

**SIPS-SOUTHSIDE BLVD. INTERTIE TO
DEERWOOD III WTP**

**VOLUME IV OF IV
SUPPLEMENTAL TECHNICAL SPECIFICATIONS**



**JEA
JACKSONVILLE, FLORIDA**

**90% DESIGN SUBMITTAL
MAY 2021
NOT FOR CONSTRUCTION**

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JEA
JACKSONVILLE, FLORIDA

**BIDDING REQUIREMENTS
AND
CONTRACT DOCUMENTS**

for the construction of the

SIPS-SOUTHSIDE BLVD. INTERTIE TO DEERWOOD III WTP

JACOBS ENGINEERING GROUP INC.

Jacksonville, FL

May 2021

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SIPS-SOUTHSIDE BLVD. INTERTIE TO
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SIGN AND SEAL SHEET

SUPPLEMENTAL TECHNICAL SPECIFICATIONS Lawrence Bradley Gunn, P.E. No. 65967

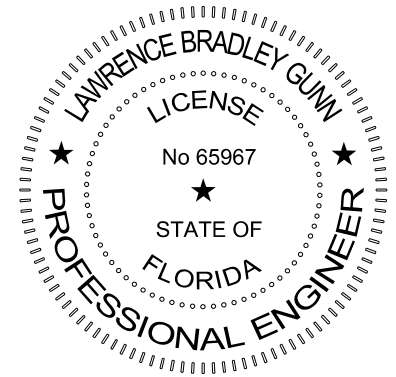
DIVISION 9—FINISHES

09 90 00

DIVISION 40—PROCESS INTEGRATION

(the following sections only)

40 27 00, 40 27 00.08, 40 27 00.10, 40 27 02



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SUPPLEMENTAL TECHNICAL SPECIFICATIONS

David R. Everson, P.E. No. 80180

DIVISION 1—GENERAL REQUIREMENTS

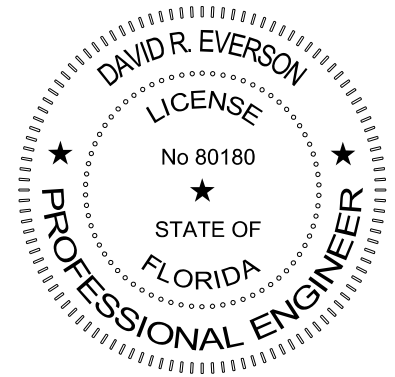
01 88 15

DIVISION 3—CONCRETE

03 63 00

DIVISION 5—METALS

05 50 19, 05 50 00



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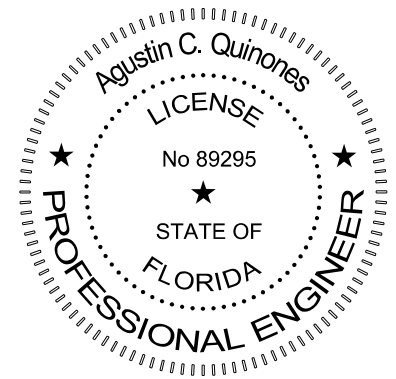
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SUPPLEMENTAL TECHNICAL SPECIFICATIONS

Agustin C. Quinones, P.E. No. 89295

DIVISION 26—ELECTRICAL

26 05 02, 26 05 04, 26 05 05, 26 05 26, 26 05 33,
26 05 70, 26 08 00, 26 22 00, 26 24 16, 26 27 26,
26 43 00



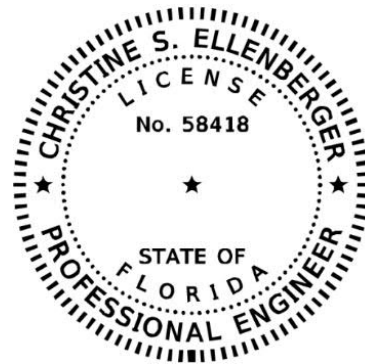
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SUPPLEMENTAL TECHNICAL SPECIFICATIONS Christine S. Ellenberger, P.E. No. 58418

DIVISION 31—EARTHWORK
31 09 13
DIVISION 33—UTILITIES
32 05 07.13, 33 05 07.23, 33 13 00



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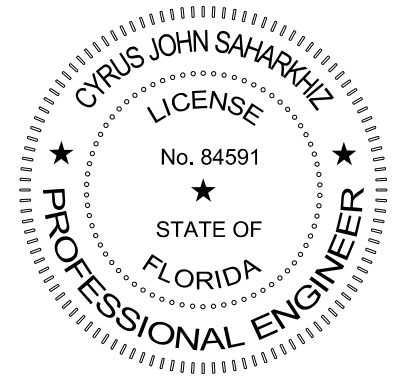
SUPPLEMENTAL TECHNICAL SPECIFICATIONS

Cyrus John Saharkhiz, P.E. No. 84591

DIVISION 40—PROCESS INTEGRATION

(the following sections only)

40 90 01



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END OF SECTION

**SUPPLEMENTAL TECHNICAL
SPECIFICATIONS**

**SECTION 01 88 15
ANCHORAGE AND BRACING**

PART 1 GENERAL

1.01 SUMMARY

- A. This section covers requirements for anchorage and bracing of equipment, distribution systems, and other nonstructural components required in accordance with the ICC 2018 International Building Code (IBC), for wind, gravity, soil, and operational loads.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Institute of Steel Construction (AISC) 360, Specification for Structural Steel Buildings.
 2. American Society of Civil Engineers (ASCE): ASCE 7, Minimum Design Loads for Buildings and Other Structures.
 3. International Code Council (ICC): International Building Code (IBC).

1.03 DEFINITIONS

- A. Authority Having Jurisdiction (AHJ): Permitting building agency; may be a federal, state, local, or other regional department, or individual including building official, fire chief, fire marshal, chief of a fire prevention bureau, labor department, or health department, electrical inspector; or others having statutory authority. AHJ may be Owner when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.

1.04 DESIGN AND PERFORMANCE REQUIREMENTS

- A. General:
1. Anchorage and bracing systems shall be designed by a qualified professional engineer registered in the State of Florida.
 2. Design anchorage into concrete including embedment in accordance with ACI 318-14; Chapter 17 (or other industry standard approved by Engineer), and Project Specifications.
 - a. Unless otherwise noted, design for cracked concrete condition.

3. Design anchorage and bracing of architectural, mechanical, and electrical components and systems in accordance with this section, unless a design is specifically provided within Contract Documents or where exempted hereinafter.
4. Design attachments, braces, and anchors for equipment, components, and distribution systems to structure for gravity, wind, and operational loading.
5. Anchor and brace piping and ductwork, whether exempt or not exempt for this section, so that lateral or vertical displacement does not result in damage or failure to essential architectural, mechanical, or electrical equipment.
6. Provide supplementary framing where required to transfer anchorage and bracing loads to structure.
7. Adjust equipment pad sizes or provide additional anchorage confinement reinforcing to provide required anchorage capacities.
8. Design anchorage and bracing for:
 - a. Equipment weighing more than 20 pounds.
9. For components exempted from design requirements of this section, provide bolted, welded, or otherwise positively fastened attachments to supporting structure.

B. Design Loads:

1. Gravity: Design anchorage and bracing for self-weight and superimposed loads on components and equipment.
2. Wind: Design anchorage and bracing for wind criteria provided on General Structural Notes on Drawings for exposed architectural components and exterior and wind-exposed mechanical and electrical equipment. Alternately, manufacturer certification may be provided for components such as roofing and flashing to verify attachments meet Project-specific design criteria.
3. Operational:
 - a. For loading supplied by equipment manufacturer for IBC required load cases.
 - b. Loads may include equipment vibration, torque, thermal effects, effects of internal contents (weight and sloshing), water hammer, and other load-inducing conditions.
 - c. Locate braces to minimize vibration to or movement of structure.
 - d. For vibrating loads, use anchors meeting requirements of Section 05 50 00, Metal Fabrications or Section 05 05 19, Post-Installed Anchors, for anchors with designated capacities for vibratory loading per manufacturer's ICC-ES report.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:

- a. List of architectural, mechanical, and electrical equipment requiring Contractor-designed anchorage and bracing, unless specifically exempted.
- b. Manufacturers' engineered hardware product data.
- c. Attachment assemblies' drawings include connection hardware, braces, and anchors or anchor bolts for nonexempt components, equipment, and systems.
- d. Submittal will be rejected if proposed anchorage method would create excessive stress to supporting member. Revise anchorages and strengthen structural support to eliminate overstressed condition.

B. Informational Submittals:

1. Anchorage and Bracing Calculations: For attachments, braces, and anchorages, include IBC and Project-specific criteria as noted on General Structural Notes on Drawings, in addition to manufacturer's specific criteria used for design; sealed by a civil or structural engineer registered in the State of Florida.
2. Manufacturer's hardware installation requirements.

1.06 SOURCE QUALITY CONTROL

- A. Provide all other specified, regulatory required, or required repair verification inspection and testing that is not listed in Statement of Special Inspections in accordance with JEA's Quality Control and Quality Assurance requirements.
- B. Provide Source Quality Control for welding and hot-dip galvanizing of anchors in accordance with Section 05 50 00, Metal Fabrications.

PART 2 PRODUCTS

2.01 GENERAL

- A. Design and construct attachments and supports transferring loads to structure of materials and products suitable for application and in accordance with design criteria shown on Drawings and nationally recognized standards.

- B. Provide anchor bolts for anchorage of equipment to concrete or masonry in accordance with Section 05 50 00, Metal Fabrications. Provide anchor bolts of the size, minimum embedment, and spacing designated in calculations submitted by Contractor and accepted by Engineer.
- C. Provide post-installed concrete and masonry anchors for anchorage of equipment to concrete or masonry in accordance with Section 05 05 19, Post-Installed Anchors. Provide post-installed anchors of the size, minimum embedment, and spacing designated in calculations submitted by Contractor and accepted by Engineer.
- D. Do not use expansion anchors, other than undercut anchors, for nonvibration isolated mechanical equipment rated over 10 horsepower.

PART 3 EXECUTION

3.01 GENERAL

- A. Make attachments, bracing, and anchorage in such a manner that component lateral force is transferred to lateral force resisting system of structure through a complete load path.
- B. Provide snubbers in each horizontal direction and vertical restraints for components mounted on vibration isolation systems where required to resist overturning.
- C. Calculations shall limit anchor bolt concrete edge distance to a maximum of 4 inches or as required to provide sufficient anchor bolt capacity to resist the applied loads.
- D. **PP**Provide piping anchorage that maintains design flexibility and expansion capabilities at flexible connections and expansion joints.
- E. Anchor tall and narrow equipment such as motor control centers and telemetry equipment at base and within 12 inches from top of equipment, unless approved otherwise by Engineer.

3.02 INSTALLATION

- A. Do not install components or their anchorages or restraints prior to review and acceptance by Engineer and AHJ.

3.03 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

- A. In accordance with Section 05 50 00, Metal Fabrications and Section 05 05 19, Post-Installed Anchors.
- B. Provide any other specified, regulatory required, or required repair verification inspection and testing that is not listed in Statement of Special Inspections in accordance with JEA's Quality Control and Quality Assurance requirements.

END OF SECTION

**SECTION 03 63 00
CONCRETE DOWELING**

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
1. American National Standards Institute (ANSI).
 2. ASTM International (ASTM):
 - a. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
 - b. E488, Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
 3. International Code Council (ICC):
 - a. 2018 International Building Code (IBC).
 - b. Evaluation Services Reports.

1.02 DEFINITIONS

- A. ICC Evaluation Services Report: Published by ICC for products provided by concrete adhesive anchor manufacturers.

1.03 SUBMITTALS

- A. Action Submittals:
1. Product Data: Manufacturer's catalog information.
- B. Informational Submittals:
1. Manufacturer's instructions for preparation, placement, drilling of holes, installation of anchors and adhesive, and handling of cartridges, nozzles, and equipment.
 2. ICC Evaluation Services Report: Specific to proposed doweling system manufacturer.

1.04 QUALITY ASSURANCE

- A. Qualifications:
1. Manufacturer: At least three similar projects with same products within last 3 years.
 2. Installer: Trained and certified by manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Container Markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
- B. Store adhesive components in accordance with manufacturer's written instructions.
- C. Dispose of when:
 - 1. Shelf life has expired.
 - 2. Stored other than per manufacturer's instructions.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Adhesive:
 - 1. Approved by an ICC Evaluation Services Report for conformance to 2018 IBC requirements for doweling of steel reinforcing bars in cracked concrete.
 - 2. Suitable for long-term loads as well as for wind and seismic loads.
 - 3. Meet requirements of ASTM C881/C881M.
 - 4. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
 - 5. Disposable, Self-Contained Cartridge System:
 - a. Capable of dispensing both components in proper mixing ratio.
 - b. Fit into manually or pneumatically operated caulking gun.
 - 6. Mixed Adhesive: Nonsag, light paste consistency with ability to remain in a 1-inch diameter overhead drilled hole without runoff.
 - 7. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
 - 8. Manufacturers and Products:
 - a. Hilti, Inc., Tulsa, OK; HIT-RE 500-SD (ESR-2322) or HIT-HY 200 (ESR-3187) Adhesive Anchors.
 - b. Powers Fasteners, Brewster, NY; Power PURE110+ Epoxy Adhesive Anchor System (ESR-3298).
 - c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-XP Epoxy Adhesive Anchors (ESR-2508).

- B. Mixing Nozzles:
 - 1. Disposable, manufactured in several sizes to accommodate size of reinforcing dowels.
 - 2. Nonremovable internal static mixer required to ensure proper blending of components.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Drilling Equipment:
 - 1. Drilling Hammers for Dowel Holes:
 - a. Electric or pneumatic rotary type with medium or light impact.
 - b. Hollow drills with flushing air systems are preferred.
 - 2. Where edge distances are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.
- B. Hole Diameter: Use drill bit diameter meeting ICC Evaluation Services Report requirements and as recommended by manufacturer.
- C. Obstructions in Drill Path: When existing steel reinforcement is encountered during drilling, obtain Engineer approval for proposed fix.
- D. Doweling:
 - 1. Install per details shown on Drawings and in accordance with adhesive manufacturer's instructions.
 - 2. When using epoxy anchors, dowels may be prebent prior to installation to 15 degrees to align with other bars. Do not heat dowels to bend.
 - 3. Bent Bar Dowels: Where edge distances are critical, and intersection with steel reinforcement is likely, drill hole at 10-degree angle or less and use prebent reinforcing bars.
 - 4. If bars have fused epoxy coating and coating is damaged, recoat damaged area with epoxy.
- E. Adhesive:
 - 1. Install in accordance with written manufacturer's instructions.
 - 2. Dispense components through specially designed static mixing nozzle that thoroughly mixes components and places mixed adhesive at base of predrilled hole.

3.02 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

- A. Contractor-Furnished Quality Control: Inspection and testing as required by JEA's Quality Control and Quality Assurance requirements.

END OF SECTION

**SECTION 05 05 19
POST-INSTALLED ANCHORS**

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Concrete Institute (ACI):
 - a. 318, Building Code Requirements for Structural Concrete.
 - b. 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete.
 - c. 355.4, Qualification of Post-Installed Adhesive Anchors in Concrete.
 2. American Iron and Steel Institute (AISI): Stainless Steel Type 316.
 3. American National Standards Institute (ANSI).
 4. ASTM International (ASTM):
 - a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
 - b. A194/A194M, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
 - c. A380/A380M, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
 - d. A967/A967M, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
 - e. E488/E488M, Standard Test Methods for Strength of Anchors in Concrete Elements.
 - f. F436/F436M, Standard Specification for Hardened Steel Washers.
 - g. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Socket Head Cap Screws, and Studs for General Use.
 - h. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 - i. F594, Standard Specification for Stainless Steel Nuts.
 - j. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
 5. International Association of Plumbing and Mechanical Officials Uniform ES (IAPMO-UES): Evaluation Reports for Concrete and Masonry Anchors.

6. International Code Council Evaluation Service (ICC-ES):
 - a. Evaluation Reports for Concrete and Masonry Anchors.
 - b. AC70, Acceptance Criteria for Fasteners Power-driven into Concrete, Steel and Masonry Elements.
 - c. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
 - d. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements. Evaluation Reports for Concrete and Masonry Anchors.
7. Specialty Steel Industry of North America (SSINA):
 - a. Specifications for Stainless Steel.
 - b. Design Guidelines for the Selection and Use of Stainless Steel.
 - c. Stainless Steel Fabrication.
 - d. Stainless Steel Fasteners.

1.02 DEFINITIONS

- A. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.
- B. Exterior Area: Location not protected from weather by a building or other enclosed structure to include buried roof structures.
- C. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or wash down, and where wall or roof slab is not common to a water-holding or earth-retaining structure.
- D. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or wash down, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.
- E. Submerged: Location at or below top of wall of open water-holding structure, such as a basin or channel, or wall, ceiling, or floor surface inside a covered water-holding structure, or exterior belowgrade wall or roof surface of water-holding structure, open or covered.

1.03 SUBMITTALS

- A. Action Submittals:
 1. Shop Drawings: Specific instructions for concrete anchor installation, including drilled hole size and depth, preparation, placement, procedures, and instructions for safe handling of anchoring systems.

B. Informational Submittals:

1. Concrete Anchors:
 - a. Manufacturer’s product description and installation instructions.
 - b. Current ICC-ES or IAPMO-UES Report for each type of post-installed anchor to be used.
 - c. Adhesive Anchor Installer Certification.
2. Passivation method for stainless steel members.

1.04 QUALITY ASSURANCE

- A. Qualifications: Installers of adhesive anchors horizontally or upwardly inclined to support sustained tension loads shall be certified by an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Installer Certification Program or equivalent.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Package stainless steel items in a manner to provide protection from carbon impregnation.

PART 2 PRODUCTS

2.01 GENERAL

- A. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Stainless Steel:	
Threaded Rods	F593, AISI Type 316, Condition CW
Nuts*	F594, AISI Type 316, Condition CW
*Nuts of other grades and styles having specified proof load stresses greater than specified grade and style are also suitable. Nuts must have specified proof load stresses equal to or greater than minimum tensile strength of specified threaded rod.	

- B. Bolts, Washers, and Nuts: Use stainless steel material types as indicated in Fastener Schedule at end of this section.

2.02 POST-INSTALLED CONCRETE ANCHORS

A. General:

1. AISI Type 316 stainless, as shown in Fastener Schedule at end of this section.
2. Post-installed anchor systems used in concrete shall be approved by ICC Evaluation Services Report or equivalent for use in cracked concrete and for short-term and long-term loads including wind and earthquake.
3. Mechanical Anchors: Comply with the requirements of ICC-ES AC193 or ACI 355.2.
4. Adhesive Anchors: Comply with the requirements of ICC-ES AC308 or ACI 355.4.

B. Torque-Controlled Expansion Anchors (Wedge Anchors):

1. Manufacturers and Products:
 - a. Hilti, Inc., Tulsa, OK; Kwik-Bolt –TZ (KB-TZ) Anchors (ESR-1917).
 - b. DeWalt/Powers Fasteners, Brewster, NY; Power-Stud +SD1 , +SD2, +SD4, or +SD6 Anchors (ESR-2502 and ESR-2818).
 - c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Strong-Bolt 2 Anchors (ESR-1771 and ESR-3037).

C. Adhesive Anchors:

1. Threaded Rod:
 - a. Diameter as shown on Drawings.
 - b. Length as required to provide minimum depth of embedment indicated and thread projection required.
 - c. Clean and free of grease, oil, or other deleterious material.
2. Adhesive:
 - a. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
 - b. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
3. Packaging and Storage:
 - a. Disposable, self-contained system capable of dispensing both components in proper mixing ratio and fitting into a manually or pneumatically operated caulking gun.
 - b. Store adhesive on pallets or shelving in a covered storage area.

- c. Package Markings: Include manufacturer's name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
- d. Dispose of When:
 - 1) Shelf life has expired.
 - 2) Stored other than in accordance with manufacturer's instructions.
- 4. Manufacturers and Products:
 - a. Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System, HIT RE 500 V3 (ESR-3814).
 - b. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-3G Epoxy Adhesive Anchors. (ESR-4057).
 - c. DeWalt/Powers Fasteners, Brewster NY; Pure 110+ Epoxy adhesive anchor system (ESR-3298).

PART 3 EXECUTION

3.01 CONCRETE ANCHORS

- A. Begin installation only after concrete to receive anchors is a minimum of 21 days old or has attained design strength whichever requires a longer duration.
- B. Locate existing reinforcing with Ground Penetrating Radar or other method approved by Engineer prior to drilling. Coordinate with Engineer to adjust anchor locations where installation would result in hitting reinforcing.
- C. Install in accordance with written manufacturer's instructions.
- D. Provide minimum embedment, edge distance, and spacing as indicated on Drawings.
- E. Use only drill type and bit type and diameter recommended by anchor manufacturer. Use rotary hammer drill unless otherwise approved by Engineer. Core drilling may only be used if specifically allowed by the Engineer.
- F. Clean hole of debris and dust per manufacturer's requirements.
- G. When unidentified embedded steel, rebar, or other obstruction is encountered in drill path, slant drill to clear obstruction. If drill must be slanted more than indicated in manufacturer's installation instructions to clear obstruction, notify Engineer for direction on how to proceed.

H. Adhesive Anchors:

1. Unless otherwise approved by Engineer and adhesive manufacturer:
 - a. Do not install adhesive anchors when temperature of concrete is below 40 degrees F or above 100 degrees F.
 - b. Do not install prior to concrete attaining an age of 21 days.
 - c. Remove any standing water from hole with oil-free compressed air. Inside surface of hole shall be dry.
 - d. Do not disturb anchor during recommended curing time.
 - e. Do not exceed maximum torque as specified in manufacturer's instructions.

3.02 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

- A. Contractor-Furnished Quality Control: Inspection and testing in accordance with JEA's Quality Control and Quality Assurance requirements.

3.03 MANUFACTURER'S SERVICES

- A. Adhesive Anchors: Conduct Site training of installation personnel for proper installation, handling, and storage of adhesive anchor system. Notify Engineer of time and place for sessions.

3.04 FASTENER SCHEDULE

- A. Unless indicated otherwise on Drawings, provide fasteners as follows:

Service Use and Location	Product	Remarks
1. Post-Installed Anchors for Metal Components to Cast-in-Place Concrete (such as, Ladders, Handrail Posts, Electrical Panels, Platforms, and Equipment)		
All service uses and locations	Stainless steel adhesive anchors	Verify product acceptability and manufacturer's requirements if anchor installation will occur in an overhead application
2. All Others		
All service uses and locations	Stainless steel fasteners	

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- B. Antiseizing Lubricant: Use on all stainless steel threads.
- C. Do not use adhesive anchors to support fire-resistive construction or where ambient temperature will exceed 120 degrees F.

END OF SECTION

**SECTION 05 50 00
METAL FABRICATIONS**

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. The Aluminum Association, Inc. (AA): The Aluminum Design Manual.
 2. American Galvanizers Association (AGA):
 - a. Inspection of Hot-Dip Galvanized Steel Products.
 - b. Quality Assurance Manual.
 3. American Institute of Steel Construction (AISC):
 - a. 201, Certification Program for Structural Steel Fabricators.
 - b. 206, Certification Program for Structural Steel Erectors Standard for Structural Steel Erectors.
 - c. 325, Steel Construction Manual.
 - d. 326, Detailing for Steel Construction.
 - e. 360, Specification for Structural Steel Buildings.
 - f. 420, Certification Standard for Shop Application of Complex Protective Coating Systems.
 4. American Iron and Steel Institute (AISI): Stainless Steel Types.
 5. American National Standards Institute (ANSI).
 6. American Society of Safety Engineers (ASSE): A10.11, Safety Requirements for Personnel and Debris Nets.
 7. American Welding Society (AWS):
 - a. D1.1/D1.1M, Structural Welding Code - Steel.
 - b. D1.2/D1.2M, Structural Welding Code - Aluminum.
 - c. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
 8. ASTM International (ASTM):
 - a. A36/A36M, Standard Specification for Carbon Structural Steel.
 - b. A48/A48M, Specification for Gray Iron Castings.
 - c. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - d. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
 - e. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - f. A143/A143M, Standard for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
 - g. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

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- h. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
- i. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
- j. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
- k. A276, Standard Specification for Stainless Steel Bars and Shapes.
- l. A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
- m. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- n. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
- o. A384/A384M, Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
- p. A385/A385M, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
- q. A489, Standard Specification for Carbon Steel Lifting Eyes.
- r. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- s. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
- t. A563, Standard Specification for Carbon and Alloy Steel Nuts.
- u. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- v. A780/A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- w. A786/A786M, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
- x. A967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
- y. A992/A992M, Standard Specification for Structural Steel Shapes.
- z. A1085, Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS).
- aa. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- bb. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

- cc. B308/B308M, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
 - dd. B429/B429M, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
 - ee. B632/B632M, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
 - ff. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
 - gg. D1056, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
 - hh. F436, Standard Specification for Hardened Steel Washers.
 - ii. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
 - jj. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 - kk. F594, Standard Specification for Stainless Steel Nuts.
 - ll. F844, Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.
 - mm. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
 - nn. F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.
9. Occupational Safety and Health Administration (OSHA):
- a. 29 CFR 1910.23, Ladders.
 - b. 29 CFR 1910.28, Duty to Have Fall Protection and Falling Object Protection.
 - c. 29 CFR 1910.29, Fall Protection Systems and Falling Object Protection-Criteria and Practices.
 - d. 29 CFR 1926.105, Safety Nets.
 - e. 29 CFR 1926.502, Fall Protections Systems Criteria and Practices.
10. Specialty Steel Industry of North America (SSINA):
- a. Specifications for Stainless Steel.
 - b. Design Guidelines for the Selection and Use of Stainless Steel.
 - c. Stainless Steel Fabrication.
 - d. Stainless Steel Fasteners.

1.02 DEFINITIONS

- A. Anchor Bolt: Cast-in-place anchor; concrete or masonry.
- B. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.

- C. Exterior Area: Location not protected from weather by building or other enclosed structure.
- D. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or washdown, nor where wall or roof slab is common to a water-holding or earth-retaining structure.
- E. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or washdown, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.
- F. Submerged: Location at or below top of wall of open water-holding structure, such as basin or channel, or wall, ceiling or floor surface inside a covered water-holding structure, or exterior belowgrade wall or roof surface of water-holding structure, open or covered.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings: Metal fabrications, including welding and fastener information.
- B. Informational Submittals:
 - 1. Passivation method for stainless steel members.
 - 2. A: Galvanized coating applicator qualifications.
 - 3. B: Hot-Dip Galvanizing: Certificate of compliance signed by galvanizer, with description of material processed and ASTM standard used for coating.

1.04 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Insofar as practical, factory assemble specified items. Package assemblies, which have to be shipped unassembled to protect materials from damage and tag to facilitate identification and field assembly.
- B. Package stainless steel items to provide protection from carbon impregnation.

- C. Protect painted coatings and hot-dip galvanized finishes from damage as a result of metal banding and rough handling. Use padded slings and straps.
- D. Store fabricated items in dry area, not in direct contact with ground.

PART 2 PRODUCTS

2.01 GENERAL

- A. For hot-dip galvanized steel that is exposed to view and does not receive paint, limit the combined phosphorus and silicon content to 0.04 percent. For steels that require a minimum of 0.15 percent silicon (such as plates over 1.5 inches thick for ASTM A36/A36M steel), limit maximum silicon content to 0.21 percent and phosphorous content to 0.03 percent.
- B. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Steel Wide Flange Shapes	A992/992M
Other Steel Shapes and Plates	A36/A36M or A572/A572M, Grade 50 or A992/A992M for other steel shapes
Steel Pipe	A500, Grade B
Hollow Structural Sections (HSS)	A500/A500M, Grade C
Aluminum:	
Aluminum Plates	B209, Alloy 6061-T6
Aluminum Structural Shapes	ASTM B221/B221M, Alloy 6061-T6
Stainless Steel:	
Bars and Angles	A276, AISI Type 316 (316L for welded connections)
Shapes	A276, AISI Type 304 (304L for welded connections)
Steel Plate, Sheet, and Strip	A240/A240M, AISI Type 316 (316L for welded connections)
Bolts, Threaded Rods, Anchor Bolts, and Anchor Studs	F593, AISI Type 316, Group 2, Condition SH
Nuts	F594, AISI Type 316, Condition CW

Item	ASTM Reference
Steel Bolts and Nuts:	
Carbon Steel	A307 bolts, with A563 nuts
High-Strength	F3125, Type 1 bolts, with A563 nuts
Anchor Bolts and Rods	F1554, Grade 36, with weldability supplement S1.
Eyebolts	A489
Threaded Rods	A36/A36M
Flat Washers (Unhardened)	F844
Flat and Beveled Washers (Hardened)	F436
Thrust Ties for Steel Pipe:	
Threaded Rods	A193/A193M, Grade B7
Nuts	A194/A194M, Grade 2H
Plate	A283/A283M, Grade D
Welded Anchor Studs	A108, Grades C-1010 through C-1020
Aluminum Bolts and Nuts	F468, Alloy 2024-T4
Cast Iron	A48/A48M, Class 35

- C. Bolts, Washers, and Nuts: Use stainless steel, hot-dip galvanized steel, zinc-plated steel, and aluminum material types as indicated in Fastener Schedule at end of this section.

2.02 ANCHOR BOLTS AND ANCHOR BOLT SLEEVES

- A. Cast-In-Place Anchor Bolts:
 - 1. Headed type, unless otherwise shown on Drawings.
 - 2. Material type and protective coating as shown in Fastener Schedule at end of this section.

B. Anchor Bolt Sleeves:

1. Plastic:
 - a. Single unit construction with corrugated sleeve.
 - b. Top of sleeve shall be self-threading to provide adjustment of threaded anchor bolt projection.
 - c. Material: High-density polyethylene.
2. Fabricated Steel: ASTM A36/A36M.

2.03 POST-INSTALLED CONCRETE ANCHORS

- A. See Section 05 05 19, Post-Installed Anchors.

2.04 ACCESSORIES

A. Antiseizing Lubricant for Stainless Steel Threaded Connections:

1. Suitable for potable water supply.
2. Resists washout.
3. Manufacturers and Products:
 - a. Bostik, Middleton, MA; Neverseez.
 - b. Saf-T-Eze Div., STL Corp., Lombard, IL; Anti-Seize.

B. Neoprene Gasket:

1. ASTM D1056, 2C1, soft, closed-cell neoprene gasket material, suitable for exposure to sewage and sewage gases, unless otherwise shown on Drawings.
2. Thickness: Minimum 1/4 inch.
3. Furnish without skin coat.
4. Manufacturer and Product: Monmouth Rubber and Plastics Corporation, Long Branch, NJ; Durafoam DK1111LD.

2.05 FABRICATION

A. General:

1. Finish exposed surfaces smooth, sharp, and to well-defined lines.
2. Furnish necessary rabbets, lugs, and brackets so work can be assembled in neat, substantial manner.
3. Conceal fastenings where practical; where exposed, flush countersink.
4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
5. Grind cut edges smooth and straight. Round sharp edges to small uniform radius. Grind burrs, jagged edges, and surface defects smooth.
6. Fit and assemble in largest practical sections for delivery to Site.

