer's recommended spare parts.

1.7 DELIVERY, STORAGE, AND HANDLING
   A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
   B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
   C. Store materials according to manufacturer's instructions.
   D. Protection:
      1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
      2. Provide additional protection according to manufacturer's instructions.
1.8 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. The Manufacturer and Contractor shall furnish a warranty extending twelve (12) months after substantial completion date of the project in its entirety.

PART 2 - PRODUCTS

2.1 FLOATING MECHANICAL AERATORS

A. Manufacturers:
   1. Aqua-Aerobics (Endura® Series Aqua-Jet® Aerator)
   2. Aquaturbo Systems, Inc. (Model AER)
   3. Evoqua (Aqua-Lator)
   4. Or Approved Equal

B. Schedule:

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C. Diffusion Head

   1. Material: 304 SS
   2. The design of the diffusion head shall be such that the liquid spray shall discharge at an angle of 90 degrees to the motor shaft over a 360 pattern in the horizontal plane and shall be a monolithic casting.
3. The diffusion head casting shall act as a base for the aerator motor and alignment of the motor to this base shall be controlled by machined index fittings that engage the P-base of the motor. Diffusion head designs that employ studs and spacers or shoulder bolts are not allowed.
4. The diffusion head shall have load bearing flange-to-flange connections.
5. The diffusion head shall contain an anti-deflection journal insert to limit the radial deflection of the motor shaft. This anti-deflection journal insert shall be located in the lower extremity of the diffusion head approximately one-half the distance between the motor base and the lower end of the shaft. The journal insert shall be machined from Delrin or molded from moly-filled urethane and shall be a minimum of 0.020 inch diameter or larger through the bore than the diameter of the motor shaft. There shall be a fluid deflector located on the motor shaft immediately below the anti-deflection journal, which shall cover completely the anti-deflection journal insert and the lower portion of the diffusion head. This fluid deflector shall be molded from black neoprene and shall be press fit onto the motor shaft or attached to the motor shaft by recessed allen head stainless steel set screws.

D. Float:

1. Material: Fiberglass-reinforced polyester (FRP) skin, resistant to ultraviolet exposure.
2. Float shall be minimum 71 inches in diameter and 12 inches thick.
3. Float construction shall be such that the volute will distribute the load of the entire motor, drive, discharge cone, and volute static load, plus the entire dynamic load from the propeller thrust and radial forces by spreading these forces uniformly around the full 360 degree circumference of the float’s central core. Point connected joints or point stressed connections will not be acceptable.
4. Float shall have internal reinforcements to transmit mooring line tension forces such that the mooring connections will not be allowed to flex the structure.
5. The aerator shall have 935 lbs. reserve buoyancy to ensure stability and to provide support flotation required during aerator servicing.
6. Fill:
   a. Material: Closed-cell polyurethane foam with minimum density of 2.0 lbs/ft³.
   b. Injection applied.
7. Float shall be completely sealed to prevent the foam from being in contact with the external environment.
8. Floats shall have three (3) mooring points, spaced at 120-degree locations around the outer circumference. All mooring connections shall be stainless steel.

E. Propeller:

1. Two-blade, left handed, self-cleaning, marine type
2. Diameter: 11.5 inch
3. Material: 316 or 15/5 SS
5. Self-cleaning
6. Propeller shall be attached to the motor shaft with a hardened stainless steel pin and set screw.

F. Volute
1. Material: 304 stainless steel
2. Minimum diameter: 12 inches
3. The volute shall have a minimum of 3/16-inch wall thickness and a minimum of four full-length stainless steel gussets shall be welded on 90° spacing around the circumference of the volute between the top and bottom flanges.
4. Volute shall be round and true so that propeller blade tip clearance is uniform within the volute as it rotates.

G. Intake Cone
1. Material: 304 stainless steel
2. The intake cone shall have a gradually expanding opening outward to the intake end. The length and inlet diameter shall be sufficient to provide uniform inlet hydraulics so that no increase in vibration is caused due to its shape or size.
3. The intake cone shall be designed so that the suction lift from the aerator propeller is vertical from the liquid depth below the aerator.
4. Anti-vortex cross vanes: 304 stainless steel

H. Balancing
1. The entire rotating assembly including the motor rotor, shaft, shaft accessories, and impeller shall be dynamically balanced within 2.0 mils peak-to-peak horizontal displacement measured at the upper and lower motor bearing. Measurements shall be taken at a frequency equivalent to the motor RPM. Measurements shall be taken with the motor in a vertical, shaft down position with the entire power section mounted on resilient pads.

I. Mooring
1. Type: Cable mooring
2. Material: stainless steel
3. Anchor cable shall be installed as recommended by the manufacturer so the aerator shall be permitted to rise and fall with some water level variations, but will have a minimum of lateral movement.

J. Cable Floats
1. The manufacturer shall provide a minimum of 8 vinyl electrical cable floats, complete with Nylon cable ties for supporting the electrical power cable. The Nylon cable ties are to be heavy duty type, black in color and UV stable. Contractor shall be responsible for field attaching the electrical cable floats in accordance with the manufacturer’s recommendations.

K. Electrical Service Cable
1. Electrical service cable shall be provided and shall be a continuous length (non-spliced). The cable shall have three power conductors and a ground conductor.
2. Conductors shall be flexible type annealed copper stranded. Each conductor, including the ground conductor, shall be insulated. Cables containing an uninsulated ground conductor will not be acceptable.
3. The insulated conductors shall be assembled together with a non-hygroscopic filler material.
4. Outer jacket shall be high quality CPE, PVC, TPE or equal, and shall be rated at a conductor operating temperature of not less than 90°C.
5. The cable shall be rated for hard usage outdoor service and shall be resistant to oil, sunlight, ozone, grease, acids, water, abrasion and impact.
6. The electrical service cable shall be factory assembled to the motor conduit box with cord grip and strain relief grip. The cord grip shall include a Neoprene bushing providing a liquid tight seal. The strain relief grip shall be a 304 stainless steel wire mesh strain relief grip for the electrical cable at the motor to prevent the cable from pulling out of the conduit box.
7. Spiral Wrap Electrical Cable Protection: A polyethylene expandable spiral wrap abrasion protection sleeve shall be provided for wrapping around the electrical cable at the unit. The spiral wrap shall be weather resistant for a temperature range from -40 °F to 122 °F, and protect the electrical cable from rubbing on the edge of the float.

L. Operation:

1. Electrical Characteristics: As specified in Section 26 05 03 - Equipment Wiring Connections and following:
   a. 460 V, 3 phase, 60 Hz.
2. Motor:
   a. As specified in Section 26 05 93 - Common Motor Requirements for Process Equipment.
   b. Type: Totally enclosed, fan cooled (TEFC).
   c. Rating: Severe chemical duty.
   d. Motor windings shall be nonhygroscopic, and insulation shall equal or exceed NEMA Class "F".
   e. Base: Vertical
   f. Shaft: 17-4 PH stainless steel
   g. Bearings shall be regreasable and be of the radial and axial thrust type.
   h. Hardware, Condensate Drains, and Grease Fittings shall be Cadmium-plated.

2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of completed assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
B. Verify that facilities are ready to receive floating mechanical aerators.

3.2 INSTALLATION
   A. Install according to manufacturer's instructions.

3.3 FIELD QUALITY CONTROL
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
   B. Wet Startup: Run equipment with wastewater and verify proper alignment and operation.
   C. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than one day (8 hrs) on Site for installation, inspection, startup, field testing, and instructing Owner's personnel in maintenance of equipment.
   D. Equipment Acceptance:
      1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
      2. Make final adjustments to equipment under direction of manufacturer's representative.
   E. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.4 DEMONSTRATION
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
   B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.
END OF SECTION 46 41 26
SECTION 46 43 63 – DISSOLVED AIR FLOTATION EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Dissolved air flotation (DAF) equipment

B. Related Requirements:

1. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electrical connections to equipment specified by this Section.
2. Section 26 05 13 - Common Motor Requirements for Water and Wastewater Equipment: Execution requirements for motors supplied with equipment specified by this Section.
3. 26 43 13 - Surge Protection for Low-Voltage Electrical Power Circuits
4. Division 26 – Electrical
5. Section 40 05 63 – Plug Valves

1.2 SUBMITTALS

A. Manufacturer shall provide, at a minimum, the following information in accordance with Section 01 33 00 Submittals.

B. Equipment supply list with electrical characteristics of motor driven equipment.

C. Make, model number and catalog information of all process equipment, including, but not limited to, recirculation pumps, instrument and sensors, and appurtenances.