B. Materials:

1. Use steel shapes, unless otherwise noted.
2. Steel to be hot-dip galvanized: Limit silicon content to less than 0.04 percent or to between 0.15 percent and 0.25 percent.
3. Fabricate aluminum in accordance with AA Specifications for Aluminum Structures—Allowable Stress Design.
4. Stainless Steel Built-up Shapes: Fabricate built-up shapes in accordance with ASTM A1069/A1069M.

C. Welding:

1. Weld connections and grind exposed welds smooth. When required to be watertight, make welds continuous.
2. Welded fabrications shall be free from twisting or distortion caused by improper welding techniques.
3. Steel: Meet fabrication requirements of AWS D1.1/D1.1M, Section 5.
4. Aluminum: Meet requirements of AWS D1.2/D1.2M.
5. Stainless Steel: Meet requirements of AWS D1.6/D1.6M.
6. Welded Anchor Studs: Prepare surface to be welded and weld with stud welding gun in accordance with AWS D1.1/D1.1M, Section 7, and manufacturer's instructions.
7. Complete welding before applying finish.

D. Painting:

1. Shop prime with rust-inhibitive primer as specified in Section 09 90 00, Painting and Coating, unless otherwise indicated.
2. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
3. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.

E. Galvanizing:

1. Fabricate steel to be galvanized in accordance with ASTM A143/A143M, ASTM A384/A384M, and ASTM A385/A385M. Avoid fabrication techniques that could cause distortion or embrittlement of the steel.
2. Provide venting and drain holes for tubular members and fabricated assemblies in accordance with ASTM A385/A385M.
3. Remove welding slag, splatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to delivery for galvanizing.

4. Remove by blast cleaning or other methods surface contaminants and coatings not removable by normal chemical cleaning process in the galvanizing operation.
 5. Hot-dip galvanize steel members, fabrications, and assemblies after fabrication in accordance with ASTM A123/A123M.
 6. Hot-dip galvanize bolts, nuts, washers, and hardware components in accordance with ASTM A153/A153M. Oversize holes to allow for zinc alloy growth. Shop assemble bolts and nuts.
 7. Galvanized steel sheets in accordance with ASTM A653/A653M.
 8. Galvanize components of bolted assemblies separately before assembly. Galvanizing of tapped holes is not required.
- F. Electrolytic Protection: Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
- G. Watertight Seal: Where required or shown, furnish neoprene gasket. Cover full bearing surfaces.
- H. Fitting: Where movement of fabrications is required or shown, cut, fit, and align items for smooth operation. Make corners square and opposite sides parallel.
- I. Accessories: Furnish as required for a complete installation. Fasten by welding or with stainless steel bolts or screws.

2.06 SOURCE QUALITY CONTROL

- A. Visually inspect all fabrication welds and correct deficiencies.
1. Steel: AWS D1.1/D1.1M, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
 2. Aluminum: AWS D1.2/D1.2M.
 3. Stainless Steel: AWS D1.6/D1.6M.

PART 3 EXECUTION

3.01 INSTALLATION OF METAL FABRICATIONS

- A. General:
1. Install metal fabrications plumb and level, accurately fitted, free from distortion or defects.
 2. Install rigid, substantial, and neat in appearance.

3. Install manufactured products in accordance with manufacturer's recommendations.
4. Obtain Engineer approval prior to field cutting steel members or making adjustments not scheduled.
5. Do not remove mill markings from concealed surfaces.
6. Remove inked or painted identification marks on exposed surfaces not otherwise coated after installed material has been inspected and approved.
7. Snug-tighten bolts, unless otherwise specified.

B. Steel:

1. Fabrication, erection, connections, bolted and welded construction shall be in accordance with AISC Steel Construction Manual and AWS D1.1.

C. Stainless Steel:

1. Fabrication, erection, connections, bolted and welded construction shall be in accordance with AWS D1.6 and the following SSINA standards:
 - a. Specifications for Stainless Steel.
 - b. Stainless Steel Fabrication.
 - c. Stainless Steel Fasteners.
2. Do not field weld unless approved by Engineer in writing.

D. Aluminum:

1. Do not remove mill markings from concealed surfaces.
2. Remove inked or painted identification marks on exposed surfaces not otherwise coated after installed material has been inspected and approved.
3. Fabrication, mechanical connections, and bolted construction shall be in accordance with the AA Aluminum Design Manual.

3.02 CAST-IN-PLACE ANCHOR BOLTS

- A. Locate and hold anchor bolts in place with templates at time concrete is placed.
- B. Use anchor bolt sleeves for location adjustment and provide two nuts and one washer per bolt of same material as bolt.
- C. Minimum Bolt Size: 1/2-inch diameter by 12 inches long, unless otherwise shown.

3.03 ELECTROLYTIC PROTECTION

A. Aluminum and Galvanized Steel:

1. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
2. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.
3. Allow coating to dry before installation of the material.
4. Protect coated surfaces during installation.
5. Should coating become marred, prepare and touch up in accordance with paint manufacturer's written instructions.

B. Titanium: Where titanium equipment is in contact with concrete or dissimilar metal, provide full-face neoprene insulation gasket, 3/32-inch minimum thickness and 70-durometer hardness.

C. Stainless Steel:

1. During handling and installation, take necessary precautions to prevent carbon impregnation of stainless steel members.
2. After installation, visually inspect stainless steel surfaces for evidence of iron rust, oil, paint, and other forms of contamination.
3. Remove contamination using cleaning and passivation methods in accordance with requirements of ASTM A380 and ASTM A967.
4. Brushes used to remove foreign substances shall utilize only stainless steel or nonmetallic bristles.
5. After treatment, visually inspect surfaces for compliance.

3.04 PAINTING

A. Painted Galvanized Surfaces: Prepare as specified in Section 09 90 00, Painting and Coating.

B. Repair of Damaged Hot-Dip Galvanized Coating:

1. Conform to ASTM A780/A780M.
2. For minor repairs at abraded areas, use sprayed zinc conforming to ASTM A780/A780M.
3. For flame cut or welded areas, use zinc-based solder, or zinc sticks, conforming to ASTM A780/A780M.
4. Use magnetic gauge to determine thickness is equal to or greater than base galvanized coating.

- C. Field Painting of Shop Primed Surfaces: Prepare surfaces and field finish in accordance with Section 09 90 00, Painting and Coating.

3.05 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

- A. Contractor-Furnished Quality Control:
 - 1. Inspection and testing in accordance with JEA’s Quality Control and Quality Assurance requirements.

3.06 FASTENER SCHEDULE

- A. Unless indicated otherwise on Drawings, provide fasteners as follows:

Service Use and Location	Product	Remarks
1. Anchor Bolts Cast Into Concrete for Structural Steel, Metal Fabrications and Castings		
Exterior and Interior Areas	Stainless steel headed anchor bolts	
2. Anchor Bolts Cast Into Concrete for Equipment Bases		
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel headed anchor bolts with fusion bonded coating, unless otherwise specified with equipment	See Section 09 90 00, Painting and Coating
3. Post-Installed Anchors: See Section 05 05 19, Post-Installed Anchors		
4. Connections for Structural Steel Framing		
Exterior and Interior Wet and Dry Areas	High-strength steel bolted connections	Use hot-dipped galvanized high-strength bolted connections for galvanized steel framing members.

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Service Use and Location	Product	Remarks
5. Connections of Aluminum Components		
Submerged, Exterior and Interior Wet and Dry Areas	Stainless steel bolted connections, unless otherwise specified with equipment	
6. All Others		
Exterior and Interior Wet and Dry Areas	Stainless steel fasteners	

- B. Antiseizing Lubricant: Use on stainless steel threads.

END OF SECTION

SECTION 26 05 02
BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 RELATED SECTIONS

- A. Requirements specified within this section apply to Division 26, Electrical. Work specified herein shall be performed as if specified in the individual sections.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. National Electrical Contractors Association (NECA): National Electrical Installation Standards.
 - 2. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. Z535.4, Product Safety Signs and Labels.
 - 3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 - 4. Underwriters Laboratories, Inc. (UL).

1.03 SUMMARY OF WORK

- A. The Contractor shall furnish and install all materials, equipment and supplies as shown on the Drawings and described in these Specifications, and as may otherwise be required to provide a complete and functional electrical system for the multiple areas of development.
- B. The Contractor shall provide for the trench excavation, water pumping and draining, supply of clean fill, backfilling, consolidation and compaction required for all underground electrical work.
- C. The Contractor shall apply the appropriate relay settings as furnished by the Engineer, and shall provide a complete checkout and testing of the installed system prior to energization per Section 26 08 00, Commissioning of Electrical Systems.
- D. The Contractor shall provide for the temporary power requirements of all disciplines as needed for the construction of the new facilities. The Contractor shall coordinate these needs directly with the Owner.

1.04 GENERAL REQUIREMENTS

- A. The Specifications and Drawings shall be considered as supplementary to each other, requiring materials and labor indicated, specified, or implied. Contradictions noted by the Contractor shall be presented to the Owner's Engineer for resolution.
- B. ANSI/NFPA.70-2017 (National Electrical Code or NEC) shall establish the minimum requirements for the installation. Where the Drawings and/or Specifications provide a more rigid requirement for the installation, then the Drawings and/or Specifications shall prevail.
- C. Interpretation of the Specifications or Drawings, if deemed necessary by the Contractor, shall be made only by the Owner's Engineer.
- D. These electrical specifications shall be considered prescriptive, meaning that there are specific manufacturer products called out and required for the work, and set the basis of design and material's acceptance for installation. It is the Contractor's responsibility to read, understand and procure the material items identified in these electrical specifications to meet these standards. Failure by the Contractor to procure and install manufactured materials identified on the Drawings and in the Specifications will be cause for rejection of the work.

1.05 DEFINITIONS

- A. Provide: To both furnish and install.
- B. Standard Supplier: The party under contract for furnishing the products covered by this Work.
- C. Contractor/Sub-Contractor/Installing Contractor: the party under contract to install the products furnished for this Work.
- D. For the purposes of this Project, the Standard Supplier and the Contractor/Sub-Contractor/Installing Contractor shall be the same party.

1.06 COORDINATION

- A. The Contractor performing the work is henceforth referred to be the Installing Contractor, Contractor, Standard Supplier or Electrical Sub-Contractor.
- B. Other work that is either directly, or indirectly, related to the scheduled performance of work under these Drawings and Specifications is anticipated to be performed by others.

- C. Coordinate the work of these Drawings and Specifications with the work of others.
- D. Include sequencing constraints specified as part of the progress schedule.
- E. Reference Drawings and Specifications for limits of work provided by others.

1.07 SUBMITTALS

- A. Review, acceptance or approval of substitutions, schedules, Shop Drawings, list of materials and procedures submitted or requested by the Standard Supplier shall not add to the contract amount, and additional costs which may result shall solely be the obligation of the Standard Supplier.
- B. The Owner is not precluded, by virtue of review, acceptance or approval from obtaining a credit for savings resulting from allowed concessions in the work or materials, or from the reduction in quantities of components.
- C. All approved documents shall be submitted to the Owner in the “Native Form” so that the Owner will have the ability to edit them as needed. Refer to the Project Specifications for procedures and requirements concerning Shop Drawing.
- D. The Owner’s and/or Owner’s Engineer’s review and approval of Contractor Submittals does not relieve the Contractor of the responsibility of assuring full compliance with the Drawings and Specifications. Contractor shall be fully responsible that all equipment, material and installations meet the full intent of these Drawings and Specifications regardless of submittal reviews.
- E. Shop Drawings:
 - 1. Shall be defined as drawings, diagrams, illustrations, schedules and other data which are specifically prepared by/for the Standard Supplier to illustrate the work to be done or the material/equipment to be provided.
 - 2. Refer to the JEA requirements for procedures concerning Shop Drawings.
- F. Quality Control Submittals:
 - 1. Furnish manufacturer’s certification of proper installation stating system/equipment has been installed in accordance with manufacturer’s recommendations and has been inspected by a manufacturer’s authorized representative.

2. Functional test certificate shall be required from the manufacturer monitoring the test and certifying in writing that the equipment tested is both functional and ready for continuous operation.
3. Refer JEA Quality Control and Quality Assurance requirements.

G. Operation and Maintenance Data:

1. Furnish for each system, or item of equipment, as necessary for the Owner to properly operate and maintain the equipment in accordance with the manufacturer's recommendations.
2. Refer to JEA requirements for procedures concerning operation and maintenance data.

1.08 PRODUCT SHIPMENT, HANDLING, STORAGE AND PROTECTION

- A. Standard Supplier shall provide Owner's representative on site notice of shipment of at least seven (7) days prior to shipment.
- B. All products, where practical, shall be fully factory assembled.
- C. Package or crate products to provide protection from damage during shipment, handling and storage.
- D. Mark spare parts and special tools to identify the associated products by name, equipment, and part number.
- E. The Contractor shall be responsible for receiving, inspecting and documenting the delivered condition of all materials, and its subsequent offloading, transporting and storage at the jobsite.

1.09 MANUFACTURER'S SERVICES

- A. As required and shown on the Drawings and as described elsewhere in these Specifications.

1.10 QUALITY ASSURANCE

- A. Provide the Work in accordance with ANSI/NFPA.70-2017 (National Electrical Code, or NEC). Where required by the Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory (NRTL) or other organization acceptable to the AHJ, in order to provide a basis for approval under the NEC.
- B. Materials and equipment manufactured within the scope of standards published by Underwriter's Laboratories, Inc. (UL) shall conform to those standards and shall have an applied NRTL listing mark or label.

1.11 ENVIRONMENTAL CONDITIONS

- A. The following areas are classified nonhazardous and wet. Use materials and methods required for such areas.
 - 1. Outdoor above and below grade areas.

PART 2 PRODUCTS

2.01 GENERAL

- A. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.
- B. Material and equipment installed in heated and ventilated areas shall be capable of continuous operation at their specified ratings within an ambient temperature range of 40 degrees F to 104 degrees F, inclusively.
- C. Materials and equipment installed outdoors shall be capable of continuous operation at their specified rating within the ambient temperature range of 0 degrees F to 104 degrees F, inclusively.

2.02 EQUIPMENT FINISH

- A. Manufacturer's standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment in accordance with light gray color finish as approved by Owner.

2.03 NAMEPLATES

- A. Material: Laminated plastic.
- B. Attachment Screws:
 - 1. Stainless steel.
- C. Color: White, engraved to a black core.
- D. Letter Height:
 - 1. Pushbuttons/Selector Switches: 1/8 inch.
 - 2. Other Electrical Equipment: 3/8 inch.

2.04 SIGNS AND LABELS

- A. Sign size, lettering, and color shall be in accordance with NEMA Z535.4.

PART 3 EXECUTION

3.01 GENERAL

- A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned. Contractor shall be responsible for actual location of equipment and devices and for proper routing and support of raceways, subject to approval of Engineer.
- B. Check approximate locations of light fixtures, switches, electrical outlets, equipment, and other electrical system components shown on Drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, notify Engineer in writing.
- C. Install work in accordance with NECA Standard of Installation, unless otherwise specified.
- D. Keep openings in boxes and equipment closed during construction.
- E. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of Engineer. Carefully perform cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces to original condition.

3.02 ANCHORING, BRACING, AND MOUNTING

- A. Equipment anchoring and mounting shall be in accordance with manufacturer's requirements for Project design criteria to meet the requirements of Section 01 88 15, Anchorage and Bracing.

3.03 COMBINING CIRCUITS INTO COMMON RACEWAY

- A. Drawings show each homerun circuit to be provided. Do not combine power or control circuits into common raceways without authorization of Engineer.

3.04 NAMEPLATES, SIGNS, AND LABELS

- A. Arc Flash Protection Warning Signs:
 - 1. Field mark panelboards to warn qualified persons of potential arc-flash hazards. Locate marking so to be clearly visible to persons before working on energized equipment.

2. Use arc flash hazard boundary, energy level, PPE level and description, shock hazard, bolted fault current, and equipment name from study required in Section 26 05 70, Electrical Systems Analysis as basis for warning signs.

B. Available Fault Current Signs:

1. Install label on service equipment to indicate the maximum available fault current at the equipment. Labels shall be of sufficient durability for the environment in which the equipment is installed. Labels shall include the following information:
 - a. Equipment name or identification.
 - b. Available fault current at the equipment.
 - c. Date the fault current calculations were performed.
2. Use bolted fault current and equipment name from study required in Section 26 05 70, Electrical Systems Analysis, as basis for the label.
3. Where existing electrical systems are modified, completely remove existing fault current labels if present, and install new labels in accordance with the above requirements.

C. Equipment Nameplates:

1. Provide a nameplate to label electrical equipment including Switchboards, motor control centers, panelboards, motor starters, transformers, terminal junction boxes, disconnect switches, switches and control stations.
2. Motor control center, transformer, and terminal junction box nameplates shall include equipment designation.
3. Disconnect switch, starter, and control station nameplates shall include name and number of equipment powered or controlled by that device.
4. Switchboard and panelboard nameplates shall include equipment designation, service voltage, and phases.
5. Receptacles shall include both the panelboard feeder source name and circuit number.

3.05 LOAD BALANCE

- A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.
- B. Balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, and other equipment where balancing is required.
- C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.06 CLEANING AND TOUCHUP PAINTING

- A. Cleaning: Throughout the Work, clean interior and exterior of devices and equipment by removing debris and vacuuming.
- B. Touchup Paint:
 - 1. Touchup scratches, scrapes and chips on exterior and interior surfaces of devices and equipment with finish matching type, color, and consistency and type of surface of original finish.
 - 2. If extensive damage is done to equipment paint surfaces, refinish entire equipment in a manner that provides a finish equal to or better than factory finish, that meets requirements of Specification, and is acceptable to Engineer.

3.07 PROTECTION FOLLOWING INSTALLATION

- A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation and contact surfaces.
- B. When equipment intended for indoor installation is installed at Contractor's convenience in areas where subject to dampness, moisture, dirt or other adverse atmosphere until completion of construction, ensure adequate protection from these atmospheres is provided and acceptable to Engineer.

END OF SECTION

SECTION 26 05 04
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. ASTM International (ASTM):
 - a. A1011/A1011M, Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy and High-Strength Low Alloy Formability.
 - b. E814, Method of Fire Tests of Through-Penetration Fire Stops.
 2. Institute of Electrical and Electronics Engineers, Inc. (IEEE): 18, Standard for Shunt Power Capacitors.
 3. International Society of Automation (ISA): RP12.06.01, Wiring Practices for Hazardous (Classified) Locations Instrumentation–Part 1: Intrinsic Safety.
 4. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. C12.1, Code for Electricity Metering.
 - c. C12.6, Phase-Shifting Devices Used in Metering, Marking and Arrangement of Terminals.
 - d. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
 - e. ICS 5, Industrial Control and Systems: Control Circuit and Pilot Devices.
 - f. KS 1, Enclosed and Miscellaneous Distribution Switches (600 Volts Maximum).
 5. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 6. UL:
 - a. 98, Standard for Enclosed and Dead-Front Switches.
 - b. 248, Standard for Low Voltage Fuses.
 - c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
 - d. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
 - e. 508, Standard for Industrial Control Equipment.
 - f. 810, Standard for Capacitors.
 - g. 943, Standard for Ground-Fault Circuit-Interrupters.
 - h. 1059, Standard for Terminal Blocks.
 - i. 1479, Fire Tests of Through-Penetration Fire Stops.

1.02 SUBMITTALS

A. Action Submittals:

1. Provide manufacturers' data for the following:
 - a. Control devices.
 - b. Control relays.
 - c. Circuit breakers.
 - d. Fused switches.
 - e. Nonfused switches.
 - f. Timers.
 - g. Fuses.
 - h. Intrinsic safety barriers.
 - i. Firestopping.
 - j. Enclosures: Include enclosure data for products having enclosures.
2. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals: Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

1.03 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

1. Fuses, 0 Volt to 600 Volts: Six of each type and each current rating installed.
2. Indicator lamps, LED: Two of each type.

PART 2 PRODUCTS

2.01 MOLDED CASE CIRCUIT BREAKER THERMAL MAGNETIC, LOW VOLTAGE

A. General:

1. Type: Molded case.
2. Trip Ratings: 15 amps to 800 amps.
3. Voltage Ratings: 120, 240, 277, 480, and 600V ac.
4. Suitable for mounting and operating in any position.
5. UL 489.

B. Operating Mechanism:

1. Overcenter, trip-free, toggle type handle.
2. Quick-make, quick-break action.
3. Locking provisions for padlocking breaker in OPEN position.
4. ON/OFF and TRIPPED indicating positions of operating handle.
5. Operating handle to assume a CENTER position when tripped.

C. Trip Mechanism:

1. Individual permanent thermal and magnetic trip elements in each pole.
2. Variable magnetic trip elements with a single continuous adjustment 3X to 10X for frames greater than 100 amps.
3. Two and three pole, common trip.
4. Automatically opens all poles when overcurrent occurs on one pole.
5. Test button on cover.
6. Calibrated for 40 degrees C ambient, unless shown otherwise.
7. Do not provide single-pole circuit breakers with handle ties where multi-pole circuit breakers are shown.

D. Short Circuit Interrupting Ratings:

1. Equal to, or greater than, available fault current or interrupting rating shown.
2. Equal to rating of existing equipment.
3. Not less than the following rms symmetrical currents for the indicated trip ratings:
 - a. Up to 100A, less than 250V ac: 10,000 amps.
 - b. Up to 100A, 250V ac to 600V ac: 14,000 amps.
 - c. Over 100A: 22,000 amps or as shown.
4. Series Connected Ratings: Do not apply series connected short circuit ratings, except where specifically shown. Where shown, provide UL-listed series ratings for the specific breaker/breaker and fuse/breaker combinations.

E. Ground Fault Circuit Interrupter (GFCI): Where indicated, equip breaker as specified above with ground fault sensor and rated to trip on 5 mA ground fault within 0.025 second (UL 943, Class A sensitivity, for protection of personnel).

1. Ground fault sensor shall be rated same as circuit breaker.
2. Push-to-test button.

F. Equipment Ground Fault Interrupter (EGFI): Where indicated, equip breaker specified above with ground fault sensor and rated to trip on 30 mA ground fault (UL-listed for equipment ground fault protection).

- G. Magnetic-only Type Breakers: Where shown; instantaneous trip adjustment which simultaneously sets magnetic trip level of each individual pole continuously through a 3X to 10X trip range.
- H. Accessories: Shunt trip, auxiliary switches, handle lock ON devices, mechanical interlocks, key interlocks, unit mounting bases, double lugs as shown or otherwise required. Shunt trip operators shall be continuous duty rated or have coil-clearing contacts.
- I. Connections:
 - 1. Supply (line side) at either end.
 - 2. Mechanical wire lugs, except crimp compression lugs where shown.
 - 3. Lugs removable/replaceable for breaker frames greater than 100 amperes.
 - 4. Suitable for 75 degrees C rated conductors without derating breaker or conductor ampacity.
 - 5. Use bolted bus connections, except where bolt-on is not compatible with existing breaker provisions.
- J. Enclosures for Independent Mounting:
 - 1. See Article Enclosures.
 - 2. Service Entrance Use: Breakers in required enclosure and required accessories shall be UL 489 listed.
 - 3. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position. Provide bypass feature for use by qualified personnel.

2.02 NONFUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

- A. NEMA KS 1.
- B. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.
- C. Lugs: Suitable for use with 75 degrees C wire at NEC 75 degrees C ampacity.
- D. Enclosures: See Article Enclosures.
- E. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

2.03 SUPPORT AND FRAMING CHANNELS

- A. Stainless Steel Framing Channel: Rolled, Type 316 stainless steel, 12-gauge minimum.
- B. Extruded Aluminum Framing Channel:
 - 1. Material: Extruded from Type 6063-T6 aluminum alloy.
 - 2. Fittings fabricated from Alloy 5052-H32.
- C. Manufacturers:
 - 1. B-Line Systems, Inc.
 - 2. Unistrut Corp.
 - 3. Aickinstrut.

2.04 FIRESTOPS

- A. General:
 - 1. Provide UL 1479 classified hourly fire rating equal to, or greater than, the assembly penetrated.
 - 2. Prevent the passage of cold smoke, toxic fumes, and water before and after exposure to flame.
 - 3. Sealants and accessories shall have fire-resistance ratings as established by testing identical assemblies in accordance with ASTM E814, by UL or other testing and inspection agency acceptable to authorities having jurisdiction.
- B. Firestop System:
 - 1. Formulated for use in through-penetration firestopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors.
 - 2. Fill, Void, or Cavity Material: 3M Brand Fire Barrier Caulk CP25, Putty 303, Wrap/Strip FS195, Composite Sheet CS195 and Penetration Sealing Systems 7902 and 7904 Series.
 - 3. Two-part, Foamed-in-place, Silicone Sealant: Dow Corning Corp. Fire Stop Foam, General Electric Co. Pensil 851.
 - 4. Firestop Devices: See Section 26 05 33, Raceway and Boxes, for raceway and cable fittings.

2.05 ENCLOSURES

- A. Finish: Sheet metal structural and enclosure parts shall be completely painted using an electrodeposition process so interior and exterior surfaces as well as bolted structural joints have a complete finish coat on and between them.

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- B. Color: Manufacturer’s standard color (gray) baked-on enamel, unless otherwise shown.
- C. Barriers: Provide metal barriers within enclosures to separate wiring of different systems and voltage.
- D. Enclosure Selections:
 - 1. Except as shown otherwise, provide electrical enclosures according to the following table:

Enclosures			
Location	Finish	Environment	NEMA 250 Type
Indoor	Finished	Dry	1
Indoor	Unfinished	Dry	1
Indoor	Unfinished	Industrial use	12
Indoor and outdoor	Any	Wet	4
Indoor and outdoor	Any	Denoted “WP”	3R
Indoor and outdoor	Any	Wet and corrosive	4X Type 304 stainless steel
Indoor and outdoor	Any	Wet, dust, or oil	13
Indoor and Outdoor	Any	Hazardous gas	7
Indoor and Outdoor	Any	Hazardous dust	9

PART 3 EXECUTION

3.01 GENERAL

- A. Install equipment in accordance with manufacturer’s recommendations.

3.02 SUPPORT AND FRAMING CHANNEL

- A. Install where required for mounting and supporting electrical equipment, raceway, and cable tray systems.
- B. Channel Type:
 - 1. Interior, Wet or Dry (Noncorrosive) Locations:
 - a. Aluminum Raceway: Extruded aluminum.
 - 2. Interior, Corrosive (Wet or Dry) Locations:
 - a. Aluminum Raceway: Extruded aluminum.
 - b. PVC Conduit: Type 316 stainless steel or nonmetallic.
 - c. Other Systems Not Covered: Type 316 stainless steel or nonmetallic.
 - 3. Outdoor, Noncorrosive Locations:
 - a. Aluminum Raceway and Other Systems Not Covered: Aluminum framing channel.
 - 4. Outdoor Corrosive Locations:
 - a. PVC Conduit: Type 316 stainless steel or nonmetallic.
 - b. Aluminum Raceway: Aluminum.
 - c. Other Systems Not Covered: Type 316 stainless steel or nonmetallic.
 - 5. Aluminum Railings: Devices mounted on aluminum railing shall use aluminum framing channel.
- C. Paint cut ends prior to installation with the following:
 - 1. Painted Channel: Rust-inhibiting epoxy or acrylic paint.
 - 2. Nonmetallic Channel: Epoxy resin sealer.

3.03 FIRESTOPS

- A. Install in strict conformance with manufacturer's instructions. Comply with installation requirements established by testing and inspecting agency.
- B. Sealant: Install sealant including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide firestops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs.

END OF SECTION

**SECTION 26 05 05
CONDUCTORS**

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. ASTM International (ASTM):
 - a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - b. B3, Standard Specification for Soft or Annealed Copper Wire.
 - c. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
 - d. B496, Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors.
 2. Insulated Cable Engineer's Association, Inc. (ICEA):
 - a. S-58-679, Standard for Control Cable Conductor Identification.
 - b. S-73-532, Standard for Control Thermocouple Extensions and Instrumentation Cables.
 - c. T-29-520, Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input of 210,000 Btu/hour.
 3. National Electrical Manufacturers' Association (NEMA):
 - a. WC 57, Standard for Control, Thermocouple Extension, and Instrumentation Cables.
 - b. WC 70, Standard for Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
 4. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - b. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
 5. UL:
 - a. 13, Standard for Safety for Power-Limited Circuit Cables.
 - b. 44, Standard for Safety for Thermoset-Insulated Wires and Cables.
 - c. 62, Standard for Safety for Flexible Cord and Cables.
 - d. 486A-486B, Standard for Safety for Wire Connectors.
 - e. 486C, Standard for Safety for Splicing Wire Connectors.
 - f. 510, Standard for Safety for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
 - g. 1277, Standard for Safety for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
 - h. 1581, Standard for Safety for Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.02 SUBMITTALS

A. Action Submittals:

1. Product Data:
 - a. Wire and cable.
 - b. Wire and cable accessories.
 - c. Cable fault detection system.
2. Cable Pulling Calculations:
 - a. Ensure submitted and reviewed before cable installation.
 - b. Provide for the following cable installations:
 - 1) Multiconductor 600-volt cable sizes larger than 2 AWG that cannot be hand pulled.
 - 2) Feeder circuits; single conductors #1/0 and larger.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with ANSI/NFPA 70-2017 (National Electrical Code NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. shall conform to those standards and shall have an applied NRTL listing mark.

PART 2 PRODUCTS

2.01 CONDUCTORS 600 VOLTS AND BELOW

- A. Conform to applicable requirements of NEMA WC 70.
- B. Conductor Type:
 1. 120- and 277-volt Lighting, 10 AWG and Smaller: Solid copper.
 2. 120-volt Receptacle Circuits, 10 AWG and Smaller: Solid copper.
 3. All Other Circuits: Stranded copper.
- C. Insulation: Type THHN/THWN 2, except for sizes No. 6 and larger, with Type XHHW 2 insulation.

D. Direct Burial and Aerial Conductors and Cables:

1. Type USE/RHH/RHW insulation, UL 854 listed, or Type RHW-2/USE-2.
2. Conform to physical and minimum thickness requirements of NEMA WC 70.

E. Flexible Cords and Cables:

1. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
2. Conform to physical and minimum thickness requirements of NEMA WC 70.

2.02 600-VOLT RATED CABLE

A. General:

1. Type TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 70,000 Btu per hour, and NFPA 70, Article 340, or UL 13 meeting requirements of NFPA 70, Article 725.
2. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
3. Suitable for installation in open air, in cable trays, or conduit.
4. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
5. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

B. Type 1, Multiconductor Control Cable:

1. Conductors:
 - a. 14 AWG, seven-strand copper.
 - b. Insulation: 15-mil PVC with 4-mil nylon.
 - c. UL 1581 listed as Type THHN/THWN rated VW-1.
 - d. Conductor group bound with spiral wrap of barrier tape.
 - e. Color Code: In accordance with ICEA S-58-679, Method 1, Table 2.
2. Cable: Passes the ICEA T-29-520, 210,000 Btu per hour Vertical Tray Flame Test.

3. Cable Sizes:

No. of Conductors	Max. Outside Diameter (Inches)	Jacket Thickness (Mils)
3	0.41	45
5	0.48	45
7	0.52	45
12	0.72	60
19	0.83	60
25	1.00	60
37	1.15	80

4. Manufacturers:

- a. Okonite Co.
- b. Southwire.

C. Type 3, 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57 requirements.

- 1. Outer Jacket: 45-mil nominal thickness.
- 2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
- 3. Dimension: 0.31-inch nominal OD.
- 4. Conductors:
 - a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
 - b. 20 AWG, seven-strand tinned copper drain wire.
 - c. Insulation: 15-mil nominal PVC.
 - d. Jacket: 4-mil nominal nylon.
 - e. Color Code: Pair conductors, black and red.
- 5. Manufacturers:
 - a. Okonite Co.
 - b. Alpha Wire Corp.
 - c. Belden.

2.03 GROUNDING CONDUCTORS

- A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.
- B. Direct Buried: Bare stranded copper, Tin-Coated.

2.04 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Tape:

1. General-purpose, Flame-retardant: 7-mil, vinyl plastic, Scotch Brand 33+, rated for 90 degrees C minimum, meeting requirements of UL 510.
2. Flame-retardant, Cold- and Weather-resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.
3. Arc and Fireproofing:
 - a. 30-mil, elastomer.
 - b. Manufacturers and Products:
 - 1) 3M; Scotch Brand 77, with Scotch Brand 69 glass cloth tape binder.
 - 2) Plymouth; 53 Plyarc, with 77 Plyglas glass cloth tape binder.

B. Identification Devices:

1. Sleeve:
 - a. Permanent, PVC, yellow or white, with legible machine-printed black markings.
 - b. Manufacturers and Products:
 - 1) Raychem; Type D-SCE or ZH-SCE.
 - 2) Brady, Type 3PS.
2. Heat Bond Marker:
 - a. Transparent thermoplastic heat bonding film with acrylic pressure sensitive adhesive.
 - b. Self-laminating protective shield over text.
 - c. Machine printed black text.
 - d. Manufacturer and Product: 3M Co.; Type SCS-HB.
3. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.
4. Tie-on Cable Marker Tags:
 - a. Chemical-resistant white tag.
 - b. Size: 1/2 inch by 2 inches.
 - c. Manufacturer and Product: Raychem; Type CM-SCE.
5. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.

C. Connectors and Terminations:

1. Nylon, Self-insulated Crimp Connectors:
 - a. Manufacturers and Products:
 - 1) Thomas & Betts; Sta-Kon.
 - 2) Burndy; Insulug.
 - 3) ILSCO.

2. Nylon, Self-insulated, Crimp Locking-fork, Torque-type Terminator:
 - a. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
 - b. Seamless.
 - c. Manufacturers and Products:
 - 1) Thomas & Betts; Sta-Kon.
 - 2) Burndy; Insulink.
 - 3) ILSCO; ILSCONS.
3. Self-insulated, Set Screw Wire Connector:
 - a. Two piece compression type with set screw in brass barrel.
 - b. Insulated by insulator cap screwed over brass barrel.
 - c. Manufacturers:
 - 1) 3M Co.
 - 2) Thomas & Betts.
 - 3) Marrette.

D. Cable Lugs:

1. In accordance with NEMA CC 1.
2. Rated 600 volts of same material as conductor metal.
3. Uninsulated Crimp Connectors and Terminators:
 - a. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
 - b. Manufacturers and Products:
 - 1) Thomas & Betts; Color-Keyed.
 - 2) Burndy; Hydent.
 - 3) ILSCO.
4. Uninsulated, Bolted, Two-way Connectors and Terminators:
 - a. Manufacturers and Products:
 - 1) Thomas & Betts; Locktite.
 - 2) Burndy; Quiklug.
 - 3) ILSCO.

E. Cable Ties:

1. Nylon, adjustable, self-locking, and reusable.
2. Manufacturer and Product: Thomas & Betts; TY-RAP.

F. Heat-shrinkable Insulation:

1. Thermally stabilized cross-linked polyolefin.
2. Single wall for insulation and strain relief.

3. Dual-wall, adhesive sealant lined, for sealing and corrosion resistance.
4. Manufacturers and Products:
 - a. Thomas & Betts; SHRINK-KON.
 - b. Raychem; RNF-100 and ES-2000.

2.05 PULLING COMPOUND

- A. Nontoxic, noncorrosive, noncombustible, nonflammable, water-based lubricant; UL-listed.
- B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.
- C. Approved for intended use by cable manufacturer.
- D. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.
- E. Manufacturers:
 1. Ideal Co.
 2. Polywater, Inc.
 3. Cable Grip Co.

2.06 WARNING TAPE

- A. As specified in Section 26 05 33, Raceway and Boxes.

2.07 SOURCE QUALITY CONTROL

- A. Conductors 600 Volts and Below: Test in accordance with UL 44 and UL 854.

PART 3 EXECUTION

3.01 GENERAL

- A. Conductor installation shall be in accordance with manufacturer's recommendations.
- B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.
- C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.
- D. Terminate conductors and cables, unless otherwise indicated.

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- E. Tighten screws and terminal bolts in accordance with UL 486A-486B for copper conductors and aluminum conductors.
- F. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.
- G. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 18 inches on center.
- H. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

3.02 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:

- 1. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering area 1-1/2 inches to 2 inches wide.
- 2. 8 AWG and Smaller: Provide colored conductors.
- 3. Colors:

System	Conductor	Color
All systems	Equipment Grounding	Green
240/120 volts, single-phase, three-wire	Grounded neutral One hot leg Other hot leg	White Black Red
208Y/120 volts, three-phase, four-wire	Grounded neutral Phase A Phase B Phase C	White Black Red Blue
240/120 volts, three-phase, four-wire, delta, center tap, ground on single-phase	Grounded neutral Phase A High (wild) leg Phase C	White Black Orange Blue
480Y/277 volts, three-phase, four-wire	Grounded neutral Phase A Phase B Phase C	White Brown Orange Yellow
Note: Phase A, B, C implies direction of positive phase rotation.		

- 4. Tracer: Outer covering of white with identifiable colored strip, other than green, in accordance with NFPA 70.

3.03 CIRCUIT IDENTIFICATION

- A. Identify power, instrumentation, and control conductor circuits at each termination, and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.
- B. Circuits Appearing in Circuit Schedules: Identify using circuit schedule designations.
- C. Circuits Not Appearing in Circuit Schedules:
 - 1. Assign circuit name based on device or equipment at load end of circuit.
 - 2. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.
- D. Method:
 - 1. Conductors 3 AWG and Smaller: Identify with sleeves or heat bond markers.
 - 2. Cables and Conductors 2 AWG and Larger:
 - a. Identify with marker plates or tie-on cable marker tags.
 - b. Attach with nylon tie cord.
 - 3. Taped-on markers or tags relying on adhesives not permitted.

3.04 CONDUCTORS 600 VOLTS AND BELOW

- A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.
- B. Do not splice incoming service conductors and branch power distribution conductors 6 AWG and larger, unless specifically indicated or approved by Engineer.
- C. Connections and Terminations:
 - 1. Install wire nuts only on solid conductors. Wire nuts are not allowed on stranded conductors.
 - 2. Install nylon self-insulated crimp connectors and terminators for instrumentation and control, circuit conductors.
 - 3. Install self-insulated, set screw wire connectors for two-way connection of power circuit conductors 12 AWG and smaller.
 - 4. Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors 4 AWG through 2/0 AWG.

5. Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors 3/0 AWG and larger.
 6. Install uninsulated terminators bolted together on motor circuit conductors 10 AWG and larger.
 7. Place no more than one conductor in any single-barrel pressure connection.
 8. Install crimp connectors with tools approved by connector manufacturer.
 9. Install terminals and connectors acceptable for type of material used.
 10. Compression Lugs:
 - a. Attach with a tool specifically designed for purpose. Tool shall provide complete, controlled crimp and shall not release until crimp is complete.
 - b. Do not use plier type crimpers.
- D. Do not use soldered mechanical joints.
- E. Splices and Terminations:
1. Insulate uninsulated connections.
 2. Indoors: Use general purpose, flame retardant tape or single wall heat shrink.
 3. Outdoors, Dry Locations: Use flame-retardant, cold- and weather-resistant tape or single-wall heat-shrink.
 4. Below Grade and Wet or Damp Locations: Use dual-wall heat-shrink.
- F. Cap spare conductors with UL listed end caps.
- G. Cabinets, Panels, and Motor Control Centers:
1. Remove surplus wire, bridle and secure.
 2. Where conductors pass through openings or over edges in sheet metal, remove burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.
- H. Control and Instrumentation Wiring:
1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
 2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.
 3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.

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4. Where connections of cables installed under this section are to be made under Section 40 90 01, Instrumentation and Control for Process Systems, leave pigtails of adequate length for bundled connections.
 5. Cable Protection:
 - a. Under Infinite Access Floors: May install without bundling.
 - b. All Other Areas: Install individual wires, pairs, or triads in flex conduit under floor or grouped into bundles at least 1/2 inch in diameter.
 - c. Maintain integrity of shielding of instrumentation cables.
 - d. Ensure grounds do not occur because of damage to jacket over shield.
- I. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. Institute of Electrical and Electronics Engineers (IEEE): C2, National Electrical Safety Code (NESC).
 2. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC).

1.02 SUBMITTALS

- A. Action Submittals:
1. Shop Drawings:
 - a. Product data for the following:
 - 1) Exothermic weld connectors.
 - 2) Mechanical connectors.
 - 3) Compression connectors.
 - 4) Ground rods.

1.03 QUALITY ASSURANCE

- A. Authority Having Jurisdiction (AHJ):
1. Provide the Work in accordance with ANSI/NFPA 70-2017, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory (NRTL) or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
 2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. (UL) shall conform to those standards and shall have an applied NRTL listing mark.

PART 2 PRODUCTS

2.01 GROUND ROD

- A. Material: Copper-clad.
- B. Diameter: Minimum 3/4 inch.
- C. Length: 20 feet.

2.02 GROUND CONDUCTORS

- A. As specified in Section 26 05 05, Conductors.

2.03 CONNECTORS

- A. Exothermic Weld Type:
 - 1. Outdoor Weld: Suitable for exposure to elements or direct burial.
 - 2. Indoor Weld: Use low-smoke, low-emission process.
 - 3. Manufacturers:
 - a. Erico Products, Inc.; Cadweld and Cadweld Exolon.
 - b. Thermoweld.
- B. Compression Type:
 - 1. Compress-deforming type; wrought copper extrusion material.
 - 2. Single indentation for conductors 6 AWG and smaller.
 - 3. Double indentation with extended barrel for conductors 4 AWG and larger.
 - 4. Barrels prefilled with oxide-inhibiting and antiseizing compound and sealed.
 - 5. Manufacturers:
 - a. Burndy Corp.; Hyground Irreversible Compression.
 - b. Thomas and Betts Co.
 - c. ILSCO.
- C. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.
 - 1. Manufacturers:
 - a. Burndy Corp.
 - b. Thomas and Betts Co.

2.04 GROUNDING WELLS

- A. Ground rod box complete with cast-iron riser ring and traffic cover marked "GROUND ROD".
- B. Manufacturers and Products:
 - 1. Christy Co.; No. G5.
 - 2. Lightning and Grounding Systems, Inc.; I-R Series.

PART 3 EXECUTION

3.01 GENERAL

- A. Grounding: In compliance with NFPA 70 and IEEE C2.
- B. Ground electrical service neutral at service entrance equipment with grounding electrode conductor to grounding electrode system.
- C. Ground each separately derived system neutral with common grounding electrode conductor to grounding electrode system.
- D. Bond together all grounding electrodes that are present at each building or structure served to form one common grounding electrode system.
- E. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.
- F. Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.
- G. Shielded Instrumentation Cables:
 - 1. Ground shield to ground bus at power supply for analog signal.
 - 2. Expose shield minimum 1 inch at termination to field instrument and apply heat-shrink tube.
 - 3. Do not ground instrumentation cable shield at more than one point.

3.02 WIRE CONNECTIONS

- A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.
- B. Nonmetallic Raceways and Flexible Tubing: Install equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.

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- C. Connect ground conductors to raceway grounding bushings.
- D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.
- E. Connect enclosure of equipment containing ground bus to that bus.
- F. Bolt connections to equipment ground bus.
- G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.
- H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.
- I. Metallic Equipment Enclosures: Use furnished ground lug; if none furnished, tap equipment housing and install solderless terminal connected to box with machine screw. For circuits greater than 20 amps use minimum 5/16-inch diameter bolt.

3.03 GROUND RODS

- A. Install full length with conductor connection at upper end.
- B. Install with connection point below finished grade, unless otherwise shown.
- C. Space multiple ground rods by one rod length.

3.04 GROUNDING WELLS

- A. Install for ground rods where shown on Drawings.
- B. Install riser ring and cover flush with surface.
- C. Place 6 inches of crushed rock in bottom of each well.

3.05 CONNECTIONS

- A. General:
 - 1. Above-grade Connections: Install exothermic weld, mechanical, or compression-type connectors; or brazing.
 - 2. Below-grade Connections: Install exothermic weld or compression type connectors.

3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.
4. Notify Engineer prior to backfilling ground connections.

B. Exothermic Weld Type:

1. Wire brush or file contact point to bare metal surface.
2. Use welding cartridges and molds in accordance with manufacturer's recommendations.
3. Avoid using badly worn molds.
4. Mold to be completely filled with metal when making welds.
5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

C. Compression Type:

1. Install in accordance with connector manufacturer's recommendations.
2. Install connectors of proper size for grounding conductors and ground rods specified.
3. Install using connector manufacturer's compression tool having proper sized dies and operate per manufacturer's instructions.

D. Mechanical Type:

1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.
2. Install in accordance with connector manufacturer's recommendations.
3. Do not conceal mechanical connections.

3.06 METAL STRUCTURE GROUNDING

- A. Bond metal sheathing and exposed metal vertical structural elements to grounding system.
- B. Bond electrical equipment supported by metal platforms to the platforms.
- C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.07 MANHOLE AND HANDHOLE GROUNDING

- A. Install one ground rod inside each manhole and handhole larger than 24-inch by 24-inch inside dimensions.
- B. Ground Rod Floor Protrusion: 4 inches to 6 inches above floor.

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- C. Make connections of grounding conductors fully visible and accessible.
- D. Connect all noncurrent-carrying metal parts and any metallic raceway grounding bushings to ground rod with 6 AWG copper conductor.

3.08 TRANSFORMER GROUNDING

- A. Bond neutrals of stepdown transformers to grounding electrode system.

3.09 LIGHTNING PROTECTION SYSTEMS

- A. Bond lightning protection system ground terminals to building or structure grounding electrode system.

3.10 SURGE PROTECTION EQUIPMENT GROUNDING

- A. Connect surge arrestor ground terminals to equipment ground bus.

END OF SECTION

**SECTION 26 05 33
RACEWAY AND BOXES**

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Association of State Highway and Transportation Officials (AASHTO): HB, Standard Specifications for Highway Bridges.
 2. ASTM International (ASTM):
 - a. A123/123M, Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.
 - b. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - c. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - d. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
 - e. D149, Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
 3. National Electrical Contractor's Association, Inc. (NECA): Installation standards.
 4. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. C80.1, Electrical Rigid Steel Conduit (ERSC).
 - c. C80.3, Steel Electrical Metallic Tubing (EMT).
 - d. C80.5, Electrical Rigid Aluminum Conduit (ERAC).
 - e. C80.6, Electrical Intermediate Metal Conduit (EIMC).
 - f. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - g. TC 2, Electrical Polyvinyl Chloride (PVC) Conduit.
 - h. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
 - i. TC 6, Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation.
 - j. TC 14, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
 - k. VE 1, Metallic Cable Tray Systems.
 5. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

6. Underwriters Laboratories Inc. (UL):
 - a. 1, Standard for Safety for Flexible Metal Conduit.
 - b. 5, Standard for Safety for Surface Metal Raceways and Fittings.
 - c. 6, Standard for Safety for Electrical Rigid Metal Conduit – Steel.
 - d. 6A, Standard for Safety for Electrical Rigid Metal Conduit – Aluminum, Red Brass and Stainless.
 - e. 360, Standard for Safety for Liquid-Tight Flexible Steel Conduit.
 - f. 514B, Standard for Safety for Conduit, Tubing, and Cable Fittings.
 - g. 651, Standard for Safety for Schedule 40 and 80 Rigid PVC Conduit and Fittings.
 - h. 651A, Standard for Safety for Type EB and A Rigid PVC Conduit and HDPE Conduit.
 - i. 797, Standard for Safety for Electrical Metallic Tubing – Steel.
 - j. 870, Standard for Safety for Wireways, Auxiliary Gutters, and Associated Fittings.
 - k. 1242, Standard for Safety for Electrical Intermediate Metal Conduit – Steel.
 - l. 1660, Standard for Safety for Liquid-Tight Flexible Nonmetallic Conduit.
 - m. 1684, Standard for Safety for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
 - n. 2024, Standard for Safety for Optical Fiber and Communication Cable Raceway.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's Literature:
 - a. Rigid aluminum conduit.
 - b. PVC Schedule 40 conduit.
 - c. PVC-coated rigid Aluminum conduit.
 - d. Flexible metal, liquid-tight conduit.
 - e. Conduit fittings.
 - f. Junction and pull boxes used at or below grade.
 - g. Large junction and pull boxes.
 - h. Terminal junction boxes.
2. Precast Manholes and Handholes:
 - a. Dimensional drawings and descriptive literature.
 - b. Traffic loading calculations.
 - c. Accessory information.
3. Equipment and machinery proposed for bending metal conduit.

4. Contractor's manufacturer certification for installation of PVC-coated rigid aluminum conduit.
 5. Method for bending PVC conduit less than 30 degrees.
 6. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
 7. Conduit Layout:
 - a. Provide drawings for underground and concealed conduits including, but not limited to ductbanks, under floor slabs, concealed in floor slabs, and concealed in walls.
 - b. Provide plan and section showing arrangement and location of conduit and duct bank required for:
 - 1) Low voltage feeder and branch circuits.
 - 2) Instrumentation and control systems.
 - 3) Communications systems.
 - 4) Empty conduit for future use.
 - c. Electronic CAD; scale not greater than 1 inch equals 20 feet.
- B. Informational Submittals: Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

1.03 QUALITY ASSURANCE

- A. Authority Having Jurisdiction (AHJ):
1. Provide the Work in accordance with ANSI/NFPA 70-2017, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory (NRTL) or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
 2. Materials and equipment manufactured within scope of standards published by Underwriters Laboratories, Inc. (UL) shall conform to those standards and shall have an applied NRTL listing mark.
- B. PVC-coated, Rigid Aluminum Conduit Installer: Certified by conduit manufacturer as having received minimum 2 hours of training on installation procedures.

PART 2 PRODUCTS

2.01 CONDUIT AND TUBING

- A. Electrical Rigid Aluminum Conduit (ERAC):
1. Meet requirements of NEMA C80.5 and UL 6A.
 2. Material: 6063 alloy in temper designation T-1.

B. PVC Schedule 40 Conduit:

1. Meet requirements of NEMA TC 2 and UL 651.
2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.

C. PVC-coated Rigid Aluminum Conduit:

1. Meet requirements of NEMA RN 1.
2. Material:
 - a. Meet requirements of NEMA C80.5 and UL 6A.
 - b. Exterior Finish: PVC coating, 40-mil nominal thickness; bond to metal shall have tensile strength greater than PVC.
 - c. Interior finish: Urethane coating, 2-mil nominal thickness.
3. Threads: Clear urethane coating over aluminum.
4. Bendable without damage to interior or exterior coating.

D. Flexible Metal, Liquid-tight Conduit:

1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel with extruded PVC jacket.

2.02 FITTINGS

A. Rigid Aluminum Conduit:

1. General:
 - a. Meet requirements of UL 6A.
 - b. Type: Threaded, aluminum. Set screw and threadless compression fittings not permitted.
2. Bushing:
 - a. Material: Aluminum with integral insulated throat, rated for 150 degrees C.
 - b. Manufacturers and Products:
 - 1) Thomas & Betts; Type 1223AL.
 - 2) O-Z/Gedney; Type AB.
3. Grounding Bushing:
 - a. Material: Aluminum with integral insulated throat rated for 150 degrees C, with solderless lugs.
 - b. Manufacturers and Products:
 - 1) Thomas & Betts; Type BGA.
 - 2) O-Z/Gedney; Type ABLG.

4. Conduit Hub:
 - a. Material: Aluminum with insulated throat with bonding screw.
 - b. UL-listed for use in wet locations.
 - c. Manufacturers and Products:
 - 1) Appleton, Series HUB.
 - 2) Thomas & Betts, Series HT.
5. Conduit Bodies:
 - a. Sized as required by NFPA 70.
 - b. Manufacturers and Products (For Normal Conditions):
 - 1) O-Z/Gedney; Type LB-A.
 - 2) Killark; Series O electrolets.
 - 3) Thomas & Betts; Form 7.
 - c. Manufacturers (For Hazardous Locations):
 - 1) Appleton.
 - 2) Thomas & Betts.
 - 3) Killark.
6. Couplings: As supplied by conduit manufacturer.
7. Unions:
 - a. Concrete tight, aluminum.
 - b. Manufacturers and Products:
 - 1) Thomas & Betts; Series EX three-piece union.
 - 2) O-Z/Gedney; Type UNF-A, three-piece coupling.
8. Conduit Sealing Fitting:
 - a. Manufacturers and Products:
 - 1) Appleton; Type EYF-AL, EYM-AL.
 - 2) Killark; Type EY or Type EYS.
9. Drain Seal:
 - a. Manufacturers and Products:
 - 1) Appleton; Type EYD.
 - 2) Killark; Type EYD.
10. Drain/Breather Fitting:
 - a. Manufacturers and Products:
 - 1) Appleton; Type ECDB.
 - 2) Thomas & Betts; ECD.
11. Expansion Fitting:
 - a. Manufacturers and Products:
 - 1) Deflection/Expansion Movement:
 - a) Killark; Type DF-AL.
 - b) Thomas & Bett; Type XD.
 - 2) Expansion Movement Only:
 - a) O-Z/Gedney; Type AX-A.
 - b) Killark; AF-AL.

12. Cable Sealing Fitting:
 - a. To form watertight nonslip cord or cable connection to conduit.
 - b. For Conductors with OD of 1/2 inch or Less: Neoprene bushing at connector entry.
 - c. Manufacturers and Products:
 - 1) Appleton; CG.
 - 2) O-Z/Gedney; CSBG-A.
- B. PVC Conduit and Tubing:
 1. Meet requirements of NEMA TC 3.
 2. Type: PVC, slip-on.
- C. PVC-coated Rigid Aluminum Conduit:
 1. Meet requirements of UL 514B.
 2. Fittings: Rigid aluminum type, PVC-coated by conduit manufacturer.
 3. Conduit Bodies: Aluminum alloy. Cover shall be of same material as conduit body. PVC-coated by conduit manufacturer.
 4. Finish: 40-mil PVC exterior, 2-mil urethane interior.
 5. Overlapping pressure-sealing sleeves.
 6. Conduit Hangers, Attachments, and Accessories: PVC-coated.
 7. Manufacturers:
 - a. Robroy Industries.
 - b. Ocal.
 8. Expansion Fitting:
 - a. Manufacturer and Product: Ocal; OCAL-BLUE XJG.
- D. Flexible Metal, Liquid-tight Conduit:
 1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
 2. Insulated throat and sealing O-rings.
 3. Manufacturers and Products:
 - a. Thomas & Betts; Series 5331.
 - b. O-Z/Gedney; Series 4Q.
- E. Watertight Entrance Seal Device:
 1. New Construction:
 - a. Material: Oversized sleeve, aluminum with sealing ring, pressure ring, grommet seal, and pressure clamp.
 - b. Manufacturer and Product: O-Z/Gedney.
 2. Cored-hole Application:
 - a. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.
 - b. Manufacturer and Product: O-Z/Gedney; Series CSM.

2.03 OUTLET AND DEVICE BOXES

A. Cast Metal:

1. Box: Aluminum.
2. Cover: Gasketed, weatherproof, aluminum, with stainless steel screws.
3. Hubs: Threaded.
4. Lugs: Cast mounting.
5. Manufacturers and Products, Nonhazardous Locations:
 - a. Appleton; Type FS-A or Type FD-A.
 - b. Killark.
6. Manufacturers and Products, Hazardous Locations:
 - a. Appleton; Type GR-A.
 - b. Killark.

B. PVC-coated Cast Metal:

1. Type: One-piece.
2. Material: Cast aluminum.
3. Coating:
 - a. Exterior Surfaces: 40-mil PVC.
 - b. Interior Surfaces: 2-mil urethane.
4. Manufacturers:
 - a. Robroy Industries.
 - b. Ocal.

C. Nonmetallic:

1. Box: PVC.
2. Cover: PVC, weatherproof, with stainless steel screws.
3. Manufacturer and Product: Carlon; Type FS or Type FD, with Type E98 or Type E96 covers.

2.04 JUNCTION AND PULL BOXES

A. Outlet Box Used as Junction or Pull Box: As specified under Article Outlet and Device Boxes.

B. Conduit Bodies Used as Junction Boxes: As specified under Article Fittings.

C. Large Cast Metal Box, Hazardous Locations:

1. NEMA 250 Type 7 or Type 9 as required for class, division, and group involved.
2. Box: Copper-free aluminum with drilled and tapped conduit entrances.
3. Cover: Nonhinged with screws.

4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Manufacturers and Products:
 - a. Crouse-Hinds; Type EJB.
 - b. Appleton; Type AJBEW.

D. Large Stainless Steel Box:

1. NEMA 250 Type 4X.
2. Box: 14-gauge, ASTM A240/A240M, Type 304 stainless steel, with white enamel painted interior mounting panel.
3. Cover: Hinged with clamps.
4. Hardware and Machine Screws: ASTM A167, Type 304 stainless steel.
5. Exterior/Interior Finish: Painted with baked-on white enamel.
6. Manufacturers:
 - a. Pentair/Hoffman.
 - b. Robroy Industries.
 - c. Wiegman.

E. Concrete Box, Nontraffic Areas:

1. Box: Reinforced, cast concrete with extension.
2. Cover: Steel diamond plate with locking bolts.
3. Cover Marking: ELECTRICAL, TELEPHONE, or as shown.
4. Size: 10 inches by 17 inches, minimum.
5. Manufacturers and Products:
 - a. Utility Vault Co.; Series 36-1017.
 - b. Christy, Concrete Products, Inc.; N9.
 - c. Quazite; "PG" Style.

F. Concrete Box, Traffic Areas:

1. Box: Reinforced, cast concrete with extension and bottom slab.
2. Cover: Steel checked plate; H/20 loading with screw down.
3. Cover Marking: ELECTRICAL, TELEPHONE, or as shown.
4. Manufacturers and Products:
 - a. Christy, Concrete Products, Inc.; B1017BOX.
 - b. Utility Vault Co.; 3030 SB.

2.05 TERMINAL JUNCTION BOX

- A. Cover: Hinged, unless otherwise shown.
- B. Interior Finish: Paint with white enamel or lacquer.

- C. Terminal Blocks:
 - 1. Separate connection point for each conductor entering or leaving box.
 - 2. Spare Terminal Points: 25 percent, minimum.

2.06 PRECAST MANHOLES AND HANDHOLES

- A. Concrete Strength: Minimum, 3,000 psi compressive, in 28 days.
- B. Loading: AASHTO, H-20 in accordance with ASTM C857.
- C. Access: Provide cast concrete 6-inch or 12-inch risers and access hole adapters between top of manhole and finished grade at required elevations.
- D. Drainage:
 - 1. Slope floors toward drain points, leaving no pockets or other nondraining areas.
 - 2. Provide drainage outlet or sump at low point of floor constructed with a heavy, cast iron, slotted or perforated hinged cover, and a minimum 4-inch outlet and outlet pipe.
- E. Raceway Entrances:
 - 1. Provide on all four sides.
 - 2. Provide knockout panels or precast individual raceway openings.
 - 3. At entrances where raceways are to be installed by others, provide minimum 12-inch-high by 24-inch-wide knockout panels for future raceway installation.
- F. Embedded Pulling Iron:
 - 1. Material: 3/4-inch-diameter stock, fastened to overall steel reinforcement before concrete is placed.
 - 2. Location:
 - a. Wall: Opposite each raceway entrance and knockout panel for future raceway entrance.
 - b. Floor: Centered below manhole or handhole cover.
- G. Cable Racks:
 - 1. Arms and Insulators: Adjustable, of sufficient number to accommodate cables for each raceway entering or leaving manhole, including spares.
 - 2. Wall Attachment:
 - a. Adjustable inserts in concrete walls. Bolts or embedded studs not permitted.

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- b. Insert Spacing: Maximum 3 feet on center for inside perimeter of manhole.
- c. Arrange in order that spare raceway ends are clear for future cable installation.

H. Manhole Frames and Covers:

1. Material: Machined cast iron.
2. Diameter: 32 inch.
3. Cover Type: Indented, solid top design, with two drop handles each.
4. Cover Loading: AASHTO H-20.
5. Cover Designation: Cast, on upper side, in integral letters, minimum 2 inches in height, appropriate titles:
 - a. 600 Volts and Below: ELECTRIC LV.
 - b. CONTROL.

I. Handhole Frames and Covers:

1. Material: Steel, hot-dipped galvanized.
2. Cover Type: Solid, hinged, of checkered design.
3. Cover Loading: AASHTO H-20.
4. Cover Designation: Burn by welder, on upper side in integral letters, minimum 2 inches in height, appropriate titles:
 - a. 600 Volts and Below: ELECTRIC LV.
 - b. CONTROL.

J. Hardware: Steel, hot-dip galvanized.

K. Furnish knockout for ground rod in each handhole and manhole.

L. Manufacturers:

1. Utility Vault Co.
2. Penn-Cast Products, Inc.
3. Concrete Conduit Co.
4. Associated Concrete Products, Inc.
5. Pipe, Inc.

2.07 ACCESSORIES

A. Duct Bank Spacers:

1. Modular Type:
 - a. Nonmetallic, interlocking, for multiple conduit sizes.
 - b. Suitable for all types of conduit.

- c. Manufacturers:
 - 1) Underground Device, Inc.
 - 2) Carlon.
- 2. Template Type:
 - a. Nonmetallic, custom made one-piece spacers.
 - b. Suitable for all types of conduit.
 - c. Material: HDPE or polypropylene, 1/2-inch minimum thickness.
 - d. Conduit openings cut 1 inch larger than conduit outside diameter.
 - e. Additional openings for stake-down, rebar, and concrete flow through as required.
 - f. Manufacturer and Product: SP Products; Quik Duct.
- B. Identification Devices:
 - 1. Raceway Tags:
 - a. Material: Permanent, nylon polyethylene.
 - b. Shape: Round.
 - c. Raceway Designation: Pressure stamped, embossed, or engraved.
 - d. Tags relying on adhesives or taped-on markers not permitted.
 - 2. Warning Tape:
 - a. Material: Polyethylene, 4-mil gauge with detectable strip.
 - b. Color: Red.
 - c. Width: Minimum 6 inches.
 - d. Designation: Warning on tape that electric circuit is located below tape.
 - e. Identifying Letters: Minimum 1-inch-high permanent black lettering imprinted continuously over entire length.
 - f. Manufacturers and Products:
 - 1) Panduit; Type HTDU.
 - 2) Reef Industries; Terra Tape.
 - 3. Buried Raceway Marker:
 - a. Material: Sheet bronze, consisting of double-ended arrows, straight for straight runs and bent at locations where runs change direction.
 - b. Designation: Engrave to depth of 3/32 inch; ELECTRIC CABLES, in letters 1/4-inch high.
 - c. Minimum Dimension: 1/4 inch thick, 10 inches long, and 3/4 inch wide.
- C. Heat-shrinkable Tubing:
 - 1. Material: Heat-shrinkable, cross-linked polyolefin.
 - 2. Semi-flexible with meltable adhesive inner liner.