D. Submit Shop Drawings and descriptive literature in accordance with Section 01 33 00.

1. Layout drawings including all proposed system components with dimensions, clearances required and sizes indicated and total weights of the equipment with off-loading instructions.
2. Detailed specifications and data describing the materials of construction.
3. Complete information on electric motors furnished including make and type of motor, brake horsepower and locked rotor current at full voltage.
4. Complete electrical wiring diagrams and data on controls to be furnished.
5. Pump performance curves.
6. Complete installation instructions, with dimensional drawings, points of electrical and plumbing connection requirements clearly shown. Field Installation Assembly drawings.

E. Manufacturer shall provide Operations and Maintenance Data in accordance with Section 01 78 23 Operation and Maintenance Data.
1.3 CLOSEOUT SUBMITTALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for closeout procedures.
   B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.4 QUALITY ASSURANCE
   A. The manufacturer shall have dissolved air flotation units of the type specified herein successfully operating on similar waste streams for a minimum of five (5) years in each of at least five (5) wastewater treatment lagoons in the USA.
   B. In lieu of the specific experience requirement listed in 1.4 A, furnish a performance bond in the name of the Owner in the amount of 150% of the dissolved air flotation equipment cost to provide for replacement of the equipment if necessary within the first five (5) years of operation.
   C. Compliance with the performance requirements of the specifications shall not relieve the vendor of his responsibilities of supplying equipment having the specified structural, mechanical, corrosion resistance and operational features.
   D. All electrical equipment and materials specified herein shall be approved by Underwriters Laboratories (UL) for the purpose for which they are used and shall bear the UL label. Labels from other electrical testing laboratories will be acceptable if approved by the local electrical inspection authority.

1.5 WARRANTY
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
   B. Guarantee the equipment against defects in material and workmanship under normal use and service for a period of one (1) year after start up not to exceed eighteen (18) months after shipment during which time repairs or replacements are to be made without charge. Manufacturer’s warranty shall be in addition to the Contractor’s obligations in Division 1.
   C. Further, provide an additional four (4) year warranty (total of five (5) years) for the dissolved air flotation vessels and their coatings, the flocculators and their coatings and the aeration systems and their coatings.

PART 2 - PRODUCTS

2.1 DISSOLVED AIR FLOTATION EQUIPMENT
   A. Manufacturers:
      1. FRC Systems International, LLC
2. Or Approved Equal
   a. Specifications and equipment arrangements for DAF system are based on FRC Systems International, LLC. Changes to the arrangement indicated in the specifications and in the plan set or any redesign required from the Engineer shall be at the expense of the installing Contractor. No change orders will be issued to the contractor for modifications to the laying length, footprint, concrete layout, electrical, mechanical, etc.

B. General:
   1. The manufacturer shall supply one (1) complete working dissolved air flotation system including all integral piping, wiring, instrumentation, controls and related accessories for the process specified herein and identified in the plans.
   2. Access platform shall be provided by the DAF manufacturer.
   3. Air compressor shall be provided by the Contractor with air quality adequate for the use as required by the DAF manufacturer.

C. Performance and Design Requirements:
   1. The dissolved air flotation (DAF) system shall be a high-rate separator system with plate packs for dissolved air assisted separation of free and/or flocculated solids from the lagoon.
   2. Design requirements:
      a. Maximum flow rate (per unit): 1.5 MGD
      b. Maximum influent TSS concentration: 100 mg/L
      c. Hydraulic loading rate shall not exceed 1 gpm/ft² of effective separation area. The recycle flow rate shall be included in the total flow of 1 gpm/ft².
      d. Effective separation area: ≥ 1550 ft²
      e. Solids loading rate: 5 lb/ft²/hr (max)
      f. Air-to-solids ratio: 6-10 liters air/kg of solids
      g. Recycle flow rate: 160 gpm
   3. The system package shall include the DAF unit, the flocculator, platform, instrumentation, air panels, control system and spare parts with ancillary equipment and features as specified in the following paragraphs.

D. Dissolved Air Flotation Unit
   1. The vessel shall be constructed of 304 stainless steel, with approximate overall dimensions of 21.5 ft long by 8.2 ft wide by 15 ft high. Units having other dimensions will be considered but may not fit within the available space.
   2. Vessel shall be constructed in accordance with the following:
      a. Minimum 78 ft² of free surface area.
      b. Full surface skimming system with stainless steel skimmer blades.
      c. Bottom settled solids removal system with solids conveyor and/or cone with dump valves and air purge valves; no bottom skimmers shall be allowed.
      d. Manually adjustable effluent weirs.
      e. FRP plate pack system
3. An aeration system shall be provided for each DAF system. The aeration system shall recycle water from the effluent compartment of the DAF unit to the inclined air dissolving tube.

4. Furnish with a pneumatic control panel for each DAF unit with pressure switches, air flow solenoid valves and pressure gauges for monitoring and control of air to the system.

5. Provide a single equipment control panel with operator interface terminal (OIT) to allow for local manual or completely automated control of each DAF system.

E. Aeration System

1. Each aeration system shall be a complete functioning system with two (2) ANSI type centrifugal recirculation pumps with flexible-coupled motors, air dissolving mechanism, aeration header, valves and appurtenances. Pumps shall be furnished as one (1) operating and one (1) standby for each aeration system. No narrow tolerance pumps shall be allowed nor aspirating pumps with air dissolving capability. The recirculation pumps shall increase the water pressure to approximately 90 psig.

2. Compressed air shall be introduced into the recycle water stream in the air dissolving tube and the air saturated recycle water shall be distributed to various points within the DAF unit. The air pressure shall be 7-10 psig greater than the pressure of the water in the recycle stream.
   a. Air shall dissolve into the recycle water stream over the entire length of the air dissolving tube.
   b. Air flow meters and adjusting valves shall be provided in the pneumatic panel for each DAF unit to allow for regulation of the air volume metered into the air dissolving tube.
   c. The recycle water, saturated with air, shall be dosed through the aeration header to strategic points within the DAF unit, including the wastewater inlet to the unit and the final bays near the skim ramp. The recycle water dosing system shall be designed to provide sufficient air bubbles to provide buoyancy to the floc and to create an air cushion below the float mat.
   d. Depressurization shall occur through specifically designed inlet devices resulting in fine air bubbles to adhere and carry very small to large particulate contaminants upward to the float mat.
   e. A portion of the pressurized recycle stream, saturated with air shall be dosed to the flocculator to mix air bubbles with the floc before the wastewater enters the flotation unit.

F. Skimming and Grit/Sludge Collection and Removal Systems

1. Each DAF unit shall have a float dewatering/skimming system with adjustable outlet weirs for regulating the solids content of the skimmed material.
   a. The adjustable outlet weirs shall be located downstream of a retention baffle which holds the float mat within the dewatering zone.
   b. A grid thickening system shall be provided above the inclined plate pack to allow for thickening or partial dewatering of the scum mat before it is taken off by the skimmer blades.
   c. A scraper system consisting of skimmer blades on a chain assembly shall be provided to continuously or intermittently remove the thickened float. An adjustable timer shall be provided to allow the float mat to build and thicken or
dewater between scraping cycles if continuous operation does not provide a satisfactory solids concentration.

2. DAF unit shall be provided with a grit collection and removal system. The grit collection and removal system shall be located at the base of the influent compartment.
   a. Heavy sand and sediment (grit) shall settle and conveyed by means of auger (no bottom skimmers allowed).
   b. The grit shall be removed from the sand trough by means of a time controlled and pneumatically operated plug valve.

3. DAF unit shall be provided with a sludge collection and removal system. The sludge collection and removal system shall be located in the bottom trough of the DAF unit.
   a. The sludge shall be removed from the bottom trough by means of a time controlled and pneumatically operated plug valve.

4. Compressed air shall be introduced into the recycle water stream in the air dissolving tube and the air saturated recycle water shall be distributed to various points within the DAF unit. The air pressure shall be 7-10 psig greater than the pressure of the water in the recycle stream.
   a. Air shall dissolve into the recycle water stream over the entire length of the air dissolving tube.
   b. The recycle water, saturated with air, shall be dosed at strategic points within the DAF unit through the aeration header.
   c. Depressurization shall occur through specifically designed inlet devices resulting in fine air bubbles to adhere and carry very small to large particulate contaminants upward to the float mat.
   d. A portion of the pressurized recycle stream, saturated with air shall be dosed to the flocculator to mix air bubbles with the floc before the wastewater enters the flotation unit.

G. Tube Flocculator

1. Construction Materials
   a. Reactor: 304 SS
   b. Support structure: 304 SS

2. Connections
   a. Inlet & outlet shall be 10" flanged.

H. Accessories

1. The DAF system shall include all required accessories necessary for operation including but not limited to the following:
   a. Pneumatic panels, valves and related appurtenances for integral air service
   b. Aeration system plumbing
c. Applicable pressure indicators  
d. Flow indicators  
e. E-stops  
f. Stainless steel cover  

I. Access Platform  

1. Access platform, including handrail and stairs, shall be provided by the manufacturer and be constructed of materials in accordance with Division 5 – Metals.  

2.2 ELECTRICAL  

A. Local Control Panel (LCP4000)  

1. Provide one (1) equipment control panel, for complete for automatic or manual operation of both DAF systems.  
2. Control panel shall be a NEMA 4X stainless steel enclosure complete with the following components:  
   a. Main panel electrical disconnect rated per the NEC.  
   b. Terminal blocks for all field wiring to instrumentation, control devices and pressurization system.  
   c. Wire management system for internal panel wiring.  
   d. Emergency stop push button for shutdown influent feed to DAFs.  
   e. Audible alarm horn (piezo type).  
   f. Control power transformer with 120 VAC transient voltage surge compressor (TVSC), and fused primary and secondary sized to accommodate all 120V loads (including solenoids, E-Stops, etc.), and 120V 12 circuit load center.  
   g. Programmable logic controller to control the flight speed, operational cycle times, equipment control valves, pressurization pumps, chemical feed pumps, etc. PLC shall be a minimum of an Allen Bradley / Rockwell Compactlogix or Controllogix PLC with Ethernet communication ports.  
   h. Provide maximum processor memory available with each PLC.  
   i. Operator Interface Terminal (OIT) in the face of control panel door – Allen Bradley Panelview Plus with Ethernet communication capability (12” screen, 128 MB of memory minimum).  
   j. Provide, as required, control transformer(s), properly sized for the application.  
   k. Refer to Division 26 for additional electrical requirements.  

3. The local electrical control panel OIT shall be set to provide graphical screens depicting the following information, alarms, control functions:  
   a. Main Operations Screen for DAFs:  
      1) Start/stop control of DAFs & Pressurization System  
      2) Adjustment of time cycle for each skimmer and sludge augers  
      3) Chemical feed rate into each DAF  
      4) Run indication status of skimmers, chemical feeds pumps, augers and other ancillary equipment for each DAF  
      5) General system alarm indication for each DAF
4. Alarms Screen:
   1) Alarm and horn acknowledge/reset
   2) Recirculation water pressure low
   3) Low air pressure
   4) Skimmer stopped fault for each
   5) Auger fault for each
   6) Float hopper high level/low level

5. Scope of supply shall include any and all components, accessory devices, valves and controls required for a complete and functional installation.

6. For full requirements on electrical specification, refer to Division 26.

2.3 SURFACE PROTECTION

A. Provide completely corrosion resistant materials of construction (stainless steel, fiberglass, plastic, etc.) and protective coatings and coverings such that shop or field applied paint coating is not required.

B. Provide completely corrosion resistant miscellaneous parts such as brackets, spacers, guards, etc. fabricated from type 304 stainless steel or plastic.

C. Provide items such as motors, gear reducers, pumps, air compressors, etc. with standard manufacturer's finish coatings.

2.4 SPARE PARTS

A. Supply spare parts as recommended by the equipment manufacturer. Include two (2) of each which are recommended to be replaced during the normal annual preventative maintenance routine.

PART 3 - EXECUTION

3.1 GENERAL

A. Contractor shall install the system outlined herein in accordance with the manufacturer’s shop drawings and instructions.

B. The equipment shall be installed properly to provide a complete working system. Installation shall follow the supplier's recommendations.

C. The equipment specified herein shall be completely factory assembled as one unit as far as practical. All mating parts shall be trial fit and match marked. The manufacturer shall submit certification of shop assembly before shipment.
3.2 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that dimensions are correct and project conditions are suitable for installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 FACTORY ACCEPTANCE TEST

A. The factory acceptance test shall include tank and piping leakage tests, motor voltage and routine checks and complete testing of control function.

3.4 INSTALLATION

A. Install the dissolved air flotation system in accordance with the contract drawings, shop drawings and the manufacturers' field service and installation manual.

B. Include the recommended oil and grease for the first twelve (12) months of operation.

C. Nameplates, plant equipment identification and maintenance direction signs must be clearly visible after finish painting. Apply manufacture supplied warning and maintenance instructions in conspicuous locations.

3.5 STARTUP, TESTING, AND TRAINING

A. The services of a factory trained engineer/technician shall be provided to supervise the installation of the equipment, test the equipment, supervise the initial operation of the treatment system, demonstrate the performance of the equipment, and to instruct the Owner’s personnel in the operation of the equipment. Factory services shall include five (5) days on-site during installation and start-up.

B. Prior to plant startup, all installed equipment shall be inspected for proper alignment, proper connection and satisfactory performance.

3.6 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. The equipment manufacturer shall make all initial adjustments to the equipment and shall operate the equipment continuously for seventy-two (72) hours, to demonstrate that the system performs its intended functions.
3.7 OPERATOR TRAINING

A. At least one (1) training session of six (6) hours in length shall be arranged to instruct the Owner’s personnel in the operation and maintenance of the system. Training of the Owner’s personnel shall be done by an experienced factory engineer. Training shall include a hands-on demonstration of all aspects of the operation and a simulation of all control and alarm functions.

END OF SECTION 464363
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APPENDIX A
Evergreen WWTP and Lift Station Upgrades

CONECUH COUNTY, ALABAMA

August 20, 2018

REPORT OF GEOTECHNICAL EXPLORATION

Prepared By

Goodwyn, Mills and Cawood, Inc.
PO Box 242128
Montgomery, AL 36124
T 334.271.3200
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GMC PROJECT NUMBER: GMGM180013
August 20, 2018

Mr. Dustin Till, EI
Goodwyn, Mills & Cawood, Inc.
2660 EastChase Lane
Suite 200
Montgomery, Alabama 36117

RE: REPORT OF GEOTECHNICAL EXPLORATION
EVERGREEN WWTP AND LIFT STATION UPGRADES
CONECUH COUNTY, ALABAMA
GMC PROJECT GMGM180013

Dear Mr. Till:

Goodwyn, Mills and Cawood, Inc. (Geotechnical & Construction Services Division) is pleased to provide this report of geotechnical exploration performed for the above referenced project. This report includes the results of field and laboratory testing, recommendations for foundation design, and general site recommendations.

We appreciate the opportunity to perform this study on this phase of the project for you and look forward to continued participation during the construction phase of this project. If you have any questions pertaining to this report, or if we may be of further service, please do not hesitate to call.

Sincerely,
GOODWYN, MILLS AND CAWOOD, INC.

Jay Shaddix
Staff Geotechnical Professional

Michael J. McNeill, PE
Senior Geotechnical Engineer
Licensed Alabama 26331
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.0 PROJECT INFORMATION AND SCOPE OF WORK</strong></td>
<td>1</td>
</tr>
<tr>
<td>1.1 Project Information</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Scope of Work</td>
<td>1</td>
</tr>
<tr>
<td><strong>2.0 FIELD EXPLORATION AND LABORATORY TESTING</strong></td>
<td>1</td>
</tr>
<tr>
<td>2.1 Field Exploration</td>
<td>1</td>
</tr>
<tr>
<td>2.2 Laboratory Testing</td>
<td>1</td>
</tr>
<tr>
<td><strong>3.0 SITE AND SUBSURFACE CONDITIONS</strong></td>
<td>2</td>
</tr>
<tr>
<td>3.1 General</td>
<td>2</td>
</tr>
<tr>
<td>3.2 Site Geology</td>
<td>2</td>
</tr>
<tr>
<td>3.3 Subsurface Conditions</td>
<td>2</td>
</tr>
<tr>
<td>3.4 Groundwater Information</td>
<td>3</td>
</tr>
<tr>
<td><strong>4.0 SITEWORK RECOMMENDATIONS</strong></td>
<td>3</td>
</tr>
<tr>
<td>4.1 Sitework</td>
<td>3</td>
</tr>
<tr>
<td>4.2 Time of Year Site Preparation Considerations</td>
<td>4</td>
</tr>
<tr>
<td>4.3 Fill Placement</td>
<td>5</td>
</tr>
<tr>
<td>4.4 Backfilling of Utility Trenches</td>
<td>6</td>
</tr>
<tr>
<td>4.5 Subgrade Restoration</td>
<td>6</td>
</tr>
<tr>
<td>4.6 Drainage Considerations</td>
<td>6</td>
</tr>
<tr>
<td><strong>5.0 STRUCTURAL RECOMMENDATIONS</strong></td>
<td>7</td>
</tr>
<tr>
<td>5.1 Foundations</td>
<td>7</td>
</tr>
<tr>
<td>5.2 Floor Slabs</td>
<td>8</td>
</tr>
<tr>
<td>5.3 Below Grade Walls</td>
<td>8</td>
</tr>
<tr>
<td><strong>6.0 REPORT LIMITATIONS</strong></td>
<td>10</td>
</tr>
<tr>
<td>APPENDIX:</td>
<td></td>
</tr>
<tr>
<td>Boring Location Plan</td>
<td></td>
</tr>
<tr>
<td>Soil Classification Chart</td>
<td></td>
</tr>
<tr>
<td>Subsurface Diagram</td>
<td></td>
</tr>
<tr>
<td>Boring Records</td>
<td></td>
</tr>
<tr>
<td>Summary of Laboratory Results</td>
<td></td>
</tr>
<tr>
<td>Field and Laboratory Procedures</td>
<td></td>
</tr>
</tbody>
</table>
1.0 PROJECT INFORMATION AND SCOPE OF WORK