3. Color: Black.
 4. Manufacturers:
 - a. Raychem.
 - b. 3M.
- D. Wraparound Duct Band:
1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.
 2. Width: 50 mm minimum.
 3. Manufacturer and Product: Raychem; Type TWDB.

PART 3 EXECUTION

3.01 GENERAL

- A. Prior to beginning Work, Contractor must provide written documentation of manufacturer's certification for training in the installation of PVC-coated rigid aluminum conduit, and a list of names of those in its employ that have the certification and will be physically installing the conduit.
- B. Conduit and tubing sizes shown are based on use of copper conductors.
- C. Comply with NECA installation standards.
- D. Crushed or deformed raceways not permitted.
- E. Maintain raceway entirely free of obstructions and moisture.
- F. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.
- G. Aluminum Conduit: Do not install in direct contact with concrete. Install in PVC sleeve or cored hole through concrete walls and slabs.
- H. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.
- I. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.
- J. Group raceways installed in same area.
- K. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

- L. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.
- M. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.
- N. Block Walls: Do not install raceways in same horizontal course or vertical cell with reinforcing steel.
- O. Install watertight fittings in outdoor, underground, or wet locations.
- P. Metal conduit shall be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.
- Q. Do not install raceways in concrete equipment pads, foundations, or beams without Engineer approval.
- R. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.
- S. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.
- T. Install conduits for fiber optic cables, telephone cables, and Category 6 data cables in strict conformance with the requirements of TIA 569B.
- U. Separate exposed conduits for analog signal cables from exposed conduits for power conductors and cables by a minimum of 12-inches.

3.02 INSTALLATION IN CAST-IN-PLACE STRUCTURAL CONCRETE

- A. Minimum Cover: 2 inches, including fittings.
- B. Conduit placement shall not require changes in reinforcing steel location or configuration.
- C. Provide nonmetallic support during placement of concrete to ensure raceways remain in position.
- D. Conduit larger than 1 inch shall not be embedded in concrete slabs, walls, foundations, columns, or beams unless approved by Engineer.
- E. Slabs and Walls (Requires Engineer Approval):
 - 1. Trade size of conduit not to exceed one-fourth of slab or wall thickness.
 - 2. Install within middle two-fourths of slab or wall.

3. Separate conduit less than 2-inch trade size by a minimum ten times conduit trade size, center-to-center, unless otherwise shown.
4. Separate conduit 2-inch and greater trade size by a minimum eight times conduit trade size, center-to-center, unless otherwise shown.
5. Cross conduit at an angle greater than 45 degrees, with minimum separation of 1 inch.
6. Separate conduit by a minimum six times the outside dimension of expansion/deflection fittings at expansion joints.
7. Conduit shall not be installed below the maximum water surface elevation in walls of water holding structures.

F. Columns and Beams (Requires Engineer Approval):

1. Trade size of conduit not to exceed one-fourth of beam thickness.
2. Conduit cross-sectional area not to exceed 4 percent of beam or column cross section.

3.03 CONDUIT APPLICATION

- A. Diameter: Minimum 3/4 inch.
- B. Exterior, Exposed:
 1. Rigid aluminum.
 2. PVC-coated rigid aluminum.
- C. Interior, Exposed:
 1. Rigid aluminum.
 2. PVC-coated rigid aluminum.
- D. Interior, Concealed (Not Embedded in Concrete):
 1. Rigid aluminum.
 2. PVC-coated rigid aluminum.
- E. Aboveground, Embedded in Concrete Walls, Ceilings, or Floors: PVC Schedule 40.
- F. Direct Earth Burial: PVC Schedule 40 for ac circuits, PVC-coated rigid aluminum for dc circuits.
- G. Concrete-encased Duct Bank: PVC Schedule 40 for ac circuits, rigid aluminum for dc circuits.
- H. Under Slabs-on-grade: PVC Schedule 40 for ac circuits, PVC-coated rigid aluminum for dc circuits.

- I. Transition from Underground or Concrete-embedded to Exposed: PVC-coated rigid aluminum conduit.
- J. Under Equipment Mounting Pads: PVC-coated rigid aluminum conduit.
- K. Exterior Light Pole Foundations: PVC-coated rigid aluminum conduit.
- L. Corrosive Areas: PVC-coated rigid aluminum.
- M. Hazardous Gas Areas:
 - 1. Rigid aluminum.
 - 2. PVC-coated rigid aluminum.

3.04 FLEXIBLE CONNECTIONS

- A. For motors, wall- or ceiling-mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other locations approved by Engineer where flexible connection is required to minimize vibration:
 - 1. Conduit Size 4 Inches or Less: Flexible, non-metallic, liquid-tight conduit, Type LNFC-B.
 - 2. Wet or Corrosive Areas: Flexible, non-metallic liquid-tight conduit, Type LNFC-B.
 - 3. Dry Areas: Flexible, metallic liquid-tight.
- B. Outdoor Areas, Process Areas Exposed to Moisture, and Areas Required to be Oil-tight and Dust-tight: Flexible, non-metallic conduit, Type LNFC-B.
- C. Flexible Conduit Length: 18 inches minimum, 60 inches maximum; sufficient to allow movement or adjustment of equipment.

3.05 PENETRATIONS

- A. Make at right angles, unless otherwise shown.
- B. Notching or penetration of structural members, including footings and beams, not permitted.
- C. Fire-rated Walls, Floors, or Ceilings: Firestop openings around penetrations to maintain fire-resistance rating using fire penetration.
- D. Apply heat-shrinkable tubing to metallic conduit protruding through concrete floor slabs to a point 2 inches above and 2 inches below concrete surface.

- E. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack, or use watertight seal device.
- F. Entering Structures:
 - 1. General: Seal raceway at first box or outlet with oakum or expandable plastic compound to prevent entrance of gases or liquids from one area to another.
 - 2. Concrete Roof or Membrane Waterproofed Wall or Floor:
 - a. Provide a watertight seal.
 - b. Without Concrete Encasement: Install watertight entrance seal device on each side.
 - c. With Concrete Encasement: Install watertight entrance seal device on accessible side.
 - d. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.
 - e. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.
 - 3. Corrosive-Sensitive Areas:
 - a. Seal conduit entering equipment panel boards and field panels containing electronic equipment.
 - b. Seal penetration with Type 5 sealant.
 - 4. Existing or Precast Wall (Underground): Core drill wall and install watertight entrance seal device.
 - 5. Nonwaterproofed Wall or Floor (Underground, without Concrete Encasement):
 - a. Provide Schedule 40, stainless steel pipe sleeve, or watertight entrance seal device.
 - b. Fill space between raceway and sleeve with expandable plastic compound or oakum and lead joint, on each side.
 - 6. Manholes and Handholes:
 - a. Metallic Raceways: Provide insulated grounding bushings.
 - b. Nonmetallic Raceways: Provide bell ends flush with wall.
 - c. Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

3.06 SUPPORT

- A. Support from structural members only, at intervals not exceeding ANSI/NFPA 70-2017 requirements. Do not exceed 8 feet in any application. Do not support from piping, pipe supports, or other raceways.
- B. Multiple Adjacent Raceways: Provide ceiling trapeze. For trapeze-supported conduit, allow 20 percent extra space for future conduit.

- C. Application/Type of Conduit Strap:
 - 1. Aluminum Conduit: Aluminum or stainless steel.
 - 2. PVC-coated Aluminum Conduit: PVC-coated aluminum.
 - 3. Nonmetallic Conduit: Nonmetallic or PVC-coated aluminum.

- D. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:
 - 1. Wood: Wood screws.
 - 2. Hollow Masonry Units: Toggle bolts.
 - 3. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
 - 4. Steelwork: Machine screws.
 - 5. Location/Type of Hardware:
 - a. Dry, Noncorrosive Areas: Aluminum.
 - b. Wet, Noncorrosive Areas: Stainless steel.
 - c. Corrosive Areas: Stainless steel.

- E. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

- F. Support aluminum conduit on concrete surfaces with stainless steel or nonmetallic spacers, or aluminum or nonmetallic framing channel.

3.07 BENDS

- A. Install concealed raceways with a minimum of bends in the shortest practical distance.

- B. Make bends and offsets of longest practical radius. Bends in conduits and ducts being installed for fiber optic cables shall be not less than 20 times cable diameter, 15 inches minimum.

- C. Install with symmetrical bends or aluminum fittings.

- D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.

- E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

SIP-SOUTHSIDE BLVD. INTERTIE TO DEERWOOD III WTP

- F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.
- G. PVC Conduit:
 - 1. Bends 30 Degrees and Larger: Provide factory-made elbows.
 - 2. 90-degree Bends: Provide rigid aluminum elbows, PVC-coated where direct buried.
 - 3. Use manufacturer's recommended method for forming smaller bends.
- H. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

3.08 EXPANSION/DEFLECTION FITTINGS

- A. Provide on raceways at structural expansion joints and in long tangential runs.
- B. Provide expansion/deflection joints for 50 degrees F maximum temperature variation.
- C. Install in accordance with manufacturer's instructions.

3.09 PVC CONDUIT

- A. Solvent Welding:
 - 1. Apply manufacturer recommended solvent to joints.
 - 2. Install in order that joint is watertight.
- B. Adapters:
 - 1. PVC to Metallic Fittings: PVC terminal type.
 - 2. PVC to Rigid Aluminum Conduit: PVC female adapter.
- C. Belled-end Conduit: Bevel unbelled end of joint prior to joining.

3.10 PVC-COATED RIGID ALUMINUM CONDUIT

- A. Install in accordance with manufacturer's instructions.
- B. Tools and equipment used in cutting, bending, threading and installation of PVC-coated rigid conduit shall be designed to limit damage to PVC coating.
- C. Provide PVC boot to cover exposed threading.

3.11 TERMINATION AT ENCLOSURES

- A. Cast Metal Enclosure: Install manufacturer's pre-molded insulating sleeve inside metallic conduit terminating in threaded hubs.
- B. Nonmetallic, Cabinets, and Enclosures:
 - 1. Terminate conduit in threaded conduit hubs, maintaining enclosure integrity.
 - 2. Metallic Conduit: Provide ground terminal for connection to maintain continuity of ground system.
- C. Sheet Metal Boxes, Cabinets, and Enclosures:
 - 1. General:
 - a. Install insulated bushing on ends of conduit where grounding is not required.
 - b. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
 - c. Use sealing locknuts or threaded hubs on sides and bottom of NEMA 3R and NEMA 12 enclosures.
 - d. Terminate conduits at threaded hubs at the tops of NEMA 3R and NEMA 12 boxes and enclosures.
 - e. Terminate conduits at threaded conduit hubs at NEMA 4 and NEMA 4X boxes and enclosures.
 - 2. Rigid Aluminum Conduit:
 - a. Provide one lock nut each on inside and outside of enclosure.
 - b. Install grounding bushing at source enclosure.
 - c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad.
 - 3. Flexible, Nonmetallic Conduit: Provide nonmetallic, liquid-tight strain relief connectors.
 - 4. PVC-coated Rigid Aluminum Conduit: Provide PVC-coated, liquid-tight, metallic connector.
 - 5. PVC Schedule 40 Conduit: Provide PVC terminal adapter with lock nut, except where threaded hubs required above.
- D. Motor Control Center, Switchboard, and Free-standing Enclosures:
 - 1. Terminate metal conduit entering bottom with grounding bushing; provide grounding jumper extending to equipment ground bus or grounding pad.
 - 2. Terminate PVC conduit entering bottom with bell end fittings.

3.12 UNDERGROUND RACEWAYS

- A. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.
- B. Cover: Maintain minimum 2-foot cover above concrete encasement, unless otherwise shown.
- C. Make routing changes as necessary to avoid obstructions or conflicts.
- D. Couplings: In multiple conduit runs, stagger so couplings in adjacent runs are not in same transverse line.
- E. Union type fittings not permitted.
- F. Spacers:
 - 1. Provide preformed, nonmetallic spacers designed for such purpose, to secure and separate parallel conduit runs in a trench or concrete encasement.
 - 2. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.
- G. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.
- H. Transition from Underground to Exposed: PVC-coated rigid aluminum conduit.
- I. Installation with Other Piping Systems:
 - 1. Crossings: Maintain minimum 12-inch vertical separation.
 - 2. Parallel Runs: Maintain minimum 12-inch separation.
 - 3. Installation over valves or couplings not permitted.
- J. Backfill:
 - 1. As specified in JEA Standards.
 - 2. Do not backfill until inspected by Engineer.

3.13 UNDER SLAB RACEWAYS

- A. Make routing changes as necessary to avoid obstructions or conflicts.
- B. Support raceways so as to prevent bending or displacement during backfilling or concrete placement.

- C. Install raceways with no part embedded within slab and with no interference with slab on grade construction.
- D. Raceway spacing, in a single layer or multiple layers:
 - 1. 3 inches clear between adjacent 2-inch or larger raceway.
 - 2. 2 inches clear between adjacent 1-1/2-inch or smaller raceway.
- E. Multiple Layers of Raceways: Install under slab on grade in trench below backfill zone.
- F. Individual Raceways and Single-layer Multiple Raceways: Install at lowest elevation of backfill zone with spacing as specified herein. Where conduits cross at perpendicular orientation, installation of conduits shall not interfere with placement of under slab fill that meets compaction and void limitations of earthwork specifications.
- G. Under slab raceways that emerge from below slab to top of slab as exposed, shall be located to avoid conflicts with structural slab rebar. Coordinate raceway stub ups with location of structural rebar.
- H. Fittings:
 - 1. Union type fittings are not permitted.
 - 2. Provide expansion/deflection fittings in raceway runs that exit building or structure below slab. Locate fittings 18 inches, maximum, beyond exterior wall. Raceway type between building exterior wall to fitting shall be PVC-coated rigid aluminum.
 - 3. Couplings: In multiple raceway runs, stagger so couplings in adjacent runs are not in same traverse line.

3.14 OUTLET AND DEVICE BOXES

- A. General:
 - 1. Install plumb and level.
 - 2. Install suitable for conditions encountered at each outlet or device in wiring or raceway system, sized to meet NFPA 70 requirements.
 - 3. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.
 - 4. Install stainless steel mounting hardware in industrial areas.

B. Size:

1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.
 - a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.
2. Ceiling Outlet: Minimum 4-inch octagonal device box, unless otherwise required for installed fixture.
3. Switch and Receptacle: Minimum 2-inch by 4-inch device box.

C. Locations:

1. Drawing locations are approximate.
2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by Owner.

D. Mounting Height:

1. General:
 - a. Dimensions given to centerline of box.
 - b. Where specified heights do not suit building construction or finish, adjust up or down to avoid interference.
 - c. Do not straddle CMU block or other construction joints.
2. Light Switch: 48 inches above floor.
3. Convenience Receptacle:
 - a. General Interior Areas: 15 inches above floor.
 - b. Industrial Areas, Workshops: 48 inches above floor.
 - c. Outdoor Areas: 24 inches above finished grade.
4. Special-purpose Receptacle: 48 inches above floor or as shown.

E. Flush-mounted:

1. Install with concealed conduit.
2. Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.
3. Holes in surrounding surface shall be no larger than required to receive box.

F. Supports:

1. Support boxes independently of conduit by attachment to building structure or structural member.
2. Install bar hangers in frame construction or fasten boxes directly as follows:
 - a. Wood: Wood screws.
 - b. Concrete or Brick: Bolts and expansion shields.

- c. Hollow Masonry Units: Toggle bolts.
- d. Steelwork: Machine screws.
3. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
4. Provide plaster rings where necessary.
5. Boxes embedded in concrete or masonry need not be additionally supported.

3.15 JUNCTION AND PULL BOXES

A. General:

1. Install plumb and level.
2. Installed boxes shall be accessible.
3. Do not install on finished surfaces.
4. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.
5. Use conduit bodies as junction and pull boxes where no splices are required and allowed by applicable codes.
6. Install pull boxes where necessary in raceway system to facilitate conductor installation.
7. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.
8. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

B. Mounting Hardware:

1. Noncorrosive Dry Areas: Aluminum.
2. Noncorrosive Wet Areas: Stainless steel.
3. Corrosive Areas: Stainless steel.

C. Supports:

1. Support boxes independently of conduit by attachment to building structure or structural member.
2. Install bar hangers in frame construction or fasten boxes directly as follows:
 - a. Wood: Wood screws.
 - b. Concrete or Brick: Bolts and expansion shields.
 - c. Hollow Masonry Units: Toggle bolts.
 - d. Steelwork: Machine screws.
3. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
4. Boxes embedded in concrete or masonry need not be additionally supported.

- D. At or Below Grade:
 - 1. Install boxes for below grade conduit flush with finished grade in locations outside of paved areas, roadways, or walkways.
 - 2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
 - 3. Obtain Owner's written acceptance prior to installation in paved areas, roadways, or walkways.
 - 4. Use boxes and covers suitable to support anticipated weights.
- E. Install Drain/breather fittings in NEMA 250 Type 4 and Type 4X enclosures.

3.16 MANHOLES AND HANDHOLES

- A. Excavate, shore, brace, backfill, and final grade in accordance with Section 31 23 16, Excavation, and Section 31 23 23.15, Trench Backfill.
- B. Do not install until final raceway grading has been determined.
- C. Install such that raceway enters at nearly right angle and as near as possible to end of wall, unless otherwise shown.
- D. Grounding: As specified in Section 26 05 26, Grounding and Bonding for Electrical Systems.
- E. Identification: Field stamp covers with manhole or handhole number as shown. Stamped numbers to be 1-inch minimum height.

3.17 EMPTY RACEWAYS

- A. Provide permanent, removable cap over each end.
- B. Provide PVC plug with pull tab for underground raceways with end bells.
- C. Provide nylon pull cord.
- D. Identify, as specified in Article Identification Devices, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.18 IDENTIFICATION DEVICES

- A. Raceway Tags:
 - 1. Identify origin and destination.
 - 2. For exposed raceways, install tags at each terminus, near midpoint, and at minimum intervals of every 50 feet, whether in ceiling space or surface-mounted.

3. Install tags at each terminus for concealed raceways.
 4. Provide noncorrosive wire for attachment.
- B. Warning Tape: Install approximately 18 inches above underground or concrete-encased raceways. Align parallel to, and within 12 inches of, centerline of run.
- C. Buried Raceway Marker:
1. Install at grade to indicate direction of underground raceway.
 2. Install at bends and at intervals not exceeding 100 feet in straight runs.
 3. Embed and secure to top of concrete base, sized 14 inches long, 6 inches wide, and 8 inches deep; top set flush with finished grade.

3.19 PROTECTION OF INSTALLED WORK

- A. Protect products from effects of moisture, corrosion, and physical damage during construction.
- B. Provide and maintain manufactured watertight and dust-tight seals over conduit openings during construction.
- C. Touch up painted conduit threads after assembly to cover nicks or scars.
- D. Touch up coating damage to PVC-coated conduit with patching compound approved by manufacturer. Compound shall be kept refrigerated according to manufacturers' instructions until time of use.

END OF SECTION

SECTION 26 05 70
ELECTRICAL SYSTEMS ANALYSIS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American National Standards Institute (ANSI).
 2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
 - b. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
 - c. 399, Recommended Practice for Industrial and Commercial Power System Analysis.
 - d. 1584, Guide for Performing Arc Flash Hazard Calculations.
 3. National Electrical Manufacturers Association (NEMA): Z535.4, Product Safety Signs and Labels.
 4. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - b. 70E, Standard for Electrical Safety in the Workplace.
 5. Occupational Safety and Health Administration (OSHA): 29 CFR, Part 1910 Subpart S, Electrical.

1.02 SUBMITTALS

- A. Action Submittals:
1. Arc Flash Study: Submit initial study. Submit final study prior to equipment energization.
 2. Arc flash warning labels; submit sample with initial study.
 3. Electronic files of final studies including all engineering software input files, output reports, and libraries.

1.03 QUALITY ASSURANCE

- A. Arc flash study shall be prepared by a professional electrical engineer registered in the State of Florida.

1.04 SEQUENCING AND SCHEDULING

- A. Initial arc flash study shall be submitted and reviewed before Engineer will review Shop Drawings for the new electrical equipment.

- B. Initial complete arc flash study shall be submitted within 90 days after approval of initial arc flash study.
- C. Initial complete arc flash study shall be submitted and accepted prior to energization of the electrical equipment.
- D. Revised arc flash study, and arc flash labels shall be submitted 10 days before energizing electrical equipment.
- E. Final arc flash study shall be completed prior to Project Substantial Completion.
- F. Submit final arc flash labels described herein and in compliance with NEMA Z535.4 prior to Project Substantial Completion.

1.05 GENERAL STUDY REQUIREMENTS

- A. Equipment and component titles used in the studies shall be identical to equipment and component titles shown on Drawings.
- B. Perform studies using one of the following electrical engineering software packages:
 - 1. SKM Power Tools for Windows.
 - 2. ETAP.
 - 3. Paladin.
 - 4. Easy Power.
- C. Perform complete fault calculations for each proposed source combination.
 - 1. Source combination may include present and future power company supply circuits, large motors, or generators.
- D. Use proposed and existing load data for study obtained from field investigation of system configuration, wiring information, and equipment.
- E. Existing System and Equipment:
 - 1. Extent of existing system to be included in study is limited to system elements that affect new system and equipment.
 - 2. Include fault contribution of existing motors and equipment in study.
 - 3. Include impedance elements that affect new system and equipment.
 - 4. Include protective devices in series with new equipment.
- F. Device coordination time-current curves for low voltage distribution system; include individual protective device time-current characteristics.

1.06 ARC FLASH STUDY

- A. Perform arc flash study in accordance with NFPA 70E, OSHA 29 CFR, Part 1910 Subpart S, and IEEE 1584.
- B. Base Calculation: For each major part of electrical power system, determine the following:
 - 1. Flash hazard protection boundary.
 - 2. Limited approach boundary.
 - 3. Restricted approach boundary.
 - 4. Incident energy level.
 - 5. Glove class required.
- C. Produce arc flash warning labels that list items in Paragraph Base Calculation and the following additional items.
 - 1. Bus name.
 - 2. Bus voltage.
- D. Produce bus detail sheets that list items in Paragraph Base Calculation and the following additional items:
 - 1. Bus name.
 - 2. Upstream protective device name, type, and settings.
 - 3. Bus line-to-line voltage.
- E. Produce arc flash evaluation summary sheet listing the following additional items:
 - 1. Bus name.
 - 2. Upstream protective device name, type, settings.
 - 3. Bus line-to-line voltage.
 - 4. Bus bolted fault.
 - 5. Protective device bolted fault current.
 - 6. Arcing fault current.
 - 7. Protective device trip/delay time.
 - 8. Breaker opening time.
 - 9. Solidly grounded column.
 - 10. Equipment type.
 - 11. Gap.
 - 12. Arc flash boundary.
 - 13. Working distance.
 - 14. Incident energy.

- F. Analyze arc flash calculations and highlight equipment that is determined to be underrated or causes incident energy values greater than 8 cal/cm^2 . Propose approaches to reduce energy levels.
- G. Prepare report summarizing arc flash study with conclusions and recommendations which may affect integrity of electric power distribution system. As a minimum, include the following:
 - 1. Equipment manufacturer's information used to prepare study.
 - 2. Assumptions made during study.
 - 3. Reduced copy of one-line drawing; 11 inches by 17 inches maximum.
 - 4. Arc flash evaluations summary spreadsheet.
 - 5. Bus detail sheets.
 - 6. Arc flash warning labels printed in color on thermally bonded adhesive backed UV- and weather-resistant labels.

PART 2 PRODUCTS

2.01 ARC FLASH WARNING LABELS

- A. Arc flash warning labels printed in color on thermally bonded adhesive backed, UV- and weather-resistant labels. An example label is located following end of section in Figure 1.

PART 3 EXECUTION

3.01 GENERAL

- A. Provide arc flash warning labels on equipment as specified in this section.

3.02 SUPPLEMENTS

- A. The supplement listed below, following "End of Section," is a part of this Specification:
 - 1. Figure 1: Example Arc Flash Label.

END OF SECTION

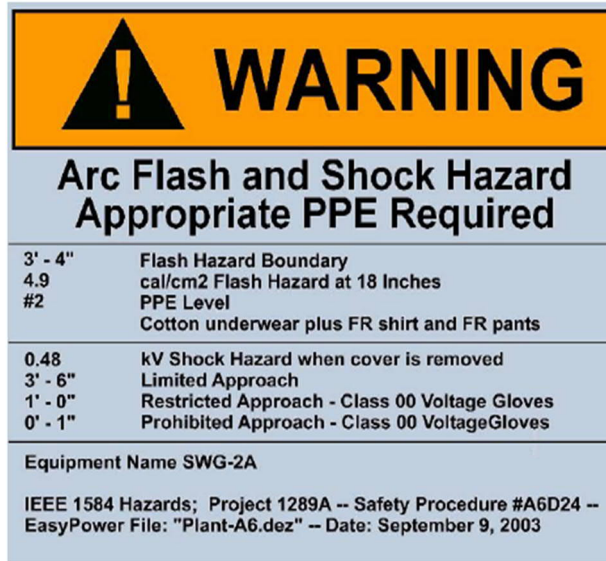


Figure 1
Example Arc Flash Label

SECTION 26 08 00
COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. ASTM International (ASTM):
 - a. D877/D877M, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
 - b. D923, Standard Practices for Sampling Electrical Insulating Liquids.
 - c. D924, Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
 - d. D971, Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method.
 - e. D974, Standard Test Method for Acid and Base Number by Color-Indicator Titration.
 - f. D1298, Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
 - g. D1500, Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).
 - h. D1524, Standard Test Method for Visual Examination of Used Electrical Insulating Liquids in the Field.
 - i. D1533, Standard Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration.
 - j. D1816, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using VDE Electrodes.
 2. Institute of Electrical and Electronics Engineers (IEEE):
 - a. 43, Recommended Practice for Testing Insulation Resistance of Electric Machinery.
 - b. 48, Standard Test Procedures and Requirements for Alternating-Current Cable Terminators Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV.
 - c. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
 - d. 95, Recommended Practice for Insulation Testing of AC Electric Machinery (2300V and Above) with High Direct Voltage.

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- e. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
 - f. 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems Rated 5 kV and Above.
 - g. 450, Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.
 - h. C2, National Electrical Safety Code.
 - i. C37.20.1, Standard for Metal-Enclosed Low-Voltage (1000 Vac and below, 3200 Vdc and below) Power Circuit Breaker Switchgear.
 - j. C37.20.2, Standard for Metal-Clad Switchgear.
 - k. C37.20.3, Standard for Metal-Enclosed Interrupter Switchgear.
 - l. C37.23, Standard for Metal-Enclosed Bus.
 - m. C62.33, Standard Test Methods and Performance Values for Metal-Oxide Varistor Surge Protective Components.
3. Insulated Cable Engineers Association (ICEA):
 - a. S-93-639, 5-46 kV Shielded Power Cables for Use in the Transmission and Distribution of Electric Energy.
 - b. S-94-649, Concentric Neutral Cables Rated 5 through 46 kV.
 - c. S-97-682, Standard for Utility Shielded Power Cables Rated 5 through 46 kV.
 4. InterNational Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
 5. National Electrical Manufacturers Association (NEMA):
 - a. AB 4, Guidelines for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
 - b. PB 2, Deadfront Distribution Switchboards.
 - c. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
 6. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - b. 70B, Recommended Practice for Electrical Equipment Maintenance.
 - c. 70E, Standard for Electrical Safety in the Workplace.
 - d. 101, Life Safety Code.
 7. National Institute for Certification in Engineering Technologies (NICET).
 8. Occupational Safety and Health Administration (OSHA): CFR 29, Part 1910, Occupational Safety and Health Standards.

1.02 SUBMITTALS

A. Informational Submittals:

1. Submit 30 days prior to performing inspections or tests:
 - a. Schedule for performing inspection and tests.
 - b. List of references to be used for each test.
 - c. Sample copy of equipment and materials inspection form(s).
 - d. Sample copy of individual device test form.
 - e. Sample copy of individual system test form.
2. Energization Plan: Prior to initial energization of electrical distribution equipment; include the following:
 - a. Owner's representative sign-off form for complete and accurate arc flash labeling and proper protective device settings for equipment to be energized.
 - b. Staged sequence of initial energization of electrical equipment.
 - c. Lock-out-tag-out plan for each stage of the progressive energization.
 - d. Barricading, signage, and communication plan notifying personnel of newly energized equipment.
3. Submit test or inspection reports and certificates for each electrical item tested within 30 days after completion of test.
4. Operation and Maintenance Data:
 - a. In accordance with JEA requirements.
 - b. After test or inspection reports and certificates have been reviewed by Engineer and returned, insert a copy of each in operation and maintenance manual.
5. Programmable Settings: At completion of performance demonstration test, submit final hardcopy printout and electronic files on compact disc of as-left setpoints, programs, and device configuration files for:
 - a. Protective relays.
 - b. Intelligent overload relays.
 - c. Adjustable frequency drives.
 - d. Power metering devices.
 - e. Uninterruptible power supplies.
 - f. Electrical communications modules.

1.03 QUALITY ASSURANCE

A. Testing Firm Qualifications:

1. Corporately and financially independent organization functioning as an unbiased testing authority.
2. Professionally independent of manufacturers, suppliers, and installers of electrical equipment and systems being tested.

3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
 4. Supervising engineer accredited as Certified Electrical Test Technologist by NICET or NETA and having a minimum of 5 years' testing experience on similar projects.
 5. Technicians certified by NICET or NETA.
 6. Assistants and apprentices assigned to Project at ratio not to exceed two certified to one noncertified assistant or apprentice.
 7. Registered professional engineer to provide comprehensive Project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
 8. In compliance with OSHA CFR 29, Part 1910.7 criteria for accreditation of testing laboratories or a full member company of NETA.
- B. Test equipment shall have an operating accuracy equal to or greater than requirements established by NETA ATS.
- C. Test Instrument Calibration: In accordance with NETA ATS.

1.04 SEQUENCING AND SCHEDULING

- A. Perform inspection and electrical tests after equipment listed herein has been installed.
- B. Perform tests with apparatus de-energized whenever feasible.
1. Scheduled with Owner prior to de-energization.
 2. Minimized to avoid extended period of interruption to the operating plant equipment.
- C. Notify Owner at least 24 hours prior to performing tests on energized electrical equipment.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Perform tests in accordance with requirements of Section 01 91 14, Equipment Testing and Facility Startup.

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- B. Tests and inspections shall establish:
 - 1. Electrical equipment is operational within industry and manufacturer's tolerances and standards.
 - 2. Installation operates properly.
 - 3. Equipment is suitable for energization.
 - 4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, NFPA 101, and IEEE C2.
- C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.
- D. Set, test, and calibrate protective relays, circuit breakers, fuses, and other applicable devices in accordance with values established by short circuit, coordination, and harmonics studies as specified in Section 26 05 70, Electrical Systems Analysis.
- E. Adjust mechanisms and moving parts of equipment for free mechanical movement.
- F. Adjust and set electromechanical electronic relays and sensors to correspond to operating conditions, or as recommended by manufacturer.
- G. Verify nameplate data for conformance to Contract Documents and approved submittals.
- H. Realign equipment not properly aligned and correct unlevelness.
- I. Properly anchor electrical equipment found to be inadequately anchored.
- J. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench/screw driver to manufacturer's recommendations, or as otherwise specified in NETA ATS.
- K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.
- L. Provide proper lubrication of applicable moving parts.
- M. Inform Engineer of working clearances not in accordance with ANSI/NFPA 70-2014.
- N. Investigate and repair or replace:
 - 1. Electrical items that fail tests.
 - 2. Active components not operating in accordance with manufacturer's instructions.