1.1 Project Information

A geotechnical exploration and evaluation has been conducted for the proposed Evergreen WWTP and lift station upgrades at the existing wastewater treatment plant in Evergreen, Alabama. The proposed construction will consist of an influent lift station approximately 25 feet below existing grade and a slab on grade DAF building. No structural loads have been provided at the time of this report.

1.2 Scope of Work

The purpose of this exploration was to perform a general evaluation of the subsurface soil conditions at the site and to provide general sitework recommendations, and foundation recommendations. The scope of the exploration and evaluation included, field and laboratory testing, and an engineering evaluation of the materials encountered.

The scope of services for the geotechnical study did not include any environmental assessment for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below or around this site. Any statements in this report or on the boring records regarding odors, colors, or unusual or suspicious items or conditions are strictly for the information of the client.

2.0 FIELD EXPLORATION AND LABORATORY TESTING

2.1 Field Exploration

The site subsurface conditions were explored by drilling four (4) soil borings at the approximate locations shown on the attached Boring Location Plan. Borings B-1 and B-2 were drilled in the approximate location of the DAF building and borings B-3 and B-4 were drilled in the proposed lift station area. The boring locations and depths were selected by GMC personnel. Field-testing employed by GMC was performed in general accordance with ASTM standards or generally accepted methods. The borings were located in the field by GMC personnel. Ground surface elevations were estimated from the grading plan provided.

The borings were performed using a truck mounted drill rig equipped with a rotary head and solid flight augers (SFA). Soils were sampled using a two-inch OD split barrel sampler in accordance with ASTM D1586 driven with a manual hammer.

2.2 Laboratory Testing

The laboratory-testing program included visual classification of all soil samples and laboratory tests consisting of natural moisture contents, grain size analysis, and Atterberg limits tests were performed on selected samples. The laboratory testing program was conducted in general
accordance with applicable ASTM standards and the results are indicated on the Boring Records and summarized in the Appendix.

3.0 SITE AND SUBSURFACE CONDITIONS

3.1 General

At the time of this study, the proposed site was relatively flat at the boring locations. The proposed structures will be constructed adjacent to the existing ponds. We have been provided the proposed finished floor elevation of 204 feet for the DAF building. The top of the pump station will be at approximate elevation 212 feet with the planned bottom elevation of 188 feet.

3.2 Site Geology

Published geologic information indicates the site is underlain by alluvial, coastal and low terrace deposits and the Jackson group undifferentiated.

Alluvial deposits consist of interbedded sands, clays, and quartz gravels. These soils consist of fine to course quartz sand with clay lenses and varying amounts of shell fragments. Gravel composed of quartz and chert pebbles and assorted metamorphic and igneous rock fragments in streams near the Piedmont.

The Jackson formation consists of white to yellowish-gray fossiliferous soft, chalky and coquinnoid limestone; glauconitic, fossiliferous sand; greenish-gray calcareous clay; and glauconitic, fossiliferous, sandy limestone. Exposures are confined to stream valleys and a few quarries. Weathered equivalents in upland areas are included in the residuum.

3.3 Subsurface Conditions

The site was explored by drilling four (4) soil test borings. Borings B-01 and B-02 were drilled in the proposed DAF building area while borings B-03 and B-04 were drilled in the proposed lift station area.

**DAF Building**

Boring B-01 was drilled to 20.5 feet and B-02 to 15.5 feet below existing grade. These boring generally encountered loose to very dense clayey sands (SC) and silty sands (SM), soft to stiff sandy lean clay (CL), and loose poorly graded sand with clay (SP-SC). The Standard Penetration Test (SPT) N-values ranged from 3 to over 100 blows per foot (bpf).

**Lift Station**

Borings B-03 and B-04 were drilled to approximately 30.5 feet below existing grade. These boring generally encountered medium to stiff sandy lean clay (CL) and soft to medium silt (ML) with sand to depths of 4 to 6 feet. SPT N-values ranged from 4 to 9 bpf. Very loose to medium silty sands (SM) were then encountered to about 21 to 22.5 feet below the existing ground surface. SPT N-
values ranged from 3 to over 100 bpf. Very stiff to hard sandy fat clay (CH) was encountered from about 21 to 22.5 feet to the boring termination depth of 30.5 feet below the existing ground surface with SPT N-values between 23 and 54 bpf.

The subsurface descriptions contained herein are of a generalized nature to highlight the major soil stratification features and soil characteristics. The boring records included in the Appendix should be reviewed for specific information as to individual boring locations. The stratification shown on the boring records represents conditions only at the actual boring locations. Variations may occur and should be expected between boring locations. The stratifications represent the approximate boundary between subsurface materials, and the transition may be gradual.

3.4 Groundwater Information

Groundwater was encountered in all borings at depths ranging from 5.0 to 6.5 feet, below the existing grade, at the time of our field exploration. The borings were backfilled prior to leaving the site and therefore no long term groundwater readings were taken. Groundwater may not have had time to sufficiently stabilize due to the brevity of the fieldwork. In addition, groundwater levels may vary due to seasonal conditions and recent rainfall.

4.0 SITENAMEWORK RECOMMENDATIONS

4.1 Sitework

Stripping
Site preparation should begin with the stripping and removal of unsuitable materials from the site. This will include, but not limited to surface vegetation and organic laden material.

Proofrolling
Once the fill areas are at grade and prior to the placement of any new fill, the areas should be proofrolled with repeated passes of a loaded tandem axle dump truck to locate deeper soft soils. Soils that are observed to rut or deflect excessively under the moving load should be undercut and replaced with properly compacted fill. The proofrolling, undercutting, and filling activities should be witnessed by a qualified representative of the geotechnical engineer and should be performed during a period of dry weather.

Medium sands and stiff clays were encountered at the planned subgrade elevation, however softer/loose soils were encountered below 5 feet, or elevation 197 feet. This corresponds to the measured groundwater levels and is not uncommon to see lower consistency soils near this level.

Typically, due to the movement of heavy equipment and weather conditions, the subgrade becomes disturbed during construction. As a result, fine grained (clayey and silty) soils have a tendency to lose shear strength and support capability. Therefore, additional effort on the Contractor’s part will be required to reduce traffic and limit disturbance of soils. It is essential that the subgrade be restored to a properly compacted condition based on optimum moisture
and density requirements. Restoration of the subgrade should be addressed in the project specifications.

High groundwater was encountered in the borings at the time of the investigation. Excavations beyond 5 feet below the existing grade should have a plan to dewater the excavation. A dewatering plan should be developed by the contractor for excavations extending below the anticipated groundwater levels. The dewatering plan should be provided to the engineer for review.

4.2 Time of Year Site Preparation Considerations

Surface drainage in areas underlain by the clay soils tends to be poor. During periods of heavy rain, the near surface soils can become saturated and swammy conditions can occur. The time of the year that the sitework begins can affect the project considerably. In this area, the “wet” season is generally between the months of November and April, and the “dry” season from May to October. There are many considerations that need to be addressed prior to bidding a project that could affect the budget based on the time of year a project starts earthwork activities. The time of the year that the geotechnical borings were performed can provide a false sense of actual near surface conditions depending on the time of year and weather conditions. Below are considerations that should be addressed based on the time of the year earthwork is started.