3. Damaged electrical equipment.
- O. Electrical Enclosures:
1. Remove foreign material and moisture from enclosure interior.
 2. Vacuum and wipe clean enclosure interior.
 3. Remove corrosion found on metal surfaces.
 4. Repair or replace, as determined by Engineer door and panel sections having dented surfaces.
 5. Repair or replace, as determined by Engineer poor-fitting doors and panel sections.
 6. Repair or replace improperly operating latching, locking, or interlocking devices.
 7. Replace missing or damaged hardware.
 8. Finish:
 - a. Provide matching paint and touch up scratches and mars.
 - b. If required because of extensive damage, as determined by Engineer, refinish entire assembly.
- P. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents or approved submittals.

3.02 CHECKOUT AND STARTUP

- A. Voltage Field Test:
1. Check voltage at point of termination of power company supply system to Project when installation is essentially complete and is in operation.
 2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.
 3. Unbalance Corrections:
 - a. Make written request to power company to correct condition if balance (as defined by NEMA) exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4 percent of nominal.
 - b. Obtain written certification from responsible power company official that voltage variations and unbalance are within their normal standards if corrections are not made.
- B. Equipment Line Current Tests:
1. Check line current in each phase for each piece of equipment.
 2. Make line current check after power company has made final adjustments to supply voltage magnitude or balance.

3. If phase current for a piece of equipment is above rated nameplate current, prepare equipment line phase current report that identifies cause of problem and corrective action taken.

3.03 PANELBOARDS

- A. Visual and Mechanical Inspection: Include the following inspections and related work:
 1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
 2. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
 3. Check panelboard mounting, area clearances, and alignment and fit of components.
 4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
 5. Perform visual and mechanical inspection for overcurrent protective devices.
- B. Electrical Tests: Include the following items performed in accordance with manufacturer's instruction:
 1. Insulation Resistance Tests:
 - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
 - b. Each phase of each bus section.
 - c. Phase-to-phase and phase-to-ground for 1 minute.
 - d. With breakers open.
 - e. With breakers closed.
 - f. Control wiring except that connected to solid state components.
 - g. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
 2. Ground continuity test ground bus to system ground.

3.04 DRY TYPE TRANSFORMERS

- A. Visual and Mechanical Inspection:
 1. Physical and insulator damage.
 2. Proper winding connections.
 3. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
 4. Defective wiring.

5. Proper operation of fans, indicators, and auxiliary devices.
6. Removal of shipping brackets, fixtures, or bracing.
7. Free and properly installed resilient mounts.
8. Cleanliness and improper blockage of ventilation passages.
9. Verify tap-changer is set at correct ratio for rated output voltage under normal operating conditions.
10. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

B. Electrical Tests:

1. Insulation Resistance Tests:
 - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.5 for each:
 - 1) Winding-to-winding.
 - 2) Winding-to-ground.
 - b. Test Duration: 10 minutes with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
 - c. Results temperature corrected in accordance with NETA ATS, Table 100.14.
 - d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
 - e. Insulation resistance test results to compare within 1 percent of adjacent windings.
2. Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.

3.05 LOW-VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect each individual exposed power cable No. 6AWG and larger for:
 - a. Physical damage.
 - b. Proper connections in accordance with single-line diagram.
 - c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
 - d. Color coding conformance with specification.
 - e. Proper circuit identification.
2. Mechanical Connections for:
 - a. Proper lug type for conductor material.
 - b. Proper lug installation.
 - c. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
3. Shielded Instrumentation Cables for:
 - a. Proper shield grounding.

- b. Proper terminations.
- c. Proper circuit identification.
4. Control Cables for:
 - a. Proper termination.
 - b. Proper circuit identification.
5. Cables Terminated Through Window-type CTs: Verify neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors No. 6AWG and Larger:

1. Insulation Resistance Tests:
 - a. Use 1,000-volt dc megohmmeter for 600-volt insulated conductors.
 - b. Test each conductor with respect to ground and to adjacent conductors for 1 minute.
 - c. Evaluate ohmic values by comparison with conductors of same length and type.
 - d. Investigate values less than 50 megohms.
2. Continuity test by ohmmeter method to ensure proper cable connections.

C. Low-voltage cable tests may be performed by installer in lieu of independent testing firm.

3.06 SAFETY SWITCHES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Proper blade pressure and alignment.
2. Proper operation of switch operating handle.
3. Adequate mechanical support for each fuse.
4. Proper contact-to-contact tightness between fuse clip and fuse.
5. Cable connection bolt torque level in accordance with NETA ATS, Table 100.12.
6. Proper phase barrier material and installation.
7. Verify fuse sizes and types correspond to one-line diagram or approved Submittals.
8. Perform mechanical operational test and verify electrical and mechanical interlocking system operation and sequencing.

B. Electrical Tests:

1. Insulation Resistance Tests:
 - a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
 - b. Phase-to-phase and phase-to-ground for 1 minute on each pole.

- c. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Contact Resistance Tests:
 - a. Contact resistance in microhms across each switch blade and fuse holder.
 - b. Investigate deviation of 50 percent or more from adjacent poles or similar switches.

3.07 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

- A. General: Inspection and testing limited to circuit breakers rated 100 amperes and larger and to motor circuit protector breakers rated 100 amperes and larger.
- B. Visual and Mechanical Inspection:
 1. Proper mounting.
 2. Proper conductor size.
 3. Feeder designation according to nameplate and one-line diagram.
 4. Cracked casings.
 5. Connection bolt torque level in accordance with NETA ATS, Table 100.12.
 6. Operate breaker to verify smooth operation.
 7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
 8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.
- C. Electrical Tests:
 1. Insulation Resistance Tests:
 - a. Use 1,000-volt dc megohmmeter for 480-volt and 600-volt circuit breakers.
 - b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
 - c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
 - d. Test values to comply with NETA ATS, Table 100.1.
 2. Contact Resistance Tests:
 - a. Contact resistance in microhms across each pole.
 - b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
 3. Primary Current Injection Test to Verify:
 - a. Long-time minimum pickup and delay.
 - b. Short-time pickup and delay.
 - c. Ground fault pickup and delay.

- d. Instantaneous pickup by run-up or pulse method.
- e. Trip characteristics of adjustable trip breakers shall be within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
- f. Trip times shall be within limits established by NEMA AB 4, Table 5-3. Alternatively, use NETA ATS, Table 100.7.
- g. Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4. Alternatively, use NETA ATS, Table 100.8.

3.08 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

- 1. Equipment and circuit grounds in motor control center, and panel board, assemblies for proper connection and tightness.
- 2. Ground bus connections in motor control center, and panelboard, assemblies for proper termination and tightness.
- 3. Effective transformer core and equipment grounding.
- 4. Accessible connections to grounding electrodes for proper fit and tightness.
- 5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

B. Electrical Tests:

- 1. Fall-of-potential Test:
 - a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
 - b. Main ground electrode system resistance to ground to be no greater than 1 ohm(s).
- 2. Two-point Direct Method Test:
 - a. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
 - b. Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.
- 3. Neutral Bus Isolation:
 - a. Test each neutral bus individually with neutral bonding jumper removed at service entrance or separately derived system.
 - b. Evaluate ohmic values by measuring resistance between ground bus and neutral bus.
 - c. Investigate values less than 50 megohms.

END OF SECTION

SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. Code of Federal Regulations (CFR): 10 CFR Part 431, DOE 2016 efficiency.
 2. Institute of Electrical and Electronics Engineers (IEEE): C57.96, Guide for Loading Dry Type Transformers.
 3. National Electrical Contractor's Association (NECA): 409, Recommended Practice for Installing and Maintaining Dry-Type Transformers.
 4. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. ST 20, Dry-Type Transformers for General Applications.
 5. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 6. UL:
 - a. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
 - b. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
 - c. 1561, Standard for Dry-Type, General Purpose, and Power Transformers.

1.02 SUBMITTALS

- A. Action Submittals:
1. Descriptive information.
 2. Dimensions and weight.
 3. Transformer nameplate data, including efficiency.
 4. Schematic and connection diagrams.
 5. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Test Report: Sound test certification for dry type power transformers (0 volt to 600 volt, primary).

PART 2 PRODUCTS

2.01 GENERAL

- A. UL 1561, NEMA ST 20, unless otherwise indicated.
- B. Dry-type, self-cooled, two-winding, with copper windings.
- C. Units larger than 5 kVA suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
- D. Efficiency: Meet or exceed DOE 2016 efficiency requirements.
- E. Maximum sound level in accordance with NEMA ST 20: 40 decibels for 0 to 9 kVA.
- F. Overload capability: Short-term overload in accordance with IEEE C57.96.
- G. Vibration Isolators:
 1. Rated for transformer's weight.
 2. Isolation Efficiency: 99 percent, at fundamental frequency of sound emitted by transformer.
 3. Less Than 30 kVA: Isolate entire unit from structure with external vibration isolators.
- H. Manufacturers:
 1. Square D Co.
 2. EATON/Cutler-Hammer.
 3. General Electric Co.

2.02 GENERAL PURPOSE TRANSFORMER

- A. Insulation Class and Temperature Rise: Manufacturer's standard.
- B. Core and Coil: Fully encapsulated for single-phase units 1/2 to 25 kVA and for three-phase units 3 to 15 kVA.

- C. Enclosure: Single-phase, 3 to 25 kVA: NEMA 250, Type 4X, nonventilated.
- D. Voltage Taps:
 - 1. Single-phase, 3 to 10 kVA: Four 2 1/2 percent, full capacity; two above and two below normal voltage rating.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with NECA and manufacturer's instructions.
- B. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.
- C. Provide moisture-proof, flexible conduit for electrical connections.
- D. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.

END OF SECTION

**SECTION 26 24 16
PANELBOARDS**

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. National Electrical Contractor's Association (NECA): 407, Recommended Practice for Installing and Maintaining Panelboards.
 2. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. 289, Application Guide for Ground Fault Circuit Interrupters.
 - c. AB 1, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
 - d. KS 1, Enclosed Switches.
 - e. LA 1, Surge Arrestors.
 - f. PB 1, Panelboards.
 - g. PB 1.1, General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
 3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 4. Underwriters Laboratories Inc. (UL):
 - a. 67, Standard for Panelboards.
 - b. 98, Standard for Enclosed and Dead-Front Switches.
 - c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
 - d. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
 - e. 508, Standard for Industrial Control Equipment.
 - f. 870, Wireways, Auxiliary Gutters and Associated Fittings.
 - g. 943, Ground-Fault Circuit-Interrupters.
 - h. 1699, Standard for Arc-Fault Circuit-Interrupters.

1.02 SUBMITTALS

- A. Action Submittals:
1. Manufacturer's data sheets for each type of panelboard, protective device, accessory item, and component.
 2. Manufacturer's shop drawings including dimensioned plan, section, and elevation for each panelboard type, enclosure, and general arrangement.

3. Tabulation of features for each panelboard to include the following:
 - a. Protective devices with factory settings.
 - b. Provisions for future protective devices.
 - c. Space for future protective devices.
 - d. Voltage, frequency, and phase ratings.
 - e. Enclosure type.
 - f. Bus and terminal bar configurations and current ratings.
 - g. Provisions for circuit terminations with wire range.
 - h. Short circuit current rating of assembled panelboard at system voltage.
 - i. Features, characteristics, ratings, and factory settings of auxiliary components.
 - j. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's recommended installation instructions.

1.03 QUALITY ASSURANCE

- A. Listing and Labeling: Provide products specified in this section that are listed and labeled as defined in NEC Article 100.

1.04 EXTRA MATERIALS

- A. Extra Materials: Furnish, tag, and box for shipment and storage the following spare parts, and special tools:

Item	Quantity
Touch-up paint for panelboards	One half-pint container

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Materials, equipment, and accessories specified in this section shall be products of:
1. EATON/Cutler-Hammer
 2. Square D Co.

2.02 GENERAL

- A. Provide equipment in accordance with NEMA PB 1, NFPA 70, and UL 67.
- B. Wire Terminations:
 - 1. Provide panelboard assemblies, including protective devices, suitable for use with 75 degrees C or greater wire insulation systems at NFPA 70, 75 degrees C conductor ampacity, and in accordance with UL 486E.
 - 2. Lugs for termination of conductors shall comply with Section 26 05 05, Conductors.
 - 3. Lugs for termination of copper feeder phase and neutral conductors shall be replaceable, bolted mechanical or crimp compression type.
- C. Load Current Ratings:
 - 1. Unless otherwise indicated, load current ratings for panelboard assemblies, including bus and circuit breakers, are noncontinuous as defined by NEC. Continuous ratings shall be 80 percent of noncontinuous rating.
 - 2. Where indicated “continuous” or “100 percent,” selected components and protective devices shall be rated for continuous load current at value shown.
- D. Short Circuit Current Rating (SCCR): Integrated equipment short circuit rating for each panelboard assembly shall be no less than the following:
 - 1. Minimum SCCR at 208Y/120 or 120/240 volts shall be 10,000 amperes rms symmetrical.

2.03 OVERCURRENT PROTECTIVE DEVICES

- A. Overcurrent Device Mounting and Arrangement: Design panelboards to accommodate device installation and replacement without disturbing adjacent devices and without removing main bus.
- B. Overcurrent Protective Devices: In accordance with NEMA KS 1, UL 98, and UL 489. Protective devices shall be adapted to panelboard installation.
- C. Provisions for Future Overcurrent Device:
 - 1. Provide space, mountings and bus connections such that like device may be installed without additional hardware.
 - 2. Panel openings shall be closed with individual removable cover for each provision for future device.

3. Unless otherwise indicated, “spaces” in panelboards shall be fully equipped provision for future like devices.
 4. Provisions for future devices shall be suitable devices rated no less than 60 amperes.
- D. Protective Device Locking: Furnish provisions for handle padlocking for main, sub feed, and branch devices where indicated.
- E. Branch Protective Devices:
1. Provide Wire Lug Load Connections: Mechanical or crimp compression type, removable/replaceable, and suitable for 75 degrees C rated conductors without derating switch nor conductor ampacity.
 2. Provide a nameplate for each circuit, blanks for spares.

2.04 CIRCUIT BREAKERS

- A. General: Thermal-magnetic unless otherwise indicated, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle.
- B. Bus Connection: Bolt-on circuit breakers in 480Y/277-volt, and plug-in circuit breakers in 208Y/120- and 240/120-volt panelboards.
- C. Trip Mechanism:
1. Individual permanent thermal and magnetic trip elements in each pole.
 2. Variable magnetic trip elements with a single continuous adjustment 3X to 10X for frames greater than 100 amps.
 3. Two- and three-pole, common trip.
 4. Automatically opens all poles when overcurrent occurs on one pole.
 5. Test button on cover.
 6. Calibrated for 40 degrees C ambient, unless shown otherwise.
- D. Unacceptable Substitution:
1. Do not substitute single-pole circuit breakers with handle ties for multi-pole breakers.
 2. Do not use tandem or dual circuit breakers in normal single-pole spaces.

- E. Specialty Breakers: Where indicated, provide breakers with the following features:
1. Ground Fault Circuit Interrupter (GFCI): Rated to trip on 5-mA ground fault within 0.025 second (UL 943, Class A sensitivity, for protection of personnel). Ground fault sensor shall be rated same as circuit breaker. Breaker shall include push-to-test and reset buttons.
 2. Equipment Ground Fault Interrupter (EGFI): Where indicated, equip breaker with ground fault sensor and rated to trip on 30 mA ground fault (UL-listed for equipment ground fault protection).

2.05 ENCLOSURES

A. General:

1. Provide as specified in Section 26 05 04, Basic Electrical Materials and Methods and as shown on the Plans.
2. Type 4X as shown on the Plans.

2.06 BUSSING AND TERMINAL BARS

A. Bus:

1. Material: Tin-plated copper full sized throughout length.
2. Provide for mounting of future protective devices along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.

B. Equipment Ground Terminal Bus: Copper with suitably sized provisions for termination of ground conductors, and bonded to box.

1. Provide individual mechanical termination points no less than the quantity of breaker pole positions.
2. Provide individual termination points for all other grounding conductors such as feeder, grounding electrode, etc.

C. Neutral Terminal Bus: Copper with suitably sized provisions for termination of neutral conductors, and isolated from box.

1. Provide individual mechanical termination points no less than the quantity of breaker pole positions.
2. Provide individual termination points for all other neutral conductors.

D. Provision for Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances for future protective device ampere ratings indicated.

2.07 SPECIAL FEATURES

- A. General: Where indicated on Drawings or schedules, provide special features as specified.
- B. Surge Protective Devices:
 - 1. In accordance with NEMA LA 1, IEEE C62.1, and IEEE C62.11.
 - 2. Comply with Section 26 43 00, Surge Protective Devices.
 - 3. Provide factory mounting within panelboard using UL-recognized mounting device.

PART 3 EXECUTION

3.01 GENERAL

- A. Install in accordance with NECA 407, NEMA PB 1.1, and manufacturers' written installation instructions.
- B. Install securely, plumb, in-line and square.
- C. Install top of cabinet trim 72 inches above floor, unless otherwise shown. Install cabinet so tops of protective device operating handles are no more than 72 inches above the floor.
- D. Install filler plates in unused spaces.
- E. Wiring in Panel Gutters: Train conductors neatly in groups; bundle and wrap with nylon wire ties.
- F. Provide typewritten circuit directory for each panelboard.

END OF SECTION

**SECTION 26 27 26
WIRING DEVICES**

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. ASTM International (ASTM): A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 2. Federal Specifications (FS):
 - a. W-C-596G, General Specification for Connector, Electrical, Power.
 - b. W-S-896F, Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).
 3. Institute of Electrical and Electronic Engineers, Inc. (IEEE):
 - a. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1000V and less) AC Power Circuits.
 - b. C62.45, Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and less) AC Power Circuits.
 4. National Electrical Contractors Association (NECA): 1, Standard Practice of Good Workmanship in Electrical Contracting.
 5. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. FB 11, Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations.
 - c. WD 1, General Color Requirements for Wiring Devices.
 - d. WD 6, Wiring Devices – Dimensional Specifications.
 6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 7. Underwriters Laboratories Inc. (UL):
 - a. 498, Standard for Safety for Attachment Plugs and Receptacles.
 - b. 508, Standard for Safety for Industrial Control Equipment.
 - c. 943, Standard for Safety for Ground-Fault Circuit-Interruption.
 - d. 1010, Standard for Safety for Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations.
 - e. 1436, Standard for Safety for Outlet Circuit Testers and Similar Indicating Devices.
 - f. 1449, Standard for Safety for Surge Protective Devices (SPD).

1.02 SUBMITTALS

- A. Action Submittals: Manufacturer's product data for wiring devices.

PART 2 PRODUCTS

2.01 RECEPTACLES

A. Receptacle, General-purpose:

1. NEMA WD 1 and FS W-C-596G.
2. Duplex, two-pole, three-wire grounding type with screw type wire terminals.
3. Impact resistant nylon cover and body, with finder grooves in face, unless otherwise indicated.
4. One-piece mounting strap with integral ground contact (rivetless construction).
5. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
6. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps, unless otherwise indicated.
7. Size: For 2-inch by 4-inch outlet box.
8. Special Features: Provide the following features in comparable devices where indicated:
 - a. Listed weather-resistant in accordance with NEC 406.8 for installation in damp or wet locations.
9. Industrial Grade Manufacturers and Products:
 - a. Cooper Arrow Hart; 5362 Series.
 - b. Hubbell Bryant; HBL5362 Series.
 - c. Leviton; 5362 Series.

B. Receptacle, Ground Fault Circuit Interrupter:

1. Meet requirements of general-purpose receptacle.
2. Listed Class A to UL 943, tripping at 5 mA.
3. Rectangular smooth face with push-to-test and reset buttons.
4. Listed weather-resistant in accordance with NEC 406.8 for installation in damp or wet locations.
5. Feed-through Capability: 20 amps.
6. Manufacturers and Products:
 - a. Hubbell Bryant; GFTR20 Series.
 - b. Cooper Arrow Hart WRVGF20 Series.
 - c. Leviton; 7899 Series.

2.02 DEVICE PLATES

- A. Sectional type plate not permitted.
- B. Stainless Steel:
 - 1. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.
 - 2. Finish: ASTM A167, Type 302/304, satin.
 - 3. Mounting Screw: Oval-head, finish matched to plate.
- C. Weatherproof:
 - 1. Receptacle, Weatherproof Type 2:
 - a. UL-listed for wet location while in use.
 - b. Die cast metal cover.
 - c. Manufacturer and Product: TayMac; Type Multi-Mac.

2.03 FINISHES

- A. Wiring device catalog numbers specified in this section do not designate device color. Unless otherwise indicated, or required by code, provide colors as specified below.
- B. Wiring Device: Ivory.
- C. Special-purpose and hazardous location devices may be manufacturer's standard color (black).

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A. Comply with NECA 1.
- B. Conductors:
 - 1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. Length of free conductors at outlets for devices shall meet provisions of ANSI/NFPA 70-2014, Article 300, without pigtails.

C. Device Installation:

1. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
2. Do not remove surface protection, such as plastic film and smudge covers, until last possible moment.
3. Connect devices to branch circuits using pigtails that are not less than 6 inches (150 mm) in length.
4. Use torque screwdriver when a torque is recommended or required by manufacturer.
5. When conductors larger than 12 AWG are installed on 15-amp or 20-amp circuits, splice 12 AWG pigtails for device connections.
6. Tighten unused terminal screws on device.

3.02 RECEPTACLE INSTALLATION

A. Duplex Receptacle:

1. Weatherproof Receptacle:
 - a. Install in cast metal box.
 - b. Install such that hinge for protective cover is above receptacle opening.
2. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for “downstream” conventional receptacles.

3.03 DEVICE PLATE INSTALLATION

- A. Securely fasten to wiring device; ensure tight fit to box.
- B. Flush-mounted: Install with all four edges in continuous contact with finished wall surface without use of mat or similar material. Plaster fillings will not be acceptable.
- C. Surface-mounted: Plate shall not extend beyond sides of box, unless plate has no sharp corners or edges.
- D. Install with alignment tolerance to box of 1/16 inch.
- E. Label with designated title.
 1. Printed:
 - a. Character Height: 1/4 inch.
 - b. Text: Black.
 - c. Background: White.

- F. Type (Exterior):
 - 1. Receptacle in Wet Location: Weatherproof Type 2.
- G. Type (Interior):
 - 1. Other Areas: Stainless steel.

3.04 IDENTIFICATION

- A. Use tape labels for identification of individual wall switches and receptacles in dry indoor locations.
 - 1. Degrease and clean device plate surface to receive tape labels.
 - 2. Use 3/16-inch Kroy black letters on white background, unless otherwise indicated.
 - 3. Identify panelboard and circuit number from which item is served on face of plate.
- B. Identify conductors with durable wire markers or tags inside outlet boxes where more than one circuit is present.

3.05 FIELD QUALITY CONTROL

- A. Perform tests and inspections, and prepare test reports.
- B. Test Instrument for 125-volt 20-amp Receptacle: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- C. Using test plug, verify device and its outlet box are securely mounted.
- D. Line Voltage Range: 105 volts to 132 volts.
- E. Percent Voltage Drop under 15-amp Load: Less than 5 percent; 5 percent or higher is not acceptable.
- F. Ground Impedance: 2 ohms, maximum.
- G. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
- H. Tests shall be diagnostic, indicating damaged conductors, high resistance at 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.

END OF SECTION

SECTION 26 43 00
SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American National Standards Institute (ANSI).
 2. Department of Defense: MIL-STD-220C, Test Method Standard – Method of Insertion Loss Measurement.
 3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.
 - b. C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits.
 - c. C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and less) AC Power Circuits.
 4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 5. UL:
 - a. 497A, Standard for Secondary Protectors for Communications Circuits.
 - b. 1283, Standard for Electromagnetic Interference Filters.
 - c. 1449, Standard for Surge Protective Devices.

1.02 SUBMITTALS

- A. Action Submittals:
1. Product data on each suppressor type, indicating component values, part numbers, and conductor sizes. Include dimensional drawing for each, showing mounting arrangements.
 2. Electrical single-line diagram showing location of each surge protective device (SPD).
 3. Manufacturer's UL-certified test data and nameplate data for each SPD.

1.03 QUALITY ASSURANCE

- A. UL Compliance and Labeling: SPDs for Power and Signal Circuits: Comply with UL 1449 and complimentary listed to UL 1283 as an electromagnetic interference filter. Provide units listed and labeled by UL.
- B. ANSI Compliance: Use SPD devices in compliance with the recommendations of IEEE C62.41.1, IEEE C62.41.2, and IEEE C62.45.

PART 2 PRODUCTS

2.01 MANUFACTURERS AND PRODUCTS

- A. Surge Supression, Inc.
- B. Emerson; EDCO.
- C. Square D; Surelogic.
- D. Advanced Protection Technologies, Inc.
- E. CITEL; MDS Series.

2.02 GENERAL

- A. Unless indicated otherwise, provide direct bus-connected and factory-installed SPDs inside distribution equipment.
- B. SPD Operating Conditions: Capable of performing at ambient temperatures between minus 40 and 60 degrees C, at relative humidity ranging from 0 to 95 percent, and at altitudes ranging from sea level to 12,000 feet.
- C. Connect SPDs through a fused switch or circuit breaker as selected by manufacturer. Provide overcurrent protection to allow full surge handling capabilities and afford safety protection from thermal overloads and short circuits.
- D. SPD Short Circuit Current Rating (SCCR): No less than the SCCR of distribution equipment.
- E. Design SPD devices to protect all modes (L-L, L-N, L-G, N-G) of electrical system being used.
- F. Power Filter: Include a high-frequency extended range power filter for each SPD complimentary listed to UL 1283 as an electromagnetic interference filter.

- G. Provide SPDs with the following monitoring and diagnostics:
 - 1. LED-type indication lights to show normal and failed status of each protected phase.
 - 2. Surge event counter.
 - 3. Form C dry contact which operates when unit fails.
- H. Provide UL Type 2 SPDs.
- I. EMI/RFI Noise Suppression: Minus 50 dB attenuation at 100 kHz, tested in accordance with MIL-STD 220C.
- J. Voltage Protection Rating (VPR):

Voltage Rating	L-N	N-G	L-G	L-L
208Y/120	800	800	800	1200
480Y/277	1200	1200	1200	2000
240 Δ	--	--	1200	1200
480 Δ	--	--	2000	2000

2.03 SERVICE ENTRANCE AND DISTRIBUTION SPD

- A. Provide SPD meeting IEEE C62.41.1 and IEEE C62.41.2 Location in accordance with Category C.
- B. Surge Current Capacity:
 - 1. Service Entrance:
 - a. 240 kA per phase.
 - b. 120 kA per mode.
 - 2. Distribution:
 - a. 160 kA per phase.
 - b. 80 kA per mode.
- C. Maximum Continuous Operating Voltage (MCOV): Not less than 115 percent of nominal system voltage.
- D. Nominal Discharge Current (I_N): 20kA.

2.04 PANELBOARD SPD

- A. Provide SPD meeting IEEE C62.41.1 and IEEE C62.41.2 Location in accordance with Category B.
- B. Surge Current Capacity:
 - 1. Distribution: 160kA per phase; 80 kA per mode.
 - 2. Branch: 120 kA per phase; 60 kA per mode
- C. MCOV: Not less than 125 percent of nominal system voltage.
- D. Nominal Discharge Current (I_N): 10kA.

2.05 PAIRED CABLE DATA LINE INTERIOR SUPPRESSORS

- A. Provide units meeting IEEE C62.41, Location Category A.
- B. Use bi-polar 1,500-watt silicon avalanche diodes between protected conductor and earth ground.
- C. Provide units with a maximum single impulse current rating of 80 amperes (10 by 1,000 microsecond-waveform).
- D. Breakdown voltage shall not exceed 36 volts.

2.06 PAIRED CABLE DATA LINE EXTERIOR SUPPRESSORS

- A. Provide units meeting IEEE C62.41, Location Category A.
- B. Design Requirements: A hybrid design with a minimum of three stages, using solid-state components and operating bi-directionally.
- C. Meet or exceed the following criteria:
 - 1. Maximum single-impulse current rating of 10,000 amperes (8 by 20 microsecond-waveform).
 - 2. Pulse Life Rating: 3,000 amperes (8 by 20 microsecond-waveform); 2,000 occurrences.
 - 3. Maximum clamping voltage at 10,000 amperes (8 by 20 microsecond current waveform), shall not exceed the peak of normal applied signal voltage by 200 percent.

PART 3 EXECUTION

3.01 APPLICATION REQUIREMENTS

- A. Provide SPDs when indicated on Drawings or in the equipment Specifications.
- B. Provide factory-installed SPDs as integral components to new panelboards. Externally mounted SPDs are not acceptable for new distribution equipment.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Install suppressors according to manufacturer's recommendations.
- B. Install suppressors directly to the cabinet that houses the circuit to be protected so that suppressor leads are straight and short, with conductors laced, running directly to the point of connection within the panel, without loops or bends. If bends are unavoidable, no bend may exceed 90 degrees and bending radius may not be less than 6 inches.
- C. Provide connecting wires as short as possible with gently twisted conductors, tied together, to prevent separation.
 - 1. Maximum Length: 24 inches.
- D. Field-installed Conductors: As specified for building wire, not smaller than 8 AWG and not larger than 4 AWG. Provide device leads not longer than the maximum length recommended by manufacturer, unless specifically reviewed and approved by manufacturer.

END OF SECTION

SECTION 31 09 13
GEOTECHNICAL INSTRUMENTATION AND MONITORING

PART 1 GENERAL

1.01 SUMMARY

- A. This section presents requirements for Geotechnical Instrumentation and Monitoring for Auger Boring and Horizontal Directional Drilling. Geotechnical Instrumentation and Monitoring includes furnishing, installing, maintaining, and monitoring geotechnical instrumentation as shown on the Drawings and as described in this section.
- B. The work includes all engineering services, supervision, labor, equipment and material required to perform the work described in this section.
- C. On completion of the Work, remove all instrumentation and restore the ground or pavement surface to pre-Construction conditions and in accordance with FDOT and COJ requirements, unless otherwise directed or agreed to by the JEA Project Representative.
- D. Provide Geotechnical Instrumentation and Monitoring subcontractors with this Section and all related Sections and reports referenced herein.
- E. Costs for geotechnical instrumentation and monitoring shall be incidental to Auger Boring and Horizontal Direction Drilling.

1.02 RELATED SECTIONS

- A. Section 33 05 07.23, Auger Boring.
- B. Section 33 05 07.13, Horizontal Directional Drilling Supplement.

1.03 DEFINITIONS

- A. Baseline Reading: Value of instrumentation reading taken prior to the start of construction to provide a baseline against which subsequent readings are compared.
- B. Piezometer: Standpipe piezometer, consisting of a hollow casing, well screen, and aggregate filter pack as shown on the Drawings. Readings are obtained by means of a water level tape.

- C. Settlement Monitoring Point (SMP): Reference point for monitoring changes in elevation of structures, surfaces, or ground, that may result due to ground settlement.
- D. Review Level: Value of instrumentation reading at which the Contractor and JEA Project Representative jointly assess the necessity of altering construction methods, rate, or sequence.