“Wet” Season
During the wet season, the amount of undercutting may be greater, therefore resulting in greater excavation costs. The soils are typically proofrolled to determine their suitability for the placement of new fill or subgrade support. During the wet season, the surface soils have a higher moisture content and will tend to pump, therefore, hindering the placement of new fill. In addition, the drying time, time period between rain events, and temperature is not conducive to scarify soils, allow to dry, and recompact. At this time, the decision should be made by the owner to try either scarify/dry/compact the in-place soils, which could take time, or undercut and replace with suitable material, which could increase the sitework costs. Based on our experience, the amount of undercut could be an additional 1 to 2 feet (or greater in localized areas), whereas in drier weather, lesser amounts of undercutting may be necessary, if recompaction or stabilization of soils left in place can be achieved.

Some undercut soils are not always “unsuitable” soil and can be moisture conditioned and reused as fill in the deep areas, if drying conditions are favorable.

“Dry” Season
During the dry season, the surface soils have a lower moisture content and will tend to “bridge” or “crust” softer underlying soils. They will generally allow the placement of new fill, but the crust can break down if repeated passes with heavily loaded equipment is persistent. In addition, new fill from cuts or other sources may need to be moisture conditioned prior to compaction. The soils can dry significantly, requiring the addition of water for proper compaction. Water trucks
should be used, as necessary, by the contractor to condition the soils within the required specifications.

Contractor Responsibility
The grading contractors have the option of performing their own evaluation of the site conditions to assess the excavation considerations based on the time of year a project is bid. We strongly suggest that the grading contractors conduct their own exploration and evaluation of the site conditions and material management requirements to cost effectively develop the site.

Typically, due to the movement of heavy equipment and weather conditions, the subgrade becomes disturbed during construction. As a result, fine grained clayey soils have a tendency to lose shear strength and support capability. Therefore, additional effort on the Contractor’s part will be required to reduce traffic and limit disturbance of soils. It is essential that the subgrade be restored to a properly compacted condition based on optimum moisture and density requirements. Restoration of the subgrade should be addressed in the project specifications.

4.3 Fill Placement

Soil Fill Material
Soil fill material in the building area should be placed in loose lifts not exceeding 8-inches in thickness with a maximum particle size of 3 inches. Fill material in confined areas (compacted utilizing walk-behind equipment) should be placed in 4-inch loose layers.

The following table summarizes the compacted fill requirements:

<table>
<thead>
<tr>
<th>Location</th>
<th>Test Method</th>
<th>Compaction Required (minimum)</th>
<th>Moisture Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Area and 5’ beyond perimeter</td>
<td>ASTM D698 (standard)</td>
<td>98 %</td>
<td>-/+3 percentage points of optimum moisture</td>
</tr>
</tbody>
</table>

Off-site low-plasticity fill material should meet the following characteristics:

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic Material</td>
<td>≤ 5%</td>
</tr>
<tr>
<td>Liquid Limit</td>
<td>≤ 50%</td>
</tr>
<tr>
<td>Plasticity Index</td>
<td>≤ 25%</td>
</tr>
<tr>
<td>Maximum Dry Density</td>
<td>≥ 95 lb/ft³</td>
</tr>
<tr>
<td>Maximum Particle Size</td>
<td>3 inches or less</td>
</tr>
</tbody>
</table>
document compaction and moisture content of any earthwork involving soils and other applicable materials.

4.4 Backfilling of Utility Trenches

Backfilling of storm drain and utility trenches must be performed in a controlled manner to reduce settlement of the fill and cracking of overlying floor slabs and pavements. We recommend that utility trenches be backfilled with acceptable borrow or dense-graded crushed stone in 6-inch loose lifts compacted with mechanical piston tampers to the project requirements. Should seepage occur in utility trenches, it may be necessary to “floor” the trench with dense-graded gravel to provide a working surface. If crushed stone is used to backfill utility trenches, we recommend that dense graded aggregate (DGA, compacted in lifts) be used. Open-graded crushed stone, such as ALDOT #57, can serve as a channel for seepage toward structures and therefore is not recommended for use as utility trench backfill.

4.5 Subgrade Restoration

Typically, due to the movement of heavy equipment and weather conditions, the subgrade soil becomes disturbed during construction. As a result, these soils have a tendency to lose shear strength and support capability. Therefore, additional effort on the contractor’s part will be required to reduce traffic and limit disturbance of soils. It is essential that the subgrade be restored to a properly compacted condition based on optimum moisture and density.

4.6 Drainage Considerations

Adequate drainage should be provided at the site to control the moisture content of the foundation soils. We recommend that the parking lots, walkways, and the ground surface be sloped away from the structure on all sides. Roof drainage should be collected by gutters and downspouts and transmitted by pipe to the storm water drainage system or discharge a minimum of 5 feet away from the building. Throughout the construction process, the subgrade soils adjacent to the structures should have adequate drainage to reduce saturation of the foundation soils.

If water inflow occurs during construction of the below grade structures, the water level should be controlled by pumping from a sump located in the corner of the excavation.
5.0 STRUCTURAL RECOMMENDATIONS

5.1 Foundations

The foundations for the structures should be designed and founded per the following table:

<table>
<thead>
<tr>
<th>Boring Number</th>
<th>Structure</th>
<th>Recommended Foundation Bearing Depth (from existing grade)</th>
<th>Allowable Bearing Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-01 &amp; B-02</td>
<td>DAF Building</td>
<td>-1.5 feet</td>
<td>2,500 psf</td>
</tr>
<tr>
<td>B-03 &amp; B-04</td>
<td>Lift Station</td>
<td>-25 feet</td>
<td>3,000 psf</td>
</tr>
</tbody>
</table>

Sandy fat clay (CH) was encountered, in borings B-03 and B-04, at the approximate foundation bearing depth of 25 feet below ground surface. This material should be maintained at or above the optimum moisture content during construction and shall not be allowed to dry out.

Total settlements of foundations are expected to be less than 1-inch, with differential settlements of approximately ½-inch. Even though computed footing dimensions may be less, footings should have a minimum width of 24 inches which allows for hand cleaning of materials disturbed during the excavation process and reduces the potential for punching shear failure. Exterior foundations should bear a minimum of at least 18 inches below adjacent exterior grade.

The geotechnical engineer or his representative should observe all foundation excavations. The engineer can provide geotechnical guidance to the owner's design team should any unforeseen foundation problems develop during construction. If any areas of foundation surfaces prove to be unsuitable, the foundation excavation should be over-excavated. The over-excavated area can be backfilled with "lean" concrete or controlled low strength material (CLSM) up to the planned foundation bearing depth.

Foundation concrete should be placed the same day as soon as possible so that the foundation bearing soils can remain near the existing moisture content. Foundation bearing surfaces should not be disturbed or left exposed during inclement weather. Saturation of the on-site soils can cause a loss of strength and increased compressibility. Excavations for footings should be hand cleaned to remove any loose soil or mud from the foundation bearing surface. If construction occurs during inclement weather and concreting is not possible immediately after excavation, we recommend that a thin layer (approximately 2 inches) of lean concrete or flowable fill be placed on the bearing surface for protection after we have observed and evaluated the exposed bearing surfaces. Exposed bearing soils should be compacted prior to placement of reinforcing.
5.2 Floor Slabs

It is our opinion that the floor slab for the DAF building can be built on-grade achieving support from properly compacted fills or stiff naturally occurring soil.

Ground supported slabs should be founded on a minimum of 4 inches of compacted, granular material such as ALDOT 825B dense graded aggregate. Granular material should be compacted to at least 95% of the standard Proctor density (ASTM D-698). This layer should provide uniform and immediate support for the slab and act as a capillary break. If an open graded stone such as ALDOT No. 57 stone is used, the compaction requirements should be waived. A vapor retarder should be used on top of the granular layer, as required by the building use.

Care should be taken so that fines from the subgrade are not allowed to contaminate the granular layer. If fines do contaminate this layer, capillary rise and subsequent damage to moisture sensitive floor coverings could occur. On most projects, there is some time lag between initial grading and the time when the contractor is ready to place concrete for the slab-on-grade. Inclement weather just prior to placement of concrete for the slab-on-grade can result in trapped water in the granular layer.

5.3 Below Grade Walls

Below grade walls for the lift station must be designed to resist the lateral earth pressures that will be induced by the weight of the backfill materials, hydrostatic pressures on the walls and any adjacent slab or foundation surcharge loads exerted on the walls. It is recommended that the walls be supported as outlined above and backfilled with a free draining material such as crushed stone/gravel or clean sand (less than 10% passing a No. 200 sieve). A drainage system should be provided near or at the base of the walls to collect and remove groundwater or seepage and to prevent buildup of hydrostatic pressures. Based on the existing grades, it is anticipated that the pump station will have groundwater elevations at or near 206 feet. Unless a redundant dewatering system is utilized for the backfill against the pump station walls, we recommend designing the pump station to withstand groundwater elevations up to 208 feet. The below grade structures should be designed to resist hydrostatic pressures up to the planned high-water levels.

Walls that support buildings or otherwise need to have little horizontal movement at the top should be designed for "at rest" earth pressure conditions. Walls that are free to deflect should be designed for "active" earth pressure conditions. The "passive" earth pressure state should be used for soils supporting the retaining structure, such as toe backfill. Fine-grained materials should not be used as backfill immediately behind walls. Relatively free-draining crushed stone/gravel or sand should be used as backfill.
The table below presents recommended values of earth pressure coefficients for the select backfill materials:

<table>
<thead>
<tr>
<th>Soil Parameter</th>
<th>Backfill Type</th>
<th>SP, SW</th>
<th>GW, GP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Unit Weight (pcf)</td>
<td></td>
<td>125</td>
<td>105</td>
</tr>
<tr>
<td>Buoyant unit Weight (pcf)</td>
<td></td>
<td>63</td>
<td>43</td>
</tr>
<tr>
<td>Angle of Internal Friction, $\Phi$, deg</td>
<td></td>
<td>34</td>
<td>38</td>
</tr>
<tr>
<td>At rest Pressure Coefficient, $K_o$</td>
<td></td>
<td>0.44</td>
<td>0.38</td>
</tr>
<tr>
<td>Active Pressure Coefficient, $K_a$</td>
<td></td>
<td>0.28</td>
<td>0.24</td>
</tr>
<tr>
<td>Passive Pressure Coefficient, $K_p$</td>
<td></td>
<td>3.54</td>
<td>4.20</td>
</tr>
<tr>
<td>At-rest Equivalent Fluid Pressure, pcf (Above GWT, below GWT)</td>
<td></td>
<td>55</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>90</td>
<td>79</td>
</tr>
<tr>
<td>Active Equivalent Fluid Pressure, pcf (Above GWT, below GWT)</td>
<td></td>
<td>35</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>80</td>
<td>72</td>
</tr>
<tr>
<td>Passive Equivalent Fluid Pressure, pcf (Above GWT, below GWT)</td>
<td></td>
<td>442</td>
<td>441</td>
</tr>
<tr>
<td></td>
<td></td>
<td>285</td>
<td>243</td>
</tr>
</tbody>
</table>

Based on the soils tested and encountered at this site, the on-site soils should not be used as backfill within this zone. Samples of all backfill material should be evaluated for use as backfill. The design values and recommendations presented above assume that the backfill behind the wall will be horizontal with no surcharge loads and that a permanent drainage system will be installed behind the retaining wall to prevent the development of hydrostatic pressures. The noted backfill should extend from the wall and upward from the top of the footing on a line 30 degrees from the vertical.

Using a select material can significantly reduce the horizontal loads on the wall as well as improve the effectiveness of the wall drainage system. Compaction of backfill behind walls should be performed by appropriate manual equipment. The wall should be properly braced and heavy equipment should not be allowed behind the wall. No equipment or construction loads should be allowed within 10 feet of the walls or half the distance of the freestanding wall-height. This will help prevent any surcharge loads from adding lateral earth pressures above that previously recommended to the wall.

Below grade walls should be braced during any backfilling operations and monitored for movement. If the footings construction precedes the subgrade preparation, then the footings should either be embedded below the subgrade a sufficient distance to achieve the required horizontal component or the footing should include a shear key to prevent movement.
6.0 REPORT LIMITATIONS

The recommendations submitted are based on the available soil information obtained by GMC and design details furnished by GMC for the proposed project. If there are any revisions to the plans for this project or if deviations from the subsurface conditions noted in this report are encountered during construction, we should be notified immediately to determine if changes in the foundation, or other, recommendations are required. If GMC is not retained to perform these functions, GMC cannot be responsible for the impact of those conditions on the performance of the project.

The geotechnical engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

After the plans and specifications are more complete, the geotechnical engineer should be provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated into the design documents. At that time, it may be necessary to submit supplementary recommendations.

We emphasize that this report was prepared for design and informational purposes only and may not be sufficient to prepare an accurate construction budget. Contractors reviewing this report should acknowledge that the recommendations contained herein are for design and informational purposes only. A more comprehensive exploration and testing program would be required to assist the contractor in preparing the final building pad preparation, grading, and foundation construction budgets. In no case should this report be utilized as a substitute for development of specific earthwork specifications.

The information contained in this report is not intended, nor is sufficient, to aid in the design of segmental or mechanically stabilized earth (MSE) retaining walls. Segmental or MSE wall designers and builders should not rely on this report and should perform independent analysis to determine all necessary soil characteristics for use in their wall design, including but not limited to, soil shear strengths, bearing capacities, global stability, etc.
APPENDIX

Boring Location Plan
Soil Classification Chart
Subsurface Diagram
Boring Records
Summary of Laboratory Results
Field and Laboratory Procedures
Approximate Boring Location

GMC drawing adapted from Google Earth
### Soil Classification Chart

<table>
<thead>
<tr>
<th>Major Divisions</th>
<th>Symbols</th>
<th>Typical Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coarse Grained Soils</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gravel and Gravelly Soils</td>
<td>GW</td>
<td>Well-graded gravels, gravel - sand mixtures, little or no fines</td>
</tr>
<tr>
<td></td>
<td>GP</td>
<td>Poorly-graded gravels, gravel - sand mixtures, little or no fines</td>
</tr>
<tr>
<td></td>
<td>GM</td>
<td>Silty gravels, gravel - sand - silt mixtures</td>
</tr>
<tr>
<td></td>
<td>GC</td>
<td>Clayey gravels, gravel - sand - clay mixtures</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 50% of material is larger</td>
<td>SW</td>
<td>Well-graded sands, gravelly sands, little or no fines</td>
</tr>
<tr>
<td>than no. 200 sieve size</td>
<td>SP</td>
<td>Poorly-graded sands, gravelly sand, little or no fines</td>
</tr>
<tr>
<td></td>
<td>SM</td>
<td>Silty sands, sand - silt mixtures</td>
</tr>
<tr>
<td></td>
<td>SC</td>
<td>Clayey sands, sand - clay mixtures</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fine Grained Soils</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silts and Clays</td>
<td>ML</td>
<td>Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey</td>
</tr>
<tr>
<td></td>
<td>CL</td>
<td>Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty</td>
</tr>
<tr>
<td></td>
<td>OL</td>
<td>Organic silts and organic clay clays of low plasticity</td>
</tr>
<tr>
<td></td>
<td>MH</td>
<td>Inorganic silts, micaceous or diatomaceous fine sand or silty soild</td>
</tr>
<tr>
<td></td>
<td>CH</td>
<td>Inorganic clays of high plasticity</td>
</tr>
<tr>
<td></td>
<td>OH</td>
<td>Organic clays of medium to high plasticity, organic silts</td>
</tr>
<tr>
<td></td>
<td>PT</td>
<td>Peat, humus, swamp soils with high organic contents</td>
</tr>
</tbody>
</table>