1.04 QUALITY ASSURANCE

- A. Piezometer installation shall be performed by a geotechnical engineering or well drilling firm, routinely engaged in drilling and installing piezometers for the purpose of groundwater level monitoring, as determined to be acceptable by the JEA Project Representative. The geotechnical engineering or well drilling firm shall be familiar with FDOT requirements.
- B. Settlement monitoring shall be performed by an experienced surveyor or survey technician with training and experience suitable to achieve the required level of accuracy for the Project.
- C. Piezometer readings shall be obtained by a technician or other qualified staff trained and/or experienced to obtain accurate water level readings relative to a fixed reference point. The reference point elevation shall be determined before the start of monitoring by the Contractor's surveyor or survey technician.
- D. Monitoring point locations, survey control points, and baseline readings shall be obtained by a Professional Surveyor and Mapper, registered in the State of Florida, with training and experience acceptable to the JEA Project Representative.
- E. Provide and install benchmarks and fixed survey control points at locations such that they are not susceptible to displacement, disturbance, or damage during monitoring.
- F. Hold a pre-construction meeting at least one week prior to the start of installation of SMPs, after the submittals have been reviewed. The meeting shall include the Contractor, the boring subcontractor, the FDOT Inspector where applicable, and the JEA Project Representative. The meeting shall address the following topics at a minimum:
 - 1. Geotechnical instrumentation installation and monitoring work plans.
 - 2. Monitoring schedule.
 - 3. Record keeping and plots to monitor instrumentation data changes and trends.

4. Chain of communication for reporting monitoring data, convening meetings as required, and communication with FDOT and other third parties, if necessary.
5. Potential actions to be taken if settlement is indicated.

1.05 SUBMITTALS

- A. Provide resumes, project lists, references, and other documentation as required to demonstrate conformance with the experience and qualification requirements.
- B. Provide work plan submittals at least 30 days prior to start of installation of SMPs and piezometers. The Contractor may propose to submit work plans as multiple separate submittals, subject to approval by the JEA Project Representative.
- C. Provide work plans for installation and monitoring of SMPs and piezometers that include the information listed below. Provide written descriptions, figures, shop drawings, and product data, as applicable.
 1. Description of methods, equipment, and products for installation and protection of the instruments, including dimensions. Include cut sheets or other product information summarizing product specifications for All products to be installed.
 2. Description of survey instruments to be used, including calibration records.
 3. Example forms, spreadsheets, and plots for recording, reporting, and tracking instrumentation monitoring data.
- D. Within five (5) days following installation of the instruments, submit as-built drawings and records showing the surveyed instrument locations, instrument identification numbers, instrument types, and installation date and time. Include log of borehole drilling for the piezometers.
- E. Maintain a complete record of SMP and piezometer monitoring data in a form compatible with Microsoft Excel. Plot trends in changes in the data and email the data and plots to the JEA Project Representative immediately after recording in the tracking file.

PART 2 PRODUCTS

2.01 EQUIPMENT

- A. Select, furnish, and operate monitoring equipment required to complete the Work.
- B. Water level meters shall be tapes with a water sensitive probe, produced for monitoring groundwater levels in standpipe piezometers.
- C. Calibrate surveying levels and water level meters in accordance with procedures recommended by manufacturer. Instruments shall be calibrated within 1 month prior to the start of monitoring.

2.02 MATERIALS

- A. Cement grout for piezometers shall be a mixture of 5.5 gallons of water per 94 lb sack of Type I or Type II cement, with sodium bentonite chips as proposed by the Contractor and acceptable to the JEA Project Representative.
- B. Flush mounted protective covers shall be traffic rated watertight steel monitoring well covers or roadway boxes with lids.
- C. Piezometers:
 - 1. Standpipe shall be NSF rated Schedule 40 PVC pipe with a 10-ft long, 10 slot screen with sump and cap at base of well.
 - 2. Sand filter pack: #20-40 silica sand, clean and free of debris and fines.

PART 3 EXECUTION

3.01 GENERAL

- A. Auger Boring and Horizontal Directional Drilling shall not start until all geotechnical instruments are in place and baseline values have been determined.
- B. Perform the work in accordance with the work plans and applicable regulations.
- C. The Contractor shall be solely responsible for the means and methods of installation and monitoring, and shall ensure the safety of construction personnel and the public throughout the work. All maintenance of traffic (MOT), signage, barriers, and other measures required for road work shall be the responsibility of the Contractor and costs shall be incidental to the Work.

- D. Notify the JEA Project Representative five (5) days prior to installing instruments.
- E. Obtain all permits required for installing instruments.
- F. Locate conduits and underground utilities in areas where drilling or excavation is required to install instruments. Obtain utility clearances and notify utility companies in accordance with regulations.
- G. Approximate instrument locations are shown on Drawings. Adjust locations as approved by the JEA Project Representative and the FDOT Inspector, to avoid interference with existing utilities and structures.
- H. Repair damage to utilities and structures resulting from instrument installations at no cost to the owner of the existing utility or structure and JEA.
- I. Survey the locations of all instruments to provide horizontal coordinates and elevations within two days of completing the installation, as follows:
 - 1. Establish the initial horizontal coordinates of each instrument to 0.1 ft, and of SMPs to 0.005 ft.
 - 2. Establish the initial elevation of SMPs to 0.005 ft. Establish the elevation of piezometer reference points to 0.005 ft.

3.02 INSTALLATION

- A. Installation schedule shall be as follows:
 - 1. Install piezometers at least 21 days prior to the start of pit construction.
 - 2. Install SMPs at least 14 days prior to start of pit construction for auger boring or horizontal directional drilling pilot hole.
- B. Use vacuum methods or hand digging to excavate for installation of instruments adjacent to existing utilities marked by the utility locator or shown on the Drawings as necessary to protect the utilities against damage.
- C. Clearly label or mark all instruments to enable field identification.
- D. Prepare an installation record as each instrument is installed, including:
 - 1. Initial coordinates of each instrument to nearest 0.1 foot.
 - 2. Project name and contract name and number.
 - 3. Instrument type and number.
 - 4. Personnel responsible for installation.
 - 5. Equipment used, including diameter and depth of any drill casing used.

6. Date and time of start and completion.
7. Written log of soil and subsurface conditions, for each hole bored or dug for instrument installation. Log shall state soil classification and engineering soil description for every 5 feet of depth, or where soil conditions are observed to change. Soil classifications and descriptions shall be generally in accordance with ASTM D2487 and ASTM D2488.
8. Type and description of backfill used.
9. Surveyed as-built location in plan and elevation.
10. As-built depths and backfill volumes placed.
11. Weather conditions at the time of installation.

3.03 INSTRUMENT READINGS

- A. Reading schedules specified are the minimum required. The JEA Project Representative may require adjusted monitoring frequencies depending upon location of the bore or drill, construction progress, rates of movement, and other factors affecting the ground or structures subject to monitoring. Perform additional readings requested at no additional cost to JEA.
- B. Baseline readings for SMPs and Piezometers shall consist of an average of three readings obtained 7 days prior to the start of construction.
- C. Settlement monitoring points:
 1. Survey elevations of points located within 50 feet of the pits, once every 24 hours during pit excavation and construction, during working days.
 2. Survey elevation of all points once every 24 hours during auger boring work or horizontal directional drilling work, during working days, until completion of the work.
 3. Survey elevations two (2) times, during a period of 1 month following backfilling of the auger bore pits and completion of the horizontal directional drilling.
- D. Obtain water level readings in piezometers according to the following schedule:
 1. Once every seven (7) days from installation until excavation of pits or dewatering commences, within 200 feet of the piezometer.
 2. Daily during construction of pits and the bore, until the casing is installed.
 3. Once every 7 days, until backfilling of pits is complete.

E. Review Levels:

1. The review level for SMPs shall be 0.04 ft of settlement relative to baseline.
2. If the Review Level is reached, immediately develop a plan of action to halt further settlement, and notify and meet with the JEA Project Representative.
3. Implement the plan of action to prevent further settlement and to remediate any adverse conditions or damage, due to settlement.
4. The cost of measures required to limit further settlement, and to repair settlement induced damage due to auger boring, pit excavation, and horizontal directional drilling shall be incidental to the Work.

3.04 REPORTING

- A. Record settlement and piezometer monitoring data, reduce the data, and plot trends in a Microsoft Excel file. Provide the reduced data and plots to the JEA Project Representative within 12 hours of taking the measurement.
- B. Calculate and plot settlement relative to baseline values, with respect to time and relative to pit depth or relative location of the auger bore or horizontal directional drill.
- C. Prepare plots to show the change in elevation of the water levels in piezometers with respect to time, and to show the change in elevation with respect to the depth of the pits or location of the bore.
- D. The Contractor shall not disclose any instrumentation data to third parties, nor publish data, without prior written approval from JEA.

3.05 PROTECTION, MAINTENANCE, AND REPAIR

- A. Protect instruments and associated elements from damage due to construction operations, weather, traffic, and vandalism.
- B. If an instrument is damaged or inoperative, notify the JEA Project Representative within 24 hours from the time that the damage was observed.
- C. Repair or replace any damaged or inoperative instrument within 24 hours after the damage occurs. The Contractor may propose to perform the repair or replacement before the next scheduled instrument reading, subject to review and acceptance by the JEA Project Representative.

3.06 RESTORATION

- A. Remove all instrumentation and associated elements installed upon completion of the work, unless otherwise directed by the JEA Project Representative.
- B. Remove portions of instruments above grade or at grade including protective covers and concrete pads. Fill any subsurface installations with non-shrink grout. Patch disturbed surfaces to match material at the surface or another material approved by the JEA Project Representative and FDOT Inspector.

END OF SECTION

**SECTION 33 05 07.13
HORIZONTAL DIRECTIONAL DRILLING SUPPLEMENT**

PART 1 GENERAL

1.01 DESCRIPTION

- A. This section supplements JEA Water and Wastewater Standards Section 755 for Horizontal Directional Drilling (Large Diameter Pipe Greater Than 12 Inches) and Section 350 Potable Water Piping. Specifically, this specification addresses additional requirements. In the case of contradictory information, this specification takes precedence over Section 755 and Section 350.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. JEA Water and Wastewater Standards Section 350 – Potable Water Piping.
 - 2. JEA Water and Wastewater Standards Section 755 – Horizontal Directional Drilling (Large Diameter Pipe Greater Than 12 Inches).
 - 3. Section 31 09 13, Geotechnical Instrumentation and Monitoring.

1.02 QUALIFICATIONS

- A. The HDD Contractor shall have successfully self-performed at least five (5) horizontal directional drilling projects to install carrier pipe of a similar nominal diameter (36-inch HDPE DR 11), or larger, and similar length (800 LF single pull HDD), or longer, to the proposed project within the last two (2) years. At least one (1) project shall have been performed in FDOT Right-of-Way or crossing FDOT Right-of-Way. References for the five (5) similar projects shall be included in the bid documents. References shall include: project name, project completion date, project HDPE pipe diameter, project single pull HDD length, reference person's name and phone number.

1.03 SUBMITTALS

- A. In addition to the requirements in JEA Water and Wastewater Standards Section 755, Paragraph I.8.1:
 - 1. Changes to Personnel: Any changes to personnel designated in Paragraph I.8.1 shall be subject to the same personnel qualifications submittal and review process as the original personnel, and deemed satisfactory by JEA prior to the new personnel performing any work. There shall be no schedule extension due to change in personnel and JEA's review of personnel qualifications.

- B. In addition to the requirements in JEA Water and Wastewater Standards Section 755, Paragraph I.8.2:
1. Buoyancy ballast plan: The Contractor shall provide the buoyancy ballast plan for the pipe pullback, including the total volume of water required for neutral buoyancy, the volume of water per pipe joint, the diameter and material of the pipe that will be used for delivering the ballast water to the HDPE pipe, the procedure for monitoring ballast water volumes injected during pullback, and the source for the ballast water. The buoyancy ballast calculations and plan shall be sealed by a Professional Engineer registered in the State of Florida.
 2. Changes to approved HDD Work Plan: Any changes to the approved HDD Work Plan or Submittal Information under Section I.8 shall be submitted to JEA for review as a RFI prior to work differing from the approved HDD Work Plan being performed. There shall be no schedule extension due to changes in the HDD Work Plan and JEA's review of changes.
- C. In addition to the requirements in JEA Water and Wastewater Standards Section 755, Paragraph I.8.2.1.1:
1. After "Procedures for pilot hole drilling and reaming", include the number of reaming and swabbing passes. For each reaming pass, provide reamer diameter, type of reamer, and total length and direction of reaming pass. For each swabbing pass, provide swab diameter, type of swab, and total length and direction of swabbing pass.
- D. In addition to the requirements in JEA Water and Wastewater Standards Section 755, Paragraph I.8.2.3:
1. Units of drill rig gauges for push/pull and rotary. Provide conversion factors to force (e.g. pounds) for the push/pull gauge and torque (e.g. foot-pounds) for the rotary if these units are not permanently marked on the drill rig gauges.
- E. Modify Paragraph I.8.5.1.3 in JEA Water and Wastewater Standards Section 755, to the following:
1. Construction Records – Daily Reports: Description of drilling fluid, including density, viscosity, and sand content. Record additives that are added to the drilling fluid, including the commercial name of the additive, the amount used, and the time of the application. Provide drilling fluid description on the daily drill log report. Drilling fluid parameters, including density, viscosity, and sand content, shall be tested and recorded at least three (3) times per 12-hour shift.

- F. In addition to the requirements in JEA Water and Wastewater Standards Section 755, Paragraph I.8.5.2:
1. Pilot hole as-built data shall be submitted to JEA within one (1) working day of completion of the pilot bore. Any subsequent reaming and installation work is performed at the Contractor's risk until the pilot bore as-built data is reviewed and approved by JEA.
- G. In addition to the requirements in JEA Water and Wastewater Standards Section 755, Paragraph I.8.5.3.3. and Paragraph III.6:
1. For each HDPE pipe joint fusion provide actual recorded values for the following data, submitted in tabular format:
 - a. Actual temperature of heating element.
 - b. Time of heating.
 - c. Time of heater removal/transition.
 - d. Time of fusion/cooling.
 - e. Minimum and maximum pressures of heating phase.
 - f. Minimum and maximum pressures of fusion/cooling phase.
 2. HDPE pipe joint fusion data files shall be immediately uploaded to the McElroy DataLogger Vault (or JEA approved equal) and made available to the JEA Representative. Data files shall also be submitted in datalogger file format (for example, ".DL6") and in PDF file format, in addition to tabular data listed above, within 2 business days of the HDPE pipe joint fusion completion. At a minimum, HDPE pipe joint fusion data for the pipe string to be installed shall be submitted at least 5 business days prior to the planned pipe pullback date. Data files shall include:
 - a. The date and time of the fusion
 - b. The fusion technician's name and ID
 - c. Joint number
 - d. Fusion machine manufacturer and model used, and serial number used
 - e. DataLogger device manufacturer and model used and serial number used
 - f. DataLogger device current calibration date
 - g. The pipe manufacturer
 - h. The pipe material and material designation
 - i. The pipe OD and DR
 - j. The heat butt fusion procedure or standard used

- k. Recommended hydraulic butt fusion machine gauge pressure for the different steps in the heat butt fusion process:
 - 1) Bead-up pressure
 - 2) Heat soak pressure
 - 3) Fusion/Cooling pressure
 - l. The drag pressure
 - m. The interfacial pressure used
 - n. The actual heater temperature at the beginning of the heat cycle
 - o. The actual pressure applied during the heating, fusing and cooling cycle
 - p. The time for each stage of the process from the beginning of the heat cycle through the end of the cool cycle (time of heating/heat soak, time of heater removal/transition, time of fusion/cooling)
 - q. Time versus pressure graph throughout the entire butt fusion process, from the start of the heating phase through the end of the fusion/cooling phase
 - r. Pictures of fused joint--A minimum of 8 pictures of the fused joint shall be included to clearly show the fused joint at the following clock positions around the joint: 12:00, 1:30, 3:00, 4:30, 6:00, 7:30, 9:00, and 10:30.
- 3. Equipment shall be McElroy DataLogger 6 or higher, or JEA approved equal.
 - 4. The joint number corresponding to the DataLogger joint number shall be painted or permanently marked on the pipe next to the fused joint.

PART 2 PRODUCTS

2.01 MATERIALS

- A. High Density Polyethylene (HDPE): The HDPE pipe shall meet the requirements of Section 755 with the additional requirement that the material used to manufacture the pipe shall be PE4710 high density polyethylene meeting cell classification 445474C or 445574C per ASTM D3350, and the HDPE pipe shall conform to AWWA C906, DR-11, Ductile Iron Pipe size (DIPS) and NSF 61 Standard.

2.02 EQUIPMENT

- A. Use pipe rollers to support the full length of the HDPE pipe string during fusing, testing, and pullback.

PART 3 DRILLING PROCEDURES

3.01 PILOT HOLE

- A. Elevation: The pilot hole tolerance is plus or minus 5 feet of the path shown on the Drawings.
- B. Curve Radius: While overall curve radii of curvature over a series of segments should average to what is shown on the plans, specific locations will be checked using the Three-Point Curve Radius method described below.
- C. Three-Point Curve Radius: The installed/drilled pilot hole radius of curvature shall not be tighter than eighty percent (80%) of the minimum radius of curvature as shown on the drawings (example, radius of curvature shown on plans = 2,000 feet; eighty percent (80%) is 1,600 feet) as calculated by the three (3) joint method described below. The drilled radius of curvature shall be calculated over any and all three (3) joint (Two (2) drill pipe rods) segment using the following formula:

$$R_{\text{drilled}} = (L_{\text{drilled}}/A_{\text{avg}}) * 57.30$$

Where: R_{drilled} , (feet) is the calculated/estimated drilled radius
 L_{drilled} , (feet) is the segment length (Two (2) drill pipe rods)
 A_{avg} , is the difference in degrees (delta) of either the inclination or azimuth angle in degrees of the joint at the beginning of the two drill rod section and the end of the two drill rod section; in the case of horizontal curves, the azimuth angles will be used and the inclination angles will be used everywhere else for A_{avg} .

3.02 PULLBACK

- A. In addition to the requirements in JEA Water and Wastewater Standards Section 755, Paragraph IV.4:
 - 1. Buoyancy control measures (ballast) are required.
 - 2. Use ballast to control pipe buoyancy during pullback. Ballast shall consist of water filling the pipe at the HDPE pipe breakover point throughout installation. Contractor may submit an alternative ballast plan for review by the JEA Project Representative.
 - 3. HDPE pipe shall be welded/fused together in one length and pulled back without stopping work. Work hours will be 24 hours a day until pipe pullback is complete.

4. Individual workers shall not work any shift or be present on site for longer than 24 hours. If the continuous pipe pullback requires a shift or work period longer than 24 hours, the Contractor shall use two (2) crews to complete the work. A minimum rest time of 8 hours is required between shifts for any individual worker.
5. Pull pipe so that a minimum of 10 feet of pipe is exposed at both ends of the bore following HDPE pipe strain recovery.

PART 4 TESTING

4.01 HDPE PIPE

- A. Prior to pullback, the HDPE pipe shall be pressure tested in accordance with JEA Section 755. After pullback, the HDPE pipe shall be again pressure tested in accordance with JEA Section 755.

END OF SECTION

**SECTION 33 05 07.23
AUGER BORING**

PART 1 GENERAL

1.01 SUMMARY

- A. The Work specified in this section includes installation of casing by auger boring, and installation of carrier pipe within the casing, at the locations shown on the Drawings. Auger boring may be referred to in the Contract Documents as “Jack and Bore”.
- B. The Contractor shall furnish all labor, equipment, materials, and professional services necessary to complete the Work.
- C. The Contractor shall provide all auger boring subcontractors with this section and all referenced sections and reports.
- D. The auger bore crossing under Beach Boulevard (US-90/FL-212) shall be constructed in accordance with this Section and the requirements of FDOT Standard Specification Section 556, “Jack and Bore,” subject to the following clarifications and modifications.
 - 1. FDOT Specification Section 556 includes requirements specifically for microtunneling that shall not apply to auger boring for the project. Specific FDOT requirements that shall not apply are:
 - a. Section 556-5.1. Installation Process. Auger boring does not provide continuous fluid pressure to the face. Operate the boring equipment as required to control the ingress of soil into the casing, and to maintain ground stability.
 - b. Section 556-5.1. Installation Process, and Section 556-5.2 Excess material and fluids. The use of fluids for face stabilization and casing lubrication is not anticipated. Requirements for fluids shall not apply.
 - 2. Section 556-2. Materials and Section 556-2.1. Steel Pipe Casing and Welds. Casing, carrier pipe, and welds shall conform to the requirements of this Section and as shown on the Drawings.
 - 3. Section 556-4.2. Construction Process. Contractor shall not inject water inside the casing for spoil removal.
 - 4. Section 556-4.3.1. Testing Requirements. Casing pressure testing is not required.

5. Section 556-7. Compensation. Compensation shall be in accordance with the Contract Documents.
 6. For the Beach Boulevard crossing, in the event of a conflict between FDOT Standard Specification Section 556 and this Section, FDOT specifications shall prevail.
- E. Stabilized excavations, supported by engineered shoring systems, are required at each end of the auger bores to perform the work, referred to in this section as jacking and receiving pits.
- F. Dewatering systems are required to lower the groundwater table at the jacking and receiving pits and along the auger bore alignments. Design, install, operate, and maintain the dewatering systems as required to perform the Work covered by this section, and to achieve the performance requirements of this section.

1.02 RELATED SECTION

- A. Section 31 09 13, Geotechnical Instrumentation and Monitoring.

1.03 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM):
1. ASTM A139 - Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe.
 2. ASTM C150 – Standard Specification for Portland Cement.
- B. American Welding Society (AWS): D1.1/D1.1M, Structural Welding Code for Steel.

1.04 DEFINITIONS

- A. Auger boring: The process of jacking a casing pipe into the ground using hydraulic jacks while simultaneously excavating the ground at the opposite end of the casing by means of a rotating cutting head. Spoil from the cutting head is transported out of the bore by rotating an auger extending continuously through the casing.
- B. Pilot tube guided auger boring: Multistage process of installing casing to a design line and grade by means of advancing a pilot tube between two pits, followed by upsizing and jacking the casing between the pits. The casing is advanced along the bore alignment by jacking while spoil is removed from the pipe by an auger.

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- C. Pilot tubes: Steerable tubes that are jacked through the ground to provide a pilot bore accurate in both line and grade. A leading slant-faced bit enables steering. The pilot tube is guided using a camera-mounted theodolite to monitor the position of an LED target mounted behind the bit.
- D. Obstruction: Any buried object encountered by the casing that acts as a physical impediment to auger boring, such that it prevents the auger bore from being advanced forward.
- E. Casing: Protective steel pipe installed to support the auger bore excavation. Casing is advanced by jacking and is designed to withstand all anticipated jacking loads, static loads, and imposed loads with appropriate factors of safety.
- F. Face: The excavation surface exposed by the cutting head.
- G. Jacking pit: Excavation from which the auger bore is advanced, supported by a shoring system and/or graded to provide stable excavation sidewalls, as designed or determined by the Contractor's engineer.
- H. Receiving pit: Excavation into which the auger bore is advanced, supported by a shoring system, and/or graded to provide stable excavation sidewalls, as designed or determined by the Contractor's engineer.
- I. Cutting head: Device fitted with excavation or cutting tools and attached to the front of the auger string and/or of a mechanical boring head, rotated to excavate the face.
- J. Jacking frame: A steel frame housing the hydraulic cylinders used to advance the casing string, designed to transmit jacking loads between the casing and a thrust block or backstop.
- K. Thrust block: A structure designed to distribute jacking force to the ground and/or to the excavation ground support system.
- L. Backstop: Jacking reaction structure, anchored into the ground in the jacking pit, or against a side of the jacking pit.
- M. Spoil: Excavated soil or rock.
- N. Allowable jacking load: Maximum jacking load that can be applied to the casing pipe after allowing for an appropriate factor of safety. The allowable jacking load is determined by the Contractor's engineer considering the capacity of the casing to withstand loads imposed by the jacking process.

- O. Over-excavation: Excavation of a volume of ground greater than the volume of the casing.
- P. Water jetting: Use of a stream of water to erode soil, and/or to create a slurry of water and soil.
- Q. Flowing ground: A mixture of sand, or sandy soil, and water will flow as a viscous fluid into the face of the bore and through the augers, or when exposed during pit excavation.
- R. Running ground: Granular soil with negligible cohesion that runs into a steep excavation until the slope of the running soil flattens to the angle of repose, or until support is placed against the soil.

1.05 QUALITY ASSURANCE

- A. Auger boring shall be performed by a company and by personnel regularly engaged in constructing auger bores similar to the required crossings. The Contractor or subcontractor performing the work, and all supervisors responsible for oversight of bore construction shall conform to the following minimum requirements:
- B. Completion of at least three (3) comparable bores in the past three (3) years.
- C. The diameters and lengths of at least two (2) of the referenced bores shall be equal to or greater than the auger bores required for this Project.
- D. At least one (1) referenced bore shall have been completed in ground conditions similar to those anticipated, for each of the two auger bores.
- E. Personnel operating the boring and pipe jacking equipment shall have completed a minimum of five bores or 500 feet with equipment similar to that proposed.
- F. Casing pipe welding shall be performed by qualified welders in accordance with ANSI/American Welding Society (AWS) D1.1/D1.1M.
- G. If a different casing configuration is proposed than the one shown on the Drawings, retain a Professional Engineer to design the casing. This engineer shall be registered in Florida, and have at least three years of related design experience, including design for at least two comparable projects.

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- H. Retain a shoring engineer to evaluate requirements for stabilizing and shoring the pits, and to design pit shoring as required. The shoring engineer shall be a Professional Engineer licensed in Florida with at least three years of related design experience, including responsibility for at least two (2) comparable designs.
- I. The Contractor's engineer responsible for shoring design shall perform a minimum of two (2) site visits during pit construction to observe ground conditions and verify that excavation methods and support comply with the design and are appropriate for the actual conditions encountered.
- J. Retain a Professional Engineer or Professional Geologist to design the dewatering systems. The dewatering system designer shall be registered in Florida and shall have at least three years of related design experience, including design for at least two comparable projects.
- K. Retain a surveyor to lay out control points for boring. The surveyor shall be registered in Florida and have experience with comparable projects.
- L. The carrier pipe manufacturer shall review the proposed work plan for pipe installation and blocking, prior to commencing auger boring.
- M. The carrier pipe manufacturer shall furnish the services of a competent factory representative to inspect storage, handling, and installation of carrier pipe during initial pipe installation. The factory representative shall be provided at no additional cost to JEA.
- N. Locate utilities within 30 feet of the auger bore alignment and within 30 feet of the pit excavations prior to mobilization to the site.

1.06 ANTICIPATED GROUND CONDITIONS

- A. The following geotechnical report has been prepared for the Project, and is included as a reference to the Contract Documents:

“JEA SIPS Deerwood Route Water Main from Southside Boulevard Intertie Station to Deerwood III WTP – Jacksonville, Florida”, dated April 19, 2021, prepared by CSI Geo, Inc.
- B. The geotechnical report includes geotechnical data collected during the subsurface investigation for the Project, presents factual information about the observed ground and groundwater conditions at the test boring locations, and interpretations of geotechnical parameters for design.

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- C. Provide copies of the geotechnical report and this Specification to all boring subcontractors, Contractor's shoring engineer, and Contractor's engineer or geologist designing the dewatering system.
- D. The Contractor shall review the geotechnical report and develop their own interpretation of the subsurface conditions and ground behavior considering the proposed construction means and methods. However, the Contractor shall develop their bid prices and plan for the work based on the anticipated ground conditions described in this section.
- E. The groundwater level is anticipated to be within 2 feet to 4 feet below the ground surface at both auger bore crossings. This section includes requirements to dewater the pits and auger bore alignments, to stabilize the pits and the face of each bore. The Contractor is required to confirm that groundwater levels have been lowered to a minimum of 2 feet below the base of the pits and casing inverts along the entire alignment of each auger bore.
- F. Ground conditions anticipated to be encountered in the Beach Boulevard bore are described below. The Contractor shall plan to implement equipment, means, and methods suitable for these conditions.
 - 1. The predominant soil material (greater than 90% by bore volume) is anticipated to be sand with fines content ranging from 1 percent to 6 percent. Other soils may be potentially be encountered in the rest of the bore.
 - 2. The in-situ relative density of sand below elevation 34 is anticipated to be "dense to very dense" based on the terminology of the geotechnical report. Representative uncorrected Standard Penetration Test (SPT) N-values (blow counts per foot) in this zone are N = 24 to 50.
 - 3. The in-situ relative density of sand above elevation 34 is anticipated to vary from medium dense to dense, with representative uncorrected SPT N-values ranging from approximately 15 to 30. Above elevation 34 the bore will tend to encounter relatively less dense soil as it is advanced from south to north.
 - 4. In ground characterized as very dense sand, the soil particles may be bonded together until disaggregated by boring. Boring equipment and tools suitable for weak rock may potentially be required to break up the ground and advance the bore in this condition.
 - 5. Where the bore encounters relatively less dense soil overlying denser soil, the bore will tend to deflect away from the design grade. The Contractor is required to use a mechanical steering head or pilot tube guided auger boring to counter potential steering difficulties.

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6. Where the bore encounters soil in a relatively less dense condition in the upper half, there will be a tendency for over-excavation because the rate of advance will be governed by the denser ground. The Contractor will have to employ equipment, means, and methods to counter the potential for over-excavation.
- G. Ground conditions anticipated to be encountered in the Gate Parkway bore are described below, and construction considerations are presented.
1. The predominant soil material (greater than 90% by bore volume) is anticipated to be sand with fines content ranging from 1 percent to 5 percent. Other soils may potentially be encountered in the rest of the bore.
 2. The in-situ relative density of sand in the bore horizon is anticipated to be “loose to medium dense” based on the terminology of the geotechnical report. Representative uncorrected Standard Penetration Test (SPT) N-values (blow counts per foot) in this zone are N = 4 to 24.
 3. Where the bore encounters loose sand, the ground may exhibit a tendency to flow if dewatering is inadequate and the ground is saturated, or to run if dried out.
 4. The Contractor is required to use a mechanical steering head or pilot tube guided auger boring to counter potential steering difficulties, which may arise due to material variability or other factors.
- H. The Beach Boulevard pits will encounter loose to medium dense to very dense soil, with representative uncorrected SPT N-values exceeding about 24 at a depth between approximately elevation 38 and 33. Refer to the geotechnical report for SPT N-values obtained at the site. The Contractor shall consider:
1. Excavation is required through the full range of soil density conditions. The Contractor shall select excavation equipment suitable for excavating dense to very dense ground.
 2. Installing excavation support systems for the full range of anticipated soil conditions. It will not be feasible to drive sheet piles or other types of sheeting to support the pits for the Beach Boulevard bore.

1.07 DESIGN CRITERIA

- A. The Contractor’s shoring engineer shall evaluate stability conditions at all pits and shall provide signed and sealed recommendations for the excavation configurations and stabilization measures, and shall provide shoring designs including sealed drawings and design calculations.
- B. The Contractor’s engineer or geologist shall design dewatering systems for each pit based on the information provided in the geotechnical report and as stated in this Section.

1.08 PERFORMANCE CRITERIA

- A. Install the casings for the auger bores so that the carrier pipe can be installed in accordance with the following tolerances:
 - 1. Provide the minimum clearance around the carrier pipe shown on the Drawings.
 - 2. Within 2 feet of the design alignment shown on the Drawings.
 - 3. Within 6 inches of the design invert grade shown on the Drawings.
 - 4. With a continuous positive slope, with no flat or reverse grades.
- B. Limit ground settlement caused by auger boring and pit construction, as required to prevent disturbance and damage to adjacent roads, utilities, structures, and other facilities. Construction-induced settlements shall not exceed 1 inch.
- C. If ground or structure settlement exceeds 1 inch, develop and implement a plan to drill, intersect, and fill all voids under adjacent structures and utilities within 20 feet either side of the auger bore centerline with backfill grout. Provide and place grout to fill any voids that develop at no additional cost to JEA.
- D. Repair all damage to adjacent roads, utilities, roadways, structures and other facilities due to settlement or any other disturbance caused by the work. Develop and implement a written work plan for repairing any damage, to restore the affected structure, utility, roadway, or walkway to the original, pre-construction condition, to the satisfaction of the JEA Project Representative. Repair all damage caused by ground settlement or other disturbance resulting due to auger boring, at no additional cost to the Owner.
- E. Install a dewatering system to lower the groundwater table elevation continuously throughout pit construction and auger boring, until all work is complete. The dewatering system shall draw the water table down to at least 2 feet below the bottom of the entire bore alignment and the bottom of the pits, as indicated by measurement of the water level in the piezometers installed as shown on the Drawings.

1.09 SUBMITTALS

- A. Provide resumes, project lists, and other supporting documentation as required to demonstrate conformance with the qualification requirements, as determined to be acceptable by the JEA Project Representative.

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- B. Provide all auger boring submittals a minimum of 60 days prior to the scheduled start of the work. The Contractor may propose to submit the work plan as multiple separate submittals, subject to prior acceptance by the JEA Project Representative.
- C. Provide a written auger boring work plan including descriptions, shop drawings, sketches, and cut sheets, to address the items listed below. Provide separate work plans for each bore, or indicate differences applicable to each bore.
1. Site layout drawings for each boring site showing equipment layout, power and water supply, access and egress, and existing utilities. Show dewatering system locations and water discharge receptors. Provide drawings to scale.
 2. Descriptions of the auger boring equipment, including manufacturer's specifications and cut sheets, and drawings of the equipment. Include the make, model, and size, of the guidance and steering systems, boring machine, bits, augers, track configuration and setup, and spoil handling system. Provide jacking cylinder sizes and jacking capacities, jacking frame and/or backstop configuration, and power unit(s). Indicate location, type, and calibration of pressure monitoring devices and readouts.
 3. Auger boring methods and procedures, addressing:
 4. Jacking procedures for operating the jacks concurrent with boring, and procedures for monitoring jacking pressures to prevent exceeding the allowable jacking load for the casing pipe.
 5. Auger operation procedures to excavate and remove spoil from the face. Address procedures to control face stability, prevent over-excavation, and limit settlement during pipe jacking, as required to achieve the maximum settlement limits and prevent voids from developing above the bore. Describe proposed methods for monitoring the soil volume removed, and for identifying potential over-excavation. Describe equipment and measures to address the potential to encounter flowing and/or running sand, for example: sand augers; use of a sand cutting head; operation with cutting head recessed inside the casing, etc.
 6. Methods and materials to maintain face stability and prevent loss of ground and erosion of fines, when jacking is temporarily stopped, and in case of a prolonged stoppage of several days.
 7. Methods and procedures for line and grade control, as required to achieve the design line and grade within the specified tolerances. Address the following.
 8. Survey control and benchmarks for the pits and auger bore.
 9. Layout to set up the track and initial casing position in the launch pit.

10. Measures and procedures for monitoring the lead casing position and grade continuously throughout jacking, and procedures for making adjustments to the lead casing orientation.
 11. Measures for checking the casing alignment and position continuously during auger boring.
 12. Measures for steering the auger bore.
 13. Spoil handling plan, including locations of on-site storage areas, truck washing stations, and offsite haulage routes.
 14. Groundwater and construction water control plan including drainage provisions, and details for the pumping, treatment, and disposal of ground and construction water. Address methods of drainage and water control in the bores and in the pits.
 15. Work schedule, identifying all major construction activities as independent tasks. Summarize construction sequence, number and duration of shifts planned and daily sequence of operations.
 16. Methods of sealing the pit break out and break in openings, including portal seals or ground improvement measures to prevent ground and groundwater inflows when portals are opened in the pit shoring system, and during jacking.
- D. Provide a dewatering work plan. Include drawings showing the proposed well or wellpoint types, configuration, and locations in plan, and bottom depths. Include description of the proposed pumps and other equipment, including pumping wells or educator wells, and describe the header and water treatment system. Provide signed and sealed calculations supporting the dewatering plan.
- E. Provide materials submittals including:
1. Description of casing products and materials, including specifications and shop drawings showing the pipe wall thickness, steel grade, and the maximum allowable axial force.
 2. Certifications from the casing manufacturer for casing pipe segments demonstrating that the materials meet the requirements of the specifications.
- F. Prepare contingency plans, describing measures that the Contactor will be prepared to employ in the event of the following conditions:
1. An obstruction is encountered in the face. Describe plan for supporting face once augers have been removed, and providing ventilation required for entry of the casing.

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2. Flowing or running ground encountered at the face.
 3. Settlement exceeding the specified criteria, and/or volume of excavated spoil exceeding the volume of the casing installed, or other indications of voids. Describe the plan to mobilize drilling and grouting equipment. Describe measures to monitor and control grout injection rates, and to prevent damage due to grouting pressures.
- G. Provide a carrier pipe installation work plan including written procedures, shop drawings, sketches, and cut sheets. Address the items listed below.
1. Survey and layout procedures, including as-built profile of the casing prior to installing the carrier pipe.
 2. Carrier pipe installation plan including:
 3. Written procedures for installation of the carrier pipe, polyethylene encasement, and casing spacers.
 4. Drawings with sections perpendicular to the bore axis showing proposed arrangement and configurations of casing spacers.
 5. Product descriptions of the casing spacers and blocking materials. Include cut sheets, Specifications, and shop drawings provided by the manufacturer. Provide the manufacturer's recommended installation procedures including recommended casing spacer intervals.
- H. Provide a written report of utility locates in accordance with ASCE 38-02 Quality Level A, within five (5) days after completing the observations, for utilities within 30 feet of the auger bore alignment and within 30 feet of the required excavations.
- I. Prepare as-built drawings and records in accordance with JEA Standard Specification Section 501.
- J. Submit shift reports for each shift within 24 hours of the end of each shift, including:
1. Hours worked per shift.
 2. General description of work performed each shift.
 3. Jacking reports including: Time of reading; cutting head position including station and elevation; thrust and torque readings (per casing joint); individual thrust jack pressures, and total thrust on the casing; start/end time for each jacking cycle; volume of spoil removed; pumping rates, description of ground encountered, and observations of lost ground or ground movement.

1.10 PRE-CONSTRUCTION MEETING

- A. Hold a pre-construction meeting at least one week prior to the start of pit construction, after submittals have been reviewed. Include the Contractor, auger boring subcontractor, Contractor's engineer, and the JEA Project Representative.
- B. The pre-construction meeting should include review of: the work plans; quality control; grade and alignment control; spoil and water management; the safety plan; and the plans for coordination of geotechnical instrumentation monitoring with boring operations for settlement mitigation.

PART 2 PRODUCTS

2.01 EQUIPMENT

- A. The Contractor shall select, furnish, and operate the auger boring equipment to complete the Work shown on the Drawings, to achieve the specified performance requirements, and to conform to the requirements of this Section.
- B. The Contractor bears sole responsibility for the suitability of the selected equipment for the Project requirements, the site conditions, the ground conditions anticipated by the Contractor, and the anticipated ground conditions described in this section.
- C. The Contractor's auger boring equipment shall incorporate the following elements, at a minimum:
 - 1. Means to monitor the vertical position of the casing within 5 feet of the face at a minimum frequency of once per 10 feet of advance without requiring personnel entry into the casing to survey the casing.
 - 2. Mechanical steering head capable of steering the casing as the bore is advanced, as required to achieve the design line and grade within the specified tolerances. The Contractor may elect to use pilot tube guided auger boring, as defined in this section, in lieu of a mechanical steering head.
- D. The cutting head and augers shall be configured to enable the Contractor to control the ingress of excavated ground at the face to prevent over-excavation. Augers shall cover 100 percent of the casing cross sectional area, unless otherwise acceptable to the JEA Project Representative.
- E. The cutting head and/or casing banding shall not result in an overcut greater than 1 inch beyond the outside diameter of the casing.

- F. Provide sump pumps and discharge lines for each pit, with appropriate pumping capacity as required to maintain equipment in a dry condition during rainfall events. Sump pump discharge lines shall incorporate water flow meters and totalizers to enable monitoring of pumping rates.
- G. The jacking system shall incorporate means to monitor jacking pressures continuously throughout boring.
- H. The jacking system shall develop a uniform distribution of jacking forces on the end of the casing pipe.

2.02 STEEL CASING PIPE

- A. Furnish steel casing pipe conforming to ASTM A139 per JEA Water and Sewer Standards Specification Section 350, Paragraph II.2.6., and Steel Casing Detail as shown on the Drawings.
- B. The Drawings show the casing diameter and minimum thickness requirements. The Contractor may propose an alternative, larger diameter casing, subject to review and acceptance by the JEA Project Representative.
- C. Casing pipe shall be designed by the Contractor's engineer for the requirements and conditions described in the Contract Documents, and the Design Criteria included in this Section, if the Contractor elects to use a different casing configuration than shown on the Drawings.
- D. The maximum casing straightness deviation in any 10-foot length shall be 1/8 inch.
- E. The casing pipe ends shall be tapered where welding is required.

2.03 CARRIER PIPE

- A. Furnish carrier pipe complying with JEA Water and Sewer Standards Specification Section 350, and as shown on the Drawings.

2.04 CASING SPACERS

- A. Casing spacers shall conform to the JEA Water and Sewer Standards Specification Section 350, Paragraph II.5.3., and as shown on the Drawings.
- B. Casing spacers shall prevent metal-to-metal contact between the carrier pipe and the spacer and/or the casing.

2.05 BACKFILL GROUT

- A. Grout used to fill voids under structures shall be a sanded water/cement grout.
- B. Cement shall be normal Portland cement conforming to ASTM C150.

PART 3 EXECUTION

3.01 GENERAL

- A. Perform the work in accordance with the approved work plans.
- B. Perform geotechnical instrumentation monitoring in accordance with Section 31 09 13, Geotechnical Instrumentation Monitoring and as shown on the Drawings.
- C. The Contractor shall be solely responsible for the safety of the work, and shall protect Project personnel and third parties from hazardous conditions.
- D. Protect adjacent existing structures, utilities, roads, facilities, and vegetation from damage due to construction operations.
- E. Wherever there is a condition which may endanger excavation stability or pose risks of damage to any adjacent structures and utilities, operate with a full crew continually for 24 hours per day, including weekends and holidays, until the conditions no longer jeopardize excavation stability or present damage risks.
- F. Repair all damage to adjacent existing structures, utilities, roads, facilities, and vegetation due to construction operations, in accordance with this Section.
- G. Prevent trucks and other equipment from tracking dirt or debris onto roads. Immediately clean any dirt or debris from the boring operations from the roads.
- H. Obtain and provide all services required to perform the work, including electrical power and water.
- I. Locate all utilities and other buried facilities within 30 feet of the auger bore alignment and within 30 feet of the limits of each pit excavation. Contact Sunshine 811 prior to starting work at the site, allowing for time to expose and verify locations of each utility within 30 feet of each pit and the auger bore alignment. Hand dig or vacuum excavate to expose all utilities within 30 feet of each pit and the auger bore alignment to verify locations, prior to starting construction at the Site.

- J. Perform all excavation within easements and rights-of-way shown on the Drawings.
- K. Provide and maintain barricades, fences, and other means to prevent entry to the pits and casing during non-working hours.
- L. Control entry to pits, and limit entry to personnel essential for the Work.
- M. Prevent entry into the casing, except for the Contractor's personnel with appropriate training for safe working inside the casing. The Contractor's personnel shall only enter the casing if appropriate safety measures are in place, as determined by the Contractor and in accordance with applicable regulations.
- N. Complete the following work prior to setting up the auger boring equipment:
 - 1. Submittals have been provided and reviewed.
 - 2. Locate utilities within 30 feet of the auger bore alignment and pit excavations.
 - 3. Install all geotechnical instrumentation and obtain baseline readings.
 - 4. Complete construction of jacking and receiving pits.
 - 5. Dewater pits and entire auger boring alignment, and confirm that groundwater levels have been lowered to a minimum of 2 feet below the base of the pits and casing invert along the entire casing alignment.
- O. Install soil anchors to prevent auger boring equipment from overturning.

3.02 DEWATERING SYSTEMS

- A. Design, install, maintain, and operate dewatering systems at each pit and along the length of the auger bore alignments. Dewatering systems shall have sufficient capacity to remove groundwater continuously throughout construction to keep the groundwater table at the required level until Work is complete.
- B. Dewatering systems shall be designed to prevent removal of soil particles, and shall discharge into a settlement pond or frac tank.
- C. Decommission dewatering wells and/or wellpoints by filling with cementitious grout approved by the JEA Project Representative.
- D. Provide a backup electrical power supply for the dewatering systems configured to alert the Contractor to a power outage, enabling restoration of power within one (1) hour following a loss of power from the primary power source.

3.03 JACKING AND RECEIVING PITS

- A. Design and construct jacking and receiving pits at the locations shown on the Drawings. Changes to pit locations shall require review and acceptance by FDOT or City of Jacksonville, and the JEA Project Representative.
- B. Perform pit construction in accordance with applicable regulations, and in accordance with the design and recommendations of the Contractor's engineer.
- C. Approximate pit dimensions are shown on the Drawings. The Contractor shall determine the final pit dimensions.
- D. Slope the ground surface to direct runoff from entering the launch and receiving pits, and to prevent runoff from affecting third parties.
- E. Operate and maintain sump pumps in each pit to maintain the pits and auger boring operations in a dry condition.
- F. Prevent voids from developing and prevent settlement around the pits. If voids or settlement are detected, immediately implement measures to prevent further ground movement and settlement. Meet with the JEA Project Representative and provide a plan to prevent further ground loss and settlement and to completely backfill any voids that develop in the ground with cementitious grout or flowable fill.
- G. Install shoring systems during construction so that the maximum unsupported height of exposed soil in the pit excavations does not exceed four (4) ft at any time, or less if required by the Contractor's engineer.
- H. Once carrier pipe connections are completed within the pits, remove pit shoring systems and all other materials, and backfill the pits in accordance with the Project's backfilling and compaction requirements for trenches.

3.04 AUGER BORING

- A. Verify the alignment and grade of the launch cradle, tracks, or other casing supports prior to starting jacking.
- B. Ensure that all personnel tasked with operating equipment are trained in the safe and appropriate operation of the equipment, in accordance with the equipment manufacturer's recommendations and guidelines and the Contractor's work plan.

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- C. Install entry and exit seals at pits and employ measures as required to prevent ground and groundwater inflows as portals are opened in the pit support system, and during pipe jacking. Provide seals at the entry and exit if required to prevent ground loss into the pit.
- D. Prevent damage to the casing and carrier pipe during handling.
- E. Inspect casing prior to lowering it into the launch pit to ensure that no cracked, broken, or otherwise defective materials are used.
- F. Casing joints shall be prepared in accordance with JEA Water and Sewer Standards Specification Section 350, Paragraph II.3.5., and this section.
- G. Weld casing joints in accordance with the American Welding Society (AWS) standard specifications to provide the full capacity of the pipe against jacking loads.
- H. Steel casing joint welds shall be complete penetration, single-bevel groove type joints, and shall be airtight and continuous over the casing circumference.
- I. Mark each casing joint with a painted number visible from the top of the launch pit, indicating installation order.
- J. Operate and control the auger boring cutting head and casing position to maintain face stability and prevent over-excavation and settlement during boring, including during temporary work stoppages.
- K. Water jetting shall not be used for boring excavation.
- L. Bulkhead the face to prevent ground movement into the casing during work stoppages. Install weep holes if necessary to prevent excessive pressure build up, and install filter materials to prevent erosion of soil into the casing.
- M. Jack the casing periodically during work stoppages, as required to prevent pipe set and to prevent start-up jacking loads from exceeding allowable loads.
- N. If an obstruction is encountered, immediately stabilize and support the face, and notify and meet with the JEA Project Representative. Within 12 hours of encountering an obstruction, provide the JEA Project Representative with a plan to remove the obstruction so that the auger bore can advance past the obstruction.

3.05 LINE AND GRADE CONTROL

- A. Continuously survey and record the position of the front of the lead casing, or a target within 5 feet of the face.
- B. Steer the front of the advancing bore each advance of the jacks, unless a pilot tube system is used. If a pilot tube system is used, complete the pilot tube installation before starting reaming.
- C. Perform an as-built survey of the installed casing before installing the carrier pipe. The survey shall consist of shots of the casing line and grade at the invert and crown at each end of the casing.
- D. If the casing deviates from the design line and grade, immediately notify the JEA Project Representative of the deviation and plan to steer the auger bore to prevent further deviations.

3.06 CARRIER PIPE INSTALLATION

- A. Remove all construction debris, spoil, oil, grease, and other materials from the casing before commencing carrier pipe installation.
- B. All carrier pipe joints to be installed within the steel casing pipe shall be restrained. All restrained joints and appurtenances shall be installed in accordance with the manufacturer's recommendations.
- C. Install spacers at locations and spacing as shown on the Steel Casing Detail in the Drawings, to fully support the carrier pipe and associated loads. Casing spacers shall be installed at a maximum interval of every 9 feet, or closer if recommended by the casing spacer manufacturer. Clearances of the spacer system from the casing wall shall be as recommended by the spacer manufacturer. Protect casing spacers from damage during installation.
- D. Install carrier pipe on the design line and grade by sliding the spacer and carrier pipe assembly into the casing. Adjust casing spacer positions and/or provide blocking prior to insertion, as needed to maintain carrier pipe position within the specified tolerances.
- E. Lubricate the casing spacers sliding on the casing before insertion.
- F. Prevent rotation of carrier pipe during installation.
- G. Prevent forces on pipe or spacers from exceeding the allowable forces provided by the manufacturers of the pipe and casing spacer assemblies.

- H. Clean all debris, oil, grease, and other materials from the installed casing and carrier pipe.
- I. Test carrier pipe in accordance with JEA Water and Sewer Standards Specification Section 350.
- J. Seal the annular space between the casing and carrier pipe at each end of the casing as shown on the Drawings.
- K. Prepare as-built drawings in accordance with JEA Water and Sewer Standards Specification Section 501.

3.07 ACCEPTANCE CRITERIA

- A. The JEA Project Representative shall be present during all inspection and testing for the results to be considered valid for JEA's acceptance.
- B. Casing Pipe:
 - 1. After installing the final casing, provide the JEA Project Representative with access to both pipe ends for visual inspection of the line and grade of the completed pipe installation.
 - 2. Lamping shall follow the visual inspection. Lamping shall include shining a sufficiently bright light from one end of the pipe to the other end of the pipe and visually inspecting the casing pipe for overall alignment, sags, humps, etc. The casing shall show, on examination from either end, a full circle of light from either end. Contractor shall furnish the light and mirror(s) to the satisfaction of the JEA Project Representative to conduct the lamping.
 - 3. Closed circuit television (CCTV) inspection shall be performed for the casing in accordance with JEA Water and Sewer Standards Specification Section 428. The casing shall be cleaned and all debris, obstructions, and stains removed prior to televising. The Contractor shall be required to replace the casing if the CCTV inspection reveals cracked, broken, deflected, or otherwise defective pipe, or evidence of leakage.
 - 4. Successful passage of the visual inspection, lamping, and CCTV inspection is required before acceptance by JEA.
 - 5. If the casing is not accepted by JEA, the Contractor shall repair or replace the casing installation as required to achieve acceptance by the JEA Project Representative, at no cost to JEA.

C. Carrier Pipe:

1. The carrier pipe shall be clean and free from debris.
2. The carrier pipe shall be installed at the design line and grade, within the tolerances specified.
3. Test carrier pipe in accordance with JEA Water and Sewer Standards Specification Section 350.
4. Carrier pipe shall meet the performance requirements for acceptance in accordance with the carrier pipe requirement.

END OF SECTION

SECTION 33 13 00
CLEANING AND DISINFECTION OF WATER MAINS

PART 1 GENERAL

1.01 SUMMARY

- A. This section describes requirements for the cleaning and disinfection of 30-inch SIPS water mains and 24-inch raw water mains. Furnish all labor, equipment, materials, and chemicals required to fulfill the requirements specified herein. This Section does not include the 24-inch SIPS water main yard piping located on the Deerwood III Water Treatment Plant (WTP) site which shall be cleaned and disinfected in accordance with JEA Standards Section 350.
- B. Supply all products and perform all work in accordance with applicable American Society for Testing and Material (ASTM), American Water Works Association (AWWA), American National Standards Institute (ANSI), JEA, State of Florida Department of Environmental Protection, or other recognized standards.
- C. The Owner will furnish all water necessary for performing the cleaning and disinfection work on this Project. The Contractor is responsible for getting the water from the Owner's facilities to the locations where needed by the Contractor.

1.02 QUALIFICATIONS

- A. Work shall be performed by a specialty sub-contractor regularly engaged in pipeline cleaning and disinfection. The specialty sub-contractor shall have successfully completed construction of at least five similar applications in the past ten (10) years. The proposed superintendent for this project must have completed at least three similar applications, in the past ten (10) years. Each application shall have consisted of the cleaning and disinfection of at least 4,000 linear feet of 30-inch or larger water main or raw water main with the cleaning pigs. The specialty sub-contractor shall be a licensed contractor in the State of Florida. The specialty sub-contractor shall be Professional Piping Services, Inc. (Tampa, Florida) or approved equal.

- B. The Contractor must demonstrate to the satisfaction of the Owner that the work will be performed by experienced and knowledgeable supervision and personnel who have properly, safely and effectively provided for the cleaning and disinfection of comparable systems in other similar applications. These personnel will be required to provide acceptable procedures prior to the work being initiated to clearly demonstrate they are capable and have the means onsite to resolve any problems that could occur with the cleaning pigs in the system.

1.03 SUBMITTALS

- A. Documentation of the specialty sub-contractor meeting the qualification criteria to perform such work as herein described. Include resumes, project descriptions and details, and project reference contact information, as required to demonstrate compliance with the Qualification requirements.
- B. Certificates of personnel that are trained and accredited to be in compliance with OSHA 29, CFR 1910.120, Health and Safety Training.
- C. Proposed plan to perform the work for review by the Owner prior to beginning work. This plan shall include a complete work schedule, procedures, water supply point, launching and retrieval points, designated cleaning operation points, disposal points for waste material and discharge water to be removed from the pipe and measures to minimize problems and hazards.
- D. Written contingency plan for dealing with inline problems (i.e. blockages, “lost” pigs) and system integrity problems (i.e. breaks, leaks, piping or fitting failures). The contingency plan shall include the Contractors means and methods for identifying and measuring changes or improvements to the flow characteristics of the water mains during and upon completion of cleaning and restoration to maximum flow capacity.
- E. Product data, specifications, and cut sheets for equipment and materials listed in Part 2 of this section.
- F. Prior to disinfection, submit a written procedure for approval before being permitted to proceed with the disinfection. This plan shall also include the steps to be taken for the neutralization of the chlorinated water. The Contractor shall modify the plan as directed by the Owner at no additional cost.

- G. Provide a written report upon completion of line cleaning to outline and detail information acquired during the cleaning process about the pigs, their sizes, styles and other pertinent information which have been entered into the system and subsequently retrieved. The condition of the pigs upon retrieval shall be documented by pictures from all angles and submitted with the report. Any visible damage to the pigs upon retrieval shall be documented.

PART 2 PRODUCTS

2.01 EQUIPMENT

- A. Pig launching equipment shall be of the latest design and construction and include the means to maintain constant monitoring of the inline flows and pressures of the system being cleaned and the constant location of the cleaning pigs in the system.
- B. Launching and retrieval devices shall be fabricated, designed, and manufactured in accordance to ANSI standards and capable of withstanding 150 psig working pressure.
- C. Launch and retrieval tubes shall be fabricated of steel, pipe sized one diameter larger than the system to which it will be attached with a minimum length equal to 2.5 times the diameter. For poly pig launchers and receivers 14-inches and larger the steel wall thickness shall be a minimum of 3/8-inch thick.
- D. The Contractor shall provide all temporary equipment and facilities for the cleaning and disinfection operation, including but not limited to temporary pumping and temporary piping.

2.02 CLEANING PIGS

- A. Cleaning pigs shall be equal to "Polly-Pig" as manufactured by Knapp Polly Pig, Inc., Houston, Texas.
- B. Size and Material:
 - 1. The cleaning pigs shall be of a slightly oversized diameter to ensure a sliding seal at all times.
 - 2. The pig cover material shall be such that it effectively scours and cleans the inside of the pipe without damage to the pipe interior and its lining. The coatings of the cleaning pigs shall be suitable for the chemicals and its concentration used for disinfection, as recommended by the pig manufacturer. Pigs shall have a crisscross coated, resilient, peripheral surface that engages the inner cylindrical wall of pipe to maintain a sliding seal.

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3. Pigs shall have a parabolic nose. Pigs shall be bi-directional and have the ability to negotiate pipe fittings, valves and other appurtenances.
 4. When in use, the pig must be able to undergo a reduction to a minimum of 65 percent of the original cross-sectional area and return to shape while maintaining the sliding seal and ability to clean.
- C. Each pig inserted into the system shall be equipped with an electronic detection device so that its location can be determined at any time.

2.03 DISINFECTION AGENT

- A. The disinfection agent shall be calcium hypochlorite granules.

PART 3 EXECUTION

3.01 GENERAL

- A. The flushing and disinfection means and methods shall minimize impact to the JEA Main Street WTP, Deerwood III WTP, and water system operations. The water source for the SIPS water main and raw water main cleaning and disinfection operations will be from the JEA Main Street WTP, with the source connection at the existing 30-inch water main on Bradley Road.
- B. Launch and retrieval points for the SIPS water main shall be at the locations shown on the Drawings. The cleaning and disinfection operation for the SIPS water main is anticipated to be performed in segments as follows:
1. From Launch Point No. 1 on Bradley Road to Retrieval Point No. 1 in the JEA T-line, just south of Forest Blvd.
 2. From Launch Point No. 2 in the JEA T-line, just south of Forest Blvd, to Retrieval Point No. 2 in the JEA T-Line, just north of the ditch crossing the JEA T-line.
 3. From Launch Point No. 3 in the JEA T-line, just north of the ditch crossing the JEA T-line, to Retrieval Point No. 3 in the JEA T-line, at the top of the berm, just south of the Deerwood III WTP. The 30-inch valve east of the tee in the JEA T-line shall be closed for the cleaning and disinfection of this segment.
 4. From Launch Point No. 3 in the JEA T-line, just north of the ditch crossing the JEA T-line, to the end point on Burnt Mill Road (Validus Drive/Burnt Mill Road segment). The 30-inch valve south of the tee in the JEA T-line shall be closed for the cleaning and disinfection of this segment.

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- C. Permanent launch and retrieval points for the raw water main are not required. The Contractor shall provide temporary piping and connections as required to perform the cleaning and disinfection operation for the raw water main. The cleaning and disinfection operation for the raw water main is anticipated to be performed in one segment as follows:
1. From the northern 24-inch raw water main point on Forest Blvd, just north of Stone Road, to the connection point at the existing 24-inch raw water main in the JEA T-line, just south of Forest Blvd.
- D. Water discharge and disposal locations shall be determined by the Contractor and reviewed and approved by the JEA Project Representative and the City of Jacksonville. Discharge and disposal locations shall be located in the City of Jacksonville Rights-of-way, or JEA property or easements. Discharge and disposal locations shall not be allowed in the FDOT Rights-of-way. Any discharge and disposal locations on private property shall require written authorization to the Contractor from the property owner.
1. The discharge location for Retrieval Points No. 1 and 2 is anticipated to be the existing ditch adjacent to the west side of the JEA T-line.
 2. The discharge location for Retrieval Point No. 3 is anticipated to be the low area in the JEA T-line, southeast of retrieval point in the vicinity of Station 568+00). Contractor shall not block access to the T-line road with the temporary piping.
 3. The discharge location for the Validus Drive and Burnt Mill Road segment is anticipated to be the existing stormwater system along Burnt Mill Road.
 4. The discharge location for the 24-inch raw water main is anticipated to be the existing ditch adjacent to the west side of the JEA T-line (same as No. 1 above).
- E. The Contractor shall provide radio communication and job site transportation between launching and retrieval points.
- F. Notification requirements:
1. A pre-cleaning/disinfection meeting shall be held at least 30 days in advance of the flushing and disinfection operations commencing. The meeting shall include review of the cleaning and disinfection work plan and procedures, contingency plan, schedule, and communications plan, at a minimum. The meeting shall include the Contractor, specialty sub-contractor superintendent, JEA Project Representative, and JEA Main Street WTP operations staff.

2. The Contractor shall remain in close communication with JEA Main Street WTP staff (904-665-4553) immediately prior to starting cleaning and disinfection operations and during cleaning and disinfection operations.
 3. The Contractor shall notify the JEA Project Representative before insertion and retrieval of the pigs.
- G. JEA reserves the right to modify the cleaning and disinfection schedule based on operational requirements.
- H. The 30-inch SIPS water main cleaning and disinfection schedule shall be subject to the following requirements:
1. No cleaning and disinfection activities shall be allowed April 15 through July 1, or on Saturdays throughout the year.
 2. No cleaning and disinfection activities shall be allowed on Wednesdays during the watering season (second Sunday in March until the first Sunday in November).
 3. Operationally, the preferred timeframe for the cleaning and disinfection activities is November 1 through February 28, Monday through Friday, 9 AM to 5 PM.
- I. The Contractor shall be solely responsible for the means and methods of cleaning and disinfection, and shall ensure the safety of construction personnel and the public throughout the work. All maintenance of traffic (MOT)/temporary traffic control (TTC), signage, barriers, and other measures required for the work shall be the responsibility of the Contractor and the costs shall be incidental to the work. If MOT/TTC will be different than shown on the Drawings, the Contractor is responsible to obtain approval from the City of Jacksonville and FDOT, as appropriate for the governing jurisdiction.

3.02 CLEANING

- A. Cleaning shall restore the original flow characteristics of the new water mains without over abrading or cleaning the interior wall of the new water mains.
- B. The water mains shall be cleaned by the controlled and pressurized passage of a series of cleaning pigs prior to disinfection.
- C. A series of cleaning pigs shall be inserted into the system by use of a pig launching assembly. The Contractor shall provide the pig launching assembly that will connect to a below grade flange.