**Note:** Dual symbols are used to indicate borderline soil classifications.
<table>
<thead>
<tr>
<th>ELEVATION (ft)</th>
<th>DEPTH (ft)</th>
<th>GRAPHIC LOG</th>
<th>MATERIAL DESCRIPTION</th>
<th>SAMPLE TYPE</th>
<th>RECOVERY % (RQD)</th>
<th>BLOW COUNTS (N VALUE)</th>
<th>POCKET PEN. (tsf)</th>
<th>DRY UNIT WT. (pcf)</th>
<th>MOISTURE CONTENT (%)</th>
<th>LIQUID LIMIT</th>
<th>PLASTIC LIMIT</th>
<th>PLASTICITY INDEX (%)</th>
<th>PLASTICITY INDEX</th>
<th>ATTERBERG LIMITS</th>
<th>FINES CONTENT (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td></td>
<td>SILTY SAND (SM), grayish-brown, medium, fine, with orangics</td>
<td>SS</td>
<td>4-10-17 (27)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td></td>
<td>SILTY SAND (SM), brown, medium, fine, with orangics</td>
<td>SS</td>
<td>7-14-15 (29)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td></td>
<td>SILTY SAND (SM), dark gray, medium, fine, with organics</td>
<td>SS</td>
<td>10-9-10 (19)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td></td>
<td>POORLY GRADED SAND with CLAY (SP-SC), brown, loose, fine, wet</td>
<td>SS</td>
<td>2-2-6 (8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td></td>
<td>CLAYEY SAND (SC), gray, brown, very loose, moist, fine, with mica</td>
<td>SS</td>
<td>1-2-1 (3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>20</td>
<td></td>
<td>CLAYEY SAND (SC), brown, loose, moist, fine, with mica</td>
<td>SS</td>
<td>2-2-6 (8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>20</td>
<td></td>
<td>CLAYEY SAND (SC), gray, very dense, coarse to fine, with mica</td>
<td>SS</td>
<td>50/2&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Boring was terminated at 20.5 feet.
<table>
<thead>
<tr>
<th>ELEVATION (ft)</th>
<th>DEPTH (ft)</th>
<th>MATERIAL DESCRIPTION</th>
<th>SAMPLE TYPE</th>
<th>RECOVERY (RQD)</th>
<th>BLOW COUNTS (N VALUE)</th>
<th>POCKET PEN. (tsf)</th>
<th>DRY UNIT WT. (pcf)</th>
<th>MOISTURE CONTENT (%)</th>
<th>LIQUID LIMIT</th>
<th>PLASTIC LIMIT</th>
<th>PLASTICITY INDEX</th>
<th>ATTERBERG LIMITS</th>
<th>FINES CONTENT (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>SANDY LEAN CLAY (CL), light brownish-gray, stiff</td>
<td>SS</td>
<td></td>
<td>6-5-7 (12)</td>
<td>2.75</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>200</td>
<td></td>
<td>SILTY SAND (SM), light brownish-gray, medium, fine</td>
<td>SS</td>
<td></td>
<td>6-7-5 (12)</td>
<td></td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>SILTY SAND (SM), brown, loose, fine, wet, with organics</td>
<td>SS</td>
<td></td>
<td>1-2-4 (6)</td>
<td></td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>195</td>
<td></td>
<td>SILTY SAND (SM), dark gray, loose, fine, with organics</td>
<td>SS</td>
<td></td>
<td>6-6-5 (11)</td>
<td>2</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>SANDY LEAN CLAY (CL), grayish-brown, soft</td>
<td>SS</td>
<td></td>
<td>3-3-1 (4)</td>
<td>1</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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Boring was terminated at 15.5 feet.
### General Information
- **Client:** City of Evergreen
- **Project Name:** Evergreen 2017 WWTP & Pump Station Upgrades SRF
- **Project Number:** GMGM180013
- **Project Location:** Evergreen, Alabama
- **Date Started:** 7/11/18
- **Completed:** 7/11/18
- **Ground Elevation:** 210 ft
- **Hole Size:** 4"
- **Drilling Contractor:** Environmental Resource Group
- **Drilling Method:** Diedrich D-50, Manual-Hammer, SFA w/ SPT
- **Logged By:** J. Shaddix
- **Checked By:** M. McNeill
- **Date Started:** 7/11/18
- **Completed:** 7/11/18

### Drilling Logs

<table>
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<tr>
<th>Elevation (ft)</th>
<th>Depth (ft)</th>
<th>Graphic Log</th>
<th>Material Description</th>
<th>Sample Type</th>
<th>Recovery % (RQD)</th>
<th>Blow Counts (N Value)</th>
<th>Pocket Pen. (tsf)</th>
<th>Dry Unit WT. (pcf)</th>
<th>Moisture Content (%)</th>
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<td>190</td>
<td>20</td>
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<td>1-1-2 (3)</td>
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<td>45 55 15 40 52</td>
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### Ground Water Levels
- **At Time of Drilling:** 5.50 ft / Elev 204.50 ft
- **At End of Drilling:** ---
- **After Drilling:** ---

### Notes
- **Ground Elevation:** 210 ft
- **Logged By:** J. Shaddix
- **Checked By:** M. McNeill
SILT WITH SAND (ML), mottled gray, yellow, red, medium to soft, with mica

SILT WITH SAND (ML), brown, gray, soft, moist, with mica

SILTY SAND (SM), brown, very loose, wet, fine, with mica

SILTY SAND (SM), brown, loose, moist, fine, with mica

SILTY SAND (SM), gray, medium, fine, with mica

- no sample return

SANDY FAT CLAY (CH), gray, very stiff to hard, with mica

Boring was terminated at 30.5 feet.
### SUMMARY OF LABORATORY RESULTS

**CLIENT** City of Evergreen  
**PROJECT NUMBER** GMGM180013  
**PROJECT NAME** Evergreen 2017 WWTP & Pump Station Upgrades SRF  
**PROJECT LOCATION** Evergreen, Alabama

<table>
<thead>
<tr>
<th>Borehole</th>
<th>Depth</th>
<th>Liquid Limit</th>
<th>Plastic Limit</th>
<th>Plasticity Index</th>
<th>Max. Sieve Size Tested (mm)</th>
<th>%&lt;#200 Sieve</th>
<th>Natural Moisture (%)</th>
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<th>Opt. Moisture Content (%)</th>
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### Specimen Identification

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### Project Information

**CLIENT** City of Evergreen

**PROJECT NUMBER** GMGM180013

**PROJECT NAME** Evergreen 2017 WWTP & Pump Station Upgrades SRF

**PROJECT LOCATION** Evergreen, Alabama
FIELD TEST PROCEDURES

General
The general field procedures employed by Goodwyn, Mills and Cawood, Inc. (GM&C), are summarized in the American Society for Testing and Materials (ASTM) Standard D420, which is entitled "Investigating and Sampling Soil and Rock". This recommended practice lists recognized methods for determining soil and rock distribution and groundwater conditions. These methods include geophysical and in-situ methods as well as borings.

The detailed collection methods used during this exploration are presented in the following paragraphs.

Standard Drilling Techniques

General: To obtain subsurface samples, borings are drilled using one of several alternate techniques depending upon the subsurface conditions. These techniques are:

- **In Soils:**
  a) Continuous hollow stem augers.
  b) Rotary borings using roller cone bits or drag bits, and water or drilling mud to flush the hole.
  c) "Hand" augers.

- **In Rock:**
  a) Core drilling with diamond-faced, double or triple tube core barrels.
  b) Core boring with roller cone bits.

Hollow Stem Auger: A hollow stem auger consists of a hollow steel tube with a continuous exterior spiral flange termed a flight. The auger is turned into the ground, returning the cuttings along the flights. The hollow center permits a variety of sampling and testing tools to be used without removing the auger.

Rotary Borings: Rotary drilling involves the use of roller cone or drag type drill bits attached to the end of drill rods. A flushing medium, normally water or bentonite slurry, is pumped through the rods to clear the cuttings from the bit face and flush them to the surface. Casing is sometimes set behind the advancing bit to prevent the hole from collapsing and to restrict the penetration of the drilling fluid into the surrounding soils. Cuttings returned to the surface by the drilling fluid are typically collected in a settling tank, to allow the fluid to be recirculated.

Hand Auger Boring: Hand auger borings are advanced by manually twisting a 4” diameter steel bucket auger into the ground and withdrawing it when filled to observe the sample collected. Post hole diggers are sometimes used in lieu of augers to obtain shallow soil samples. Occasionally these hand auger borings are used for driving 3 inch diameter steel tubes to obtain intact soil samples.
Core Drilling: Soil drilling methods are not normally capable of penetrating through hard cemented soil, weathered rock, coarse gravel or boulders, thin rock seams, or the upper surface of sound, continuous rock. Material that cannot be penetrated by auger or rotary soil-drilling methods at a reasonable rate is designated as “refusal material”. Core drilling procedures are required to penetrate and sample refusal materials.

Prior to coring, casing may be set in the drilled hole through the overburden soils, to keep the hole from caving and to prevent excessive water loss. The refusal materials are then cored according to ASTM D2113 using a diamond studded bit fastened to the end of a hollow, double or triple tube core barrel. This device is rotated at high speeds, and the cuttings are brought to the surface by circulating water. Core samples of the material penetrated are protected and retained in the swivel-mounted inner tube. Upon completion of each drill run, the core barrel is brought to the surface, the core recovery is measured, and the core is placed, in sequence, in boxes for storage and transported to our laboratory.