- D. The Contractor is responsible for retrieving all pigs. The cleaning pigs shall be removed or discharged from the system.
- E. Flushing shall continue until the water is completely clear and the cleaning pigs are removed. At a minimum, a two-pass pigging procedure shall be employed to attain proper cleanliness of the water mains. The first pass shall remove large debris. The second pass shall remove remaining fine material and debris. Additional passes may be required to the satisfaction of the Owner.
- F. The flow rate shall be determined by the specialty sub-contractor, subject to JEA Main Street WTP operations staff approval and limitations of the existing system capacity.
- G. All water necessary for cleaning of the water mains will be supplied by the Owner. Only representatives of the Owner are to operate valves. The Contractor shall provide any temporary piping required for the disposal of discharge water from the cleaning operations.

3.03 DISINFECTION

- A. Commence disinfection activities upon the completion of cleaning as approved by the Owner.
- B. Disinfection shall be achieved by the use of cleaning pigs in accordance with AWWA C651 for the slug method and these Specifications.
- C. Two cleaning pigs, inserted such that they are approximately one thousand feet apart, shall be inserted and retrieved from the system in the same manner as the cleaning procedure. The disinfection solution shall be injected between the cleaning pigs.
- D. All water necessary for disinfection of the water mains will be supplied by the Owner. Only representatives of the Owner are to operate valves and hydrants. The Contractor shall provide any temporary piping required for the disposal of discharge water from the disinfection operations.
- E. Chlorination:
 - 1. Apply chlorine solution to achieve a concentration of at least 100 milligrams per liter (mg/L) free chlorine in new line. The chlorine shall be applied continuously until a solid column, or slug, of chlorinated water is developed. All lengths of the transmission main shall be in contact with the chlorinated water for at least three hours with the chlorine concentration not falling below 50 mg/L at any time.

2. The free chlorine residual shall be measured in the slug as it moves through the main. If at any time it drops below 50 mg/L, the flow shall be stopped, chlorination equipment shall be relocated at the head of the slug, and as flow resumes, chlorine shall be applied to restore the free chlorine in the slug to not less than 100 mg/L
 3. As the chlorinated water flows past fittings and valves, related valves and hydrants shall be operated so as to disinfect appurtenances and pipe branches.
- F. Disposal of Chlorinated Water: Reduce chlorine residual of disinfection water to less than one-one hundredth (0.01) mg/L prior to discharge. Treat water with sodium thiosulfate. Flush all lines until residual is equal to existing system residual. Contractor shall locate the chemical injection point along the above ground piping and provide sufficient mixing. Contractor shall continuously monitor the injection point and chemicals during the dechlorination operation.
- G. Bacteriological Testing on the water transmission main shall be scheduled and completed by the Owner. The Owner will collect the water samples and be responsible for completing the water analysis (lab testing). The Contractor shall notify JEA a minimum of seven (7) days prior to the sampling event to confirm the availability and schedule for sampling.

3.04 INSPECTION

- A. The Contractor shall maintain a representative on site for the duration of the cleaning and disinfection operation and have available for immediate use an electronic cleaning pig detector with the appropriately sized cavity cleaning pig for use in the system being cleaned to provide a means of tracking the passage of the pig in the system to locate areas of potential or suspected blockage and to find "lost" valves and other disparities within the system.
- B. The Contractor shall maintain constant monitoring of the inline flows and pressures of the system being cleaned and disinfected and the constant location of the cleaning pigs in the system.
- C. The Contractor shall immediately report to the Owner, any deviation from established pigging procedures, any inline problems encountered, or any malfunctions of the system discovered, by the passage of the pigs through the system. The Contractor is responsible for repairing any damage from retrieval activities.

3.05 SPECIAL CONDITIONS

- A. Erosion and sedimentation control measures shall be utilized to prevent erosion and prevent sediment from exiting the site. Erosion and sedimentation control shall comply with applicable codes, ordinances, rules, and regulations and laws of local and municipal authorities having jurisdiction. Employ frac tanks, filter bags, and/or other temporary containment measures to reduce turbidity and suspended solids to acceptable levels before discharging water to a receptor approved by the JEA Project Representative and the City of Jacksonville. Turbidity curtains shall be provided for any discharge points into existing stormwater ponds or open waterways or channels.
- B. The Contractor shall monitor rainfall events prior to the cleaning and disinfection operation. The cleaning and disinfection operation shall not commence during a rainfall event, nor shall it commence if a rainfall event is forecasted. The cleaning and disinfection operation shall be terminated at the onset of a rainfall event.
- C. A minimum of 30 days prior to discharging into the existing stormwater system, open waterways and channels, the Contractor shall inspect the system to check for sediment or debris. If sediment or debris are present, they shall be removed, and the pipe or channel cleaned.
- D. The discharge rate shall be controlled to avoid overflows or flooding. In no case shall the existing stormwater system, open waterways or channels be surcharged. In addition, sheet flowing of discharge water on roadways, bike lanes, driveways, sidewalks, or private property will not be allowed.
- E. The Contractor shall monitor the existing stormwater system, open waterways and channels continuously during the cleaning and disinfection operation.
- F. The Contractor shall re-inspect the existing stormwater system, and open waterways and channels, following the completion of the cleaning and disinfection operation to check for sediment and debris. If sediment or debris are present, they shall be removed, and the system cleaned to the pre-existing condition or better.

END OF SECTION

SECTION 40 90 01
INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. ASTM International (ASTM):
 - a. A182, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
 - b. A276, Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
 - c. A312, Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
 - d. B32, Standard Specification for Solder Metal.
 - e. B88, Standard Specification for Seamless Copper Water Tube.
 2. Instrumentation, Systems, and Automation Society (ISA):
 - a. S5.1, Instrumentation Symbols and Identification (NRC ADOPTED).
 - b. PR12.6, Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations
 - c. S5.4, Standard Instrument Loop Diagrams.
 - d. S20, Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
 - e. S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
 3. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. ICS 1, General Standards for Industrial Control and Systems.
 4. National Institute of Standards and Technology (NIST).
 5. Underwriters Laboratory, Inc. (UL): 508A, Standard for Safety, Industrial Control Panels.

1.02 SUMMARY

- A. Work Includes:
1. Engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and Owner training for a complete valve intertie station, including integration with the Owner's current facility SCADA system and future implementation of a SIPS distribution control system for additional intertie stations.

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2. Major parts are:
 - a. Plant instrumentation including primary elements, transmitters, and control devices.
 - b. One rack mounted control panel with remote I/O at the Deerwood III WTP.
 - c. One programmable logic controller at the Ridenour WTP.
 - d. Interfaces with existing control system.
 - 1) Interface the New RIO station with the existing Deerwood III WTP PLC.
 - 2) Connect the new SIPS master PLC at the Ridenour WTP with the existing SCADA system fiber network.
3. PLC application software, including the Siemens SIMATIC Step 7 software and associated license, shall be provided by the Contractor to perform the work specified herein. Work includes, but is not limited to, programming of the new PLC provided under this section, configuration of the communication network and modifications to the existing plant control system. Within 60 days after Notice to Proceed, Contractor shall determine and obtain the current software versions used by the Owner, in addition to Owner PLC project files where modifications to the existing system are required in this Project, to ensure compatible software delivery.
 - a. For PICS Contractor modifications to the Owner's existing plant control system, activities shall be coordinated with Owner prior to implementation to prevent unauthorized or unprepared system changes.
 - 1) For loading newly modified control code in existing PLC systems, Contractor shall notify Owner or Owner's designated representative of the requested modification. Contractor must receive documented approval from Owner at least one week prior to implementation. Contractor shall retain an original copy of the PLC program so that changes can be reverted if needed or requested by Owner. Once program changes are loaded and determined successful, the Contractor shall deliver a copy of the new PLC project file to the Owner. File delivery method shall correspond to JEA standards.
 - 2) For configuration changes to existing network devices, including, but not limited to, routers, switches, PLC communication modules, protocol converters, or network cable routing, Contractor shall notify Owner or Owner's designated representative of the requested modification. Contractor must receive documented approval from Owner at least two weeks prior to implementation.

- 3) For new network hardware to be interfaced with the Owner's existing plant control system, PICS Contractor shall obtain all required network parameters from the Owner for successful integration. Examples include, but are not limited to, IP addresses to assign the new hardware, subnet masks, network device names, and managed port assignments. Network parameters shall be obtained prior to any proposed modifications or additions to the existing plant control system network.
- B. Detailed Design: PICS as shown and specified includes functional and performance requirements and component specifications. Complete detailed PICS design.
- C. Work Performed by Others: The SIPS control system implementation includes modifications to the Owner's existing HMI at the Ridenour Operations Building. The Owner's designated system integrator shall perform all HMI work related to this Project. Additionally, the Owner will modify the existing network switch configuration as needed to incorporate the new master control panel PLC at the Ridenour Operations Building. All PLC programming and commissioning activities shall be coordinated with the Owner during construction to ensure a seamless interface between the Owner HMI and the new PLC and instrument subsystem.

1.03 DEFINITIONS

A. Abbreviations:

1. AFD: Adjustable Frequency Drive.
2. CP: Local Control Panel.
3. FAT: Factory Acceptance Test.
4. FOFP: Fiber-Optic Patch Panel.
5. HMI: Human-Machine Interface.
6. I/O: Input/Output.
7. MCC: Motor Control Center.
8. OIT: Operator Interface Terminal.
9. ORT: Operational Readiness Test.
10. P&ID: Piping & Instrumentation Diagram.
11. PAT: Performance Acceptance Test.
12. PICS: Plant Instrumentation and Control System.
13. PLC: Programmable Logic Controller.
14. PS: Power Supply.
15. RIO: Remote I/O.
16. SCADA: Supervisory Control And Data Acquisition.
17. UPS: Uninterruptible Power Supply.

- B. Enclosure: Control panel, console, cabinet, or instrument housing.
- C. Instructor Day: Eight hours of actual instruction time.
- D. Standard Software: Software packages that are independent of Project on which they are used. Standard software includes system software, supervisory control, and data acquisition (SCADA) software.
 - 1. System Software: Application independent (non-project specific) software developed by digital equipment manufacturers and software companies. Includes, but is not limited to, operating systems; network support, programming languages (C, C++, Visual C++, BASIC, Visual Basic, etc.); Office Suites (word processor, spreadsheet, database, etc.); e-mail; security (firewall, antivirus; spam, spyware, etc.) debugging aids; and diagnostics.
 - 2. SCADA Software: Software packages independent of specific process control project on which they are used. Includes, but is not limited to, providing configuring and run-time capability for, data acquisition (I/O driver, OPC servers, etc.), monitoring, alarming, human-machine interface, supervisory control, data collection, data retrieval, trending, report generation, control, and diagnostics.
 - 3. Controller Programming Software: Software packages for the configuring of PLCs, RIOS, and fieldbus devices.
- E. Application Software: Software to provide functions unique to this Project and that are not provided by standard software alone, including but not limited to:
 - 1. Configuring databases, tables, displays, historians, reports, parameter lists, ladder logic, function block, and control strategies required to implement functions unique to this Project.
 - 2. Programming in any programming or scripting language.
- F. Rising/Falling: Terms used to define actions of discrete devices about their set points.
 - 1. Rising: Contacts close when an increasing process variable rises through set point.
 - 2. Falling: Contacts close when a decreasing process variable falls through set point.
- G. Signal Types:
 - 1. Analog Signals, Current Type:
 - a. 4 to 20 mA dc signals conforming to ISA S50.1.

- b. Unless otherwise indicated for specific PICS Subsystem components, use the following ISA 50.1 options:
 - 1) Transmitter Type: Number 2, two-wire.
 - 2) Transmitter Load Resistance Capacity: Class L.
 - 3) Fully isolated transmitters and receivers.
- 2. Analog Signals, Voltage Type: 1 to 5 volts dc within panels where a common high precision dropping resistor is used.
- 3. Discrete signals, two-state logic signals using dc or 120V ac sources as indicated.
- 4. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

H. Instrument Tag Numbers:

- 1. A shorthand tag number notation is used in the Loop Specifications. For example: UP-FF-ISA-UU:

UP = Unit process abbreviation. For this project, all tags will use the SIPS unit process abbreviation.

FF = Facility area abbreviation. For this project, all equipment at the Deerwood III WTP will use the DW facility area abbreviation, and all equipment at the Ridenour Operations Building will use the RD facility area abbreviation.

ISA = 1- to 4-letter device International Society of Automation (ISA) identifier for equipment and instruments (for example, FCV for flow control valve, HS for hand switch, FIT for flow indicating transmitter). If the equipment cannot be identified with the ISA table, it will instead use a project-specific equipment abbreviation. Refer to P&IDs for detailed requirements.

UU = Unit number, two digit identification for equipment of the same type in a facility area and unit process.

BB = 1 to 4-letter clarifying functional abbreviation (for example, OO for ON/OFF, PH for pH)

An example tag is SIPS-DW-HS-01[L/R], referring to a hand switch for the SIPS unit process, at the Deerwood III WTP facility area, with a unit number of 01 and the abbreviation L/R clarifying Local/Remote function.

1.04 SUBMITTALS

A. Action Submittals:

1. General:
 - a. Shop Drawings, full-scaled details, wiring diagrams, catalog cuts, and descriptive literature.
 - b. Identify proposed items and options. Identify installed spares and other provisions for future work (e.g., reserved panel space; unused components, wiring, and terminals).
 - c. Legends and Abbreviation Lists: Complete definition of symbols and abbreviations used on this Project (e.g., engineering units, flow streams, instruments, structures, and other process items used in nameplates, legends, and data sheets).
2. Bill of Materials: List of required equipment.
 - a. Group equipment items as follows:
 - 1) I&C Components: By component identification code.
 - 2) Other Equipment: By equipment type.
 - b. Data Included:
 - 1) Equipment tag number.
 - 2) Description.
 - 3) Manufacturer, complete model number, and all options not defined by model number.
 - 4) Quantity supplied.
 - 5) Component identification code where applicable.
3. Catalog Cuts: I&C Components, Electrical Devices, and Mechanical Devices:
 - a. Catalog information, mark to identify proposed items and options.
 - b. Descriptive literature.
 - c. External power and signal connections.
 - d. Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.
4. Component Data Sheets: Data sheets for I&C components.
 - a. Format and Level of Detail: In accordance with ISA-S20.
 - b. Include component type identification code and tag number on data sheet.
 - c. Specific features and configuration data for each component:
 - 1) Location or service.
 - 2) Manufacturer and complete model number.
 - 3) Size and scale range.
 - 4) Set points.
 - 5) Materials of construction.
 - 6) Options included.
 - d. Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.

5. Sizing and Selection Calculations:
 - a. Primary Elements: Complete calculations plus process data used. Example, for flow elements, minimum and maximum values, permanent head loss, and assumptions made.
 - b. Controlling, Computing and Function Generating Modules: Actual scaling factors with units and how they were computed.
6. Panel Construction Drawings:
 - a. Scale Drawings: Show dimensions and location of panel mounted devices, doors, louvers, and subpanels, internal and external.
 - b. Panel Legend: List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
 - c. Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.
 - d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.
 - e. Construction Notes: Finishes, wire color schemes, wire ratings, wire and terminal block, numbering and labeling scheme.
7. Panel Control Diagrams: For discrete control and power circuits.
 - a. Diagram Type: Ladder diagrams include devices, related to discrete functions, that are mounted in or on the panel and that require electrical connections. Show unique rung numbers on left side of each rung.
 - b. Item Identification: Identify each item with attributes listed.
 - 1) Wires: Wire number and color. Cable number if part of multiconductor cable.
 - 2) Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.
 - 3) Discrete Components:
 - a) Tag number, terminal numbers, and location ("FIELD", enclosure number, or MCC number).
 - b) Switching action (open or close on rising or falling process variable), set point value and units, and process variable description (e.g. Sump Level High).
 - 4) Relay Coils:
 - a) Tag number and its function.
 - b) On right side of run where coil is located, list contact location by ladder number and sheet number. Underline normally closed contacts.
 - 5) Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).

- c. Show each circuit individually. No “typical” diagrams or “typical” wire lists will be permitted.
 - d. Ground wires, surge protectors, and connections.
 - e. Circuit Names: Show names corresponding to Circuit and Raceway Schedule for circuits entering and leaving a panel. Refer to Division 26, Electrical.
8. Panel Wiring Diagrams: Show point-to-point and terminal-to-terminal wiring within panel.
9. Loop Diagrams: Individual wiring diagram for each analog or pulse frequency loop.
- a. Conform to the minimum requirements of ISA S5.4.
 - b. Under Paragraph 5.3 of ISA S5.4, include the information listed under subparagraphs 2 and 6.
 - c. Drawing Size: Individual 11-inch by 17-inch sheet for each loop.
 - d. Divide each loop diagram into areas for panel face, back-of-panel, and field.
 - e. Show:
 - 1) Terminal numbers, location of dc power supply, and location of common dropping resistors.
 - 2) Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.
 - 3) Tabular summary on each diagram:
 - a) Transmitting Instruments: Output capability.
 - b) Receiving Instruments: Input impedance.
 - c) Loop Wiring Impedance: Estimate based on wire sizes and lengths shown.
 - d) Total loop impedance.
 - e) Reserve output capacity.
 - 4) Circuit and raceway schedule names.
10. Interconnecting Wiring Diagrams:
- a. Diagrams, device designations, and symbols in accordance with NEMA ICS 1.
 - b. Diagrams shall bear electrical Subcontractor’s signature attesting diagrams have been coordinated with Division 26, Electrical.
 - c. Show:
 - 1) Electrical connections between equipment, consoles, panels, terminal junction boxes, and field mounted components.
 - 2) Component and panel terminal board identification numbers, and external wire and cable numbers.
 - 3) Circuit names matching Circuit and Raceway Schedule.
 - 4) Intermediate terminations between field elements and panels for, e.g., to terminal junction boxes and pull boxes.
 - 5) Pull boxes.

11. Installation Details: Include modifications or further details required to adequately define installation of I&C components.
 12. List of spares, expendables, test equipment, and tools.
 13. Additional Equipment Recommended: List of, and descriptive literature for, additional spares, expendables, test equipment and tools recommended.
- B. Informational Submittals: For PICS equipment, provide Manufacturer's Certificate of Proper Installation and readiness for operation.
1. Owner Training Plan.
 2. Operation and Maintenance (O&M) Manuals: In accordance with JEA requirements, unless otherwise specified in this section.
 - a. Content and Format:
 - 1) Complete sets O&M manuals.
 - 2) Sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for each PICS component.
 - 3) Final versions of Legend and Abbreviation Lists.
 - 4) Manual format in accordance with JEA requirements.
 - b. Include:
 - 1) Process and Instrumentation Diagrams: One reproducible copy of revised P&ID to reflect as-built PICS design.
 - 2) Refer to paragraph Shop Drawings for the following items:
 - a) Bill of Materials.
 - b) Catalog Cuts.
 - c) Component Data Sheets.
 - d) Panel Control Diagrams.
 - e) Panel Wiring Diagrams, one reproducible copy.
 - f) Panel Plumbing Diagrams, one reproducible copy.
 - g) Loop Diagrams, one reproducible copy.
 - h) Interconnecting Wiring Diagrams, one reproducible copy.
 - i) Application Software Documentation.
 - 3) Device O&M manuals for components, electrical devices, and mechanical devices include:
 - a) Operations procedures.
 - b) Installation requirements and procedures.
 - c) Maintenance requirements and procedures.
 - d) Troubleshooting procedures.
 - e) Calibration procedures.
 - f) Internal schematic and wiring diagrams.
 - g) Component Calibration Sheets from field quality control calibrations.

- 4) List of spares, expendables, test equipment and tools provided.
- 5) List of additional spares, expendables, test equipment and tools recommended.
3. Factory Acceptance Test (FAT) Submittals:
 - a. Refer to paragraph 2.12, Source Quality Control, on FAT requirements.
4. Performance Acceptance Tests (PAT) Submittals:
 - a. Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.
 - b. Final Test Procedures: Proposed test procedures, forms, and checklists.
 - c. Test Documentation: Copy of signed off test procedures when tests are completed.

1.05 QUALITY ASSURANCE

- A. Calibration Instruments: Each instrument used for calibrating PICS equipment shall bear the seal of a reputable laboratory certifying that instrument has been calibrated within the previous 12 months to a standard endorsed by the NIST.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Provide Site and warehouse storage facilities for PICS equipment.
- B. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers, and related equipment as recommended by the capsule manufacturer.
- C. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.
- D. Cover panels and other elements that are exposed to dusty construction environments.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Standard Environmental Requirements: Unless otherwise noted, design equipment for continuous operation in these environments:
 1. Freestanding Panel and Consoles:
 - a. Inside, Electrical Non-Process Area: NEMA 12.
 2. Smaller Panels and Assemblies (that are not Freestanding):
 - a. Inside, Electrical Non-Process Area: NEMA 12.
 - b. All Other Locations: NEMA 4X.

3. Field Elements:
 - a. Inside, Electrical Non-Process Area: NEMA 12.
 - b. All Other Locations: NEMA 4X.

- B. Special Environmental Requirements: Design following panels for continuous operation in environments listed.

- C. Environmental Design Requirements: Following defines the types of environments referred to in the above.
 1. Inside, Air Conditioned:
 - a. Temperature:
 - 1) Normal: 60 to 80 degrees F.
 - 2) With Up to 4-Hour HVAC System Interruptions: 40 to 105 degrees F.
 - b. Relative Humidity:
 - 1) Normal: 10 percent (winter) to 70 percent (summer).
 - 2) With Up to 4-Hour HVAC System Interruption: 10 to 100 percent.
 - c. NEC Classification: Nonhazardous.
 2. Inside:
 - a. Temperature: 20 to 104 degrees F.
 - b. Relative Humidity: 10 to 100 percent.
 - c. NEC Classification: Nonhazardous.
 3. Inside, Corrosive:
 - a. Temperature: Minus 20 to 104 degrees F.
 - b. Relative Humidity: 10 to 100 percent.
 - c. Corrosive Environment: Hydrogen sulfide gas, sea air, chlorine gas.
 - d. NEC Classification: Nonhazardous.
 4. Outside:
 - a. Temperature: Minus 20 to 110 degrees F.
 - b. Relative Humidity: 10 to 100 percent, rain.
 - c. NEC Classification: Nonhazardous.
 5. Outside, Corrosive:
 - a. Temperature: Minus 20 to 110 degrees F.
 - b. Relative Humidity 10 to 95 percent noncondensing, rain.
 - c. Corrosive Environment: Hydrogen sulfide gas, sea air, chlorine gas.
 - d. NEC Classification: Nonhazardous.

1.08 SEQUENCING AND SCHEDULING

- A. Activity Completion: The following is a list of key activities and their completion criteria:
 - 1. Shop Drawings: Reviewed and approved.
 - 2. Quality Control Submittals: Reviewed and accepted.
 - 3. Hardware Delivery: Hardware delivered to Site and inventoried by Owner.
 - 4. PAT: Completed and required test documentation accepted.

- B. PICS Substantial Completion: When Engineer issues Certificate of Substantial Completion.
 - 1. Prerequisites:
 - a. All PICS Submittals have been completed.
 - b. PICS has successfully completed PAT.
 - c. Owner training plan is on schedule.
 - d. All spares, expendables, and test equipment have been delivered to Owner.

- C. PICS Acceptance: When Engineer issues a written notice of Final Payment and Acceptance.
 - 1. Prerequisites:
 - a. Certificate of Substantial Completion issued for PICS.
 - b. Punch-list items completed.
 - c. Final revisions to O&M manuals accepted.
 - d. Maintenance service agreements for PICS accepted by Owner.

- D. Prerequisite Activities and Lead Times: Do not start the following key Project activities until the prerequisite activities and lead times listed below have been completed and satisfied:

<u>Activity</u>	<u>Prerequisites and Lead Times</u>
Submittal reviews by Engineer	Engineer acceptance of Submittal breakdown and schedule.
Hardware purchasing, fabrication, and assembly	Associated shop drawing Submittals completed.
Shipment	Completion of PICS Shop Drawing Submittals and preliminary O&M manuals.

<u>Activity</u>	<u>Prerequisites and Lead Times</u>
Owner Training PAT	Owner training plan completed Startup, Owner training, and PAT procedures completed; notice 4 weeks prior to start.

PART 2 PRODUCTS

2.01 GENERAL

- A. PICS functions as shown on Drawings and as required for each loop. Furnish equipment items as required. Furnish all materials, equipment, and software, necessary to effect required system and loop performance.
- B. First Named Manufacturer: PICS design is based on first named manufacturers of equipment and materials.
 - 1. If an item is proposed from other than first named manufacturer, obtain approval from Engineer for such changes in accordance with Article Submittals.
 - 2. If using proposed item requires other changes, provide work and equipment to implement these changes. Changes that may be required include, but are not limited to: different installation, wiring, raceway, enclosures, connections, isolators, intrinsically safe barriers, software, and accessories.
- C. Like Equipment Items:
 - 1. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.
 - 2. Implement all same or similar functions in same or similar manner. For example, control logic, sequence controls, and display layouts.

2.02 LOOP SPECIFICATIONS

- A. Location: Article Supplements.
- B. Organization: By unit process and loop number.
- C. Functional Requirements for Control Loops:
 - 1. Shown on Drawings, in Panel Control Diagrams, and Process and Instrumentation Diagrams (P&ID). P&ID format and symbols are in accordance with ISA S5.1, except as specified or shown on Drawings.
 - 2. Supplemented by Loop Specifications.

D. Subheadings for Each Loop:

1. Functions: Clarifies functional performance of loop.
 - a. Components: Lists major components for each loop. Information listed include: Tag numbers.
 - b. Component Identification Codes: Alphanumeric codes of required components. Refer to Component Specification referenced in Article Supplements.
 - c. Component Names and Options: Required to tailor general Component Specifications to specific application. For example, special materials, mounting, size, unit range, scale, set points, and controller options.

2.03 I&C COMPONENTS

- A. Components for Each Loop: Major components for each loop are listed in Component List referenced in Article Supplements. Furnish all equipment that is necessary to achieve required loop performance.
- B. Component Specifications: Generalized specifications for each type of component are located in Article Supplements.
- C. Additional component requirements, including mounting options, configuration settings, and detailed model numbers, are listed in the Component List in Article Supplements.

2.04 NAMEPLATES AND TAGS

- A. Panel Nameplates: Enclosure identification located on the enclosure face.
 1. Location and Inscription: As shown.
 2. Materials: Laminated plastic attached to panel with stainless steel screws.
 3. Letters: 1/2-inch white on black background, unless otherwise noted.
- B. Component Nameplates—Panel Face: Component identification located on panel face under or near component.
 1. Location and Inscription: As shown.
 2. Materials: Laminated plastic attached to panel with stainless steel screws.
 3. Letters: 3/16-inch white on black background, unless otherwise noted.

- C. Component Nameplates—Back of Panel: Component identification located on or near component inside of enclosure.
 - 1. Inscription: Component tag number.
 - 2. Materials: Adhesive backed, laminated plastic.
 - 3. Letters: 3/16-inch white on black background, unless otherwise noted.

- D. Legend Plates for Panel Mounted Pushbuttons, Lights, and Switches.
 - 1. Inscription: Refer to:
 - a. Table under paragraph Standard Pushbutton Colors and Inscriptions.
 - b. Table under paragraph Standard Light Colors and Inscriptions.
 - c. P&IDs in Drawings.
 - 2. Materials: Stainless steel, keyed legend plates. Secured to panel by mounting nut for pushbutton, light, or switch.
 - 3. Letters: Black on gray or white background.

- E. Service Legends: Component identification nameplate located on face of component.
 - 1. Inscription: As shown.
 - 2. Materials: Adhesive backed, laminated plastic.
 - 3. Letters: 3/16-inch white on black background, unless otherwise noted.

- F. Nametags: Component identification for field devices.
 - 1. Inscription: Component tag number.
 - 2. Materials: 16-gauge, Type 304 stainless steel.
 - 3. Letters: 3/16-inch imposed.
 - 4. Mounting: Affix to component with 16- or 18-gauge stainless steel wire or stainless steel screws.

2.05 ELECTRICAL REQUIREMENTS

- A. In accordance with Division 26, Electrical.

- B. I&C and electrical components, terminals, wires, and enclosures: UL recognized or UL listed.

- C. Wires within Enclosures:
 - 1. AC Circuits:
 - a. Type: 300-volt, Type MTW stranded copper.
 - b. Size: For current to be carried, but not less than No. 18 AWG.

2. Analog Signal Circuits:
 - a. Type: 300-volt stranded copper, twisted shielded pairs.
 - b. Size: No. 18 AWG, minimum.
 3. Other DC Circuits.
 - a. Type: 300-volt, Type MTW stranded copper.
 - b. Size: For current carried, but not less than No. 18 AWG.
 4. Special Signal Circuits: Use manufacturer's standard cables.
 5. Wire Identification: Numbered and tagged at each termination.
 - a. Wire Tags: Machine printed, heat shrink.
 - b. Manufacturers:
 - 1) Brady PermaSleeve.
 - 2) Tyco Electronics.
- D. Wires entering or leaving enclosures, terminate and identify as follows:
1. Analog and discrete signal, terminate at numbered terminal blocks.
 2. Special signals terminated using manufacturer's standard connectors.
 3. Identify wiring in accordance with Section 26 05 05, Conductors.
- E. Terminal Blocks for Enclosures:
1. Quantity:
 - a. Accommodate present and spare indicated needs.
 - b. Wire spare PLC I/O points to terminal blocks.
 - c. One wire per terminal for field wires entering enclosures.
 - d. Maximum of 2 wires per terminal for 18-WG wire for internal enclosure wiring.
 - e. Spare Terminals: 20 percent of all connected terminals, but not less than 10 per terminal block.
 2. General:
 - a. Connection Type: Screw compression clamp.
 - b. Compression Clamp:
 - 1) Complies with DIN-VDE 0611.
 - 2) Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
 - 3) Guides strands of wire into terminal.
 - c. Screws: Hardened steel, captive and self-locking.
 - d. Current Bar: Copper or treated brass.
 - e. Insulation:
 - 1) Thermoplastic rated for minus 55 to plus 110 degree C.
 - 2) Two funneled shaped inputs to facilitate wire entry.
 - f. Mounting:
 - 1) Standard DIN rail.
 - 2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
 - 3) End Stops: Minimum of one at each end of rail.

- g. Wire preparation: Stripping only permitted.
 - h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
 - i. Marking System:
 - 1) Terminal number shown on both sides of terminal block
 - 2) Allow use of preprinted and field marked tags.
 - 3) Terminal strip numbers shown on end stops.
 - 4) Mark terminal block and terminal strip numbers as shown on Panel Control Diagrams and Loop Diagrams.
 - 5) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.
3. Terminal Block, General-Purpose:
- a. Rated Voltage: 600V ac.
 - b. Rated Current: 30 amp.
 - c. Wire Size: No. 22 to 10 AWG.
 - d. Rated Wire Size: No. 10 AWG.
 - e. Color: Gray body.
 - f. Spacing: 0.25 inch, maximum.
 - g. Test Sockets: One screw test socket 0.079-inch diameter.
 - h. Manufacturer and Product: Entrelec; Type M4/6.T.
4. Terminal Block, Ground:
- a. Wire Size: No. 22 to 12 AWG.
 - b. Rated Wire Size: No. 12 AWG.
 - c. Color: Green and yellow body.
 - d. Spacing: 0.25 inch, maximum.
 - e. Grounding: Ground terminal blocks electrically grounded to the mounting rail.
 - f. Manufacturer and Product: Entrelec; Type M4/6.P.
5. Terminal Block, Blade Disconnect Switch:
- a. Rated Voltage: 600V ac.
 - b. Rated Current: 10-amp.
 - c. Wire Size: No. 22 to 12 AWG.
 - d. Rated Wire Size: No. 