Sampling and Testing in Boreholes

General: Several techniques are used to obtain samples and data in soils; however the most common methods in this area are:

a) Standard Penetrating Testing
b) Water Level Readings

These procedures are presented below. Any additional testing techniques employed during this exploration are contained in other sections of the Appendix.

Standard Penetration Testing: At regular intervals, the drilling tools are removed and soil samples obtained with a standard 2 inch diameter split tube sampler connected to an A or N-size rod. The sampler is first seated 6 inches to penetrate any loose cuttings, and then driven an additional 12 inches with blows of a 140 pound safety hammer falling 30 inches. Generally, the number of hammer blows required to drive the sampler the final 12 inches is designated the “penetration resistance” or “N” value, in blows per foot (bpf). The split barrel sampler is designed to retain the soil penetrated, so that it may be returned to the surface for observation. Representative portions of the soil samples obtained from each split barrel sample are placed in jars, sealed and transported to our laboratory.

The standard penetration test, when properly evaluated, provides an indication of the soil strength and compressibility. The tests are conducted according to ASTM Standard D1586. The depths and N-values of standard penetration tests are shown on the Boring Records. Split barrel samples are suitable for visual observation and classification tests but are not sufficiently intact for quantitative laboratory testing.

Water Level Readings: Water table readings are normally taken in the borings and are recorded on the Boring Records. In sandy soils, these readings indicate the approximate location of the hydrostatic water table at the time of our field exploration. In clayey soils, the rate of water seepage into the borings is low and it is generally not possible to establish the location of the hydrostatic water table through short term water level readings. Also, fluctuation in the water table should be expected with variations in precipitation, surface run-off, evaporation, and other factors. For long-term monitoring of water levels, it is necessary to install piezometers.
The water levels reported on the Boring Records are determined by field crews immediately after the drilling tools are removed, and several hours after the borings are completed, if possible. The time lag is intended to permit stabilization of the groundwater table which may have been disrupted by the drilling operation.

Occasionally the borings will cave-in, preventing water level readings from being obtained or trapping drilling water above the cave-in zone. The cave-in depth is measured and recorded on the Boring Records.

**Boring Records**

The subsurface conditions encountered during drilling are reported on a field boring record prepared by the Driller. The record contains information concerning the boring method, samples attempted and recovered, indications of the presence of coarse gravel, cobbles, etc., and observations of ground water. It also contains the driller’s interpretation of the soil conditions between samples. Therefore, these boring records contain both factual and interpretive information. The field boring records are kept on file in our office.

After the drilling is completed, a geotechnical professional classifies the soil samples and prepares the final Boring Records which are the basis for all evaluations and recommendations. The following terms are taken from ASTM D2487 or Deere’s Technical Description of Rock Cores for Engineering Purposes, *Rock Mechanical Engineering Geology* 1, pp. 18-22.
## Relative Density of Cohesionless Soils From Standard Penetration Test

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<th>Consistency of Cohesive Soils</th>
<th>Relative Density of Cohesionless Soils From Standard Penetration Test</th>
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<td>Very Loose, ≤ 4 bpf</td>
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<td>Soft</td>
<td>Loose, 5 - 10 bpf</td>
</tr>
<tr>
<td>Medium</td>
<td>Medium, 11 - 30 bpf</td>
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<tr>
<td>Dense</td>
<td>Dense, 31 - 50 bpf</td>
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<tr>
<td>Very Dense</td>
<td>Very Dense, &gt; 50 bpf</td>
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<td>(bpf = blows per foot, ASTM D 1586)</td>
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</table>

## Consistency of Cohesive Soils

<table>
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<tr>
<th>Consistency of Cohesive Soils</th>
<th>Relative Hardness of Rock</th>
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<tr>
<td>Soft</td>
<td>Soft, 3 - 4 bpf</td>
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<tr>
<td>Medium</td>
<td>Medium, 5 - 8 bpf</td>
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<td>Dense</td>
<td>Dense, 9 - 15 bpf</td>
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<tr>
<td>Very Dense</td>
<td>Very Stiff, 16 - 30 bpf</td>
</tr>
<tr>
<td>Hard</td>
<td>Hard, &gt; 30 bpf</td>
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</tbody>
</table>

## Relative Hardness of Rock

- **Very Soft**: Hard Rock disintegrates or easily compresses to touch; can be hard to very hard soil.
- **Soft**: May be broken with fingers.
- **Moderately Soft**: May be scratched with a nail, corners and edges may be broken with fingers.
- **Moderately Hard**: Light blow of hammer required to break samples.
- **Hard**: Hard blow of hammer required to break sample.

## Particle Size Identification

- **Boulders**: Larger than 12”
- **Cobbles**: 3” - 12”
- **Gravel**: 3/4” - 3”
- **Sand**: 4.76mm - 3/4”
- **Coarse**: 2.0 - 4.76 mm
- **Medium**: 0.42 - 2.00 mm
- **Fine**: 0.42 - 0.074 mm
- **Fines**: Smaller than 0.074 mm

## Rock Continuity

- **RECOVERY** = \( \frac{\text{Total Length of Core}}{\text{Length of Core Run}} \) \times 100 %

## Relative Quality of Rocks

- **RQD** = \( \frac{\text{Total core, counting only pieces > 4” long}}{\text{Length of Core Run}} \) \times 100 %

<table>
<thead>
<tr>
<th>Description</th>
<th>Core Recovery %</th>
<th>Description</th>
<th>RQD %</th>
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<td>Less than 40</td>
<td>Very Poor</td>
<td>0 - 25 %</td>
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<td>Competent</td>
<td>40 - 70</td>
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<td>91 - 100</td>
<td>Good</td>
<td>75 - 90 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Excellent</td>
<td>90 - 100 %</td>
</tr>
</tbody>
</table>
LABORATORY TESTING

GENERAL

The laboratory testing procedures employed by Goodwyn, Mills and Cawood, Inc. (GM&C) are in general accordance with ASTM standard methods and other applicable specifications. Several test methods, described together with others in this Appendix, were used during the course of this exploration. The Laboratory Data Summary sheet indicates the specific tests performed.

SOIL CLASSIFICATION

Soil classifications provide a general guide to the engineering properties of various soil types and enable the engineer to apply his past experience to current problems. In our investigations, samples obtained during drilling operations are examined in our laboratory and visually classified by an engineer. The soils are classified according to consistency (based on number of blows from standard penetration tests), color and texture. These classification descriptions are included on our "Boring Records".

The classification system discussed above is primarily qualitative and for detailed soil classification two laboratory tests are necessary; grain size tests and plasticity tests. Using these test results the soil can be classified according to the AASHTO or Unified Classification Systems (ASTM D-2487). Each of these classification systems and the in-place physical soil properties provides an index for estimating the soil's behavior. The soil classification and physical properties obtained are presented in this report.

POCKET PENETROMETER TEST

A pocket penetrometer test is performed by pressing the tip of a small, spring-loaded penetrometer with even pressure to a prescribed depth into a soil sample. This test yields a value for unconfined compressive strength which may be correlated with unconfined compressive strengths obtained by other laboratory methods.

MOISTURE CONTENT

Moisture contents are determined from representative portions of the specimen. The soil is dried to a constant weight in an oven at 100° C and the loss of moisture during the drying process is measured. From this data, the moisture content is computed.

ATTERBERG LIMITS

Liquid Limit (LL), Plastic Limit (PL) and Shrinkage Limit (SL) tests are performed to aid in the classification of soils and to determine the plasticity and volume change characteristics of the materials. The Liquid Limit is the minimum moisture content at which a soil will flow as a heavy viscous fluid. The Plastic Limit is the minimum moisture content at which the soil behaves as a plastic material. The Shrinkage Limit is the moisture content below which no further volume change will take place with continued drying. The Plasticity Index (PI) is the numeric difference of Liquid Limit and Plastic Limit and indicates the range of moisture content over which a soil remains plastic. These tests are performed in accordance with ASTM D4318, D4943 and D427.

PARTICLE SIZE DISTRIBUTION

The distribution of soils coarser than the No. 200 (75-mm) sieve is determined by passing a representative specimen through a standard set of nested sieves. The weight of material retained on each sieve is determined and the percentage retained (or passing) is calculated.
A specimen may be washed through only the No. 200 sieve, if the full range of particle sizes is not required. The percentage of material passing the No. 200 sieve is reported.

The distribution of materials finer than the No. 200 sieve is determined by use of a hydrometer. The particle sizes and distribution are computed from the time rate of settlement of the different size particles while suspended in water. These tests are performed in accordance with ASTM D-421, D-422 and D-1140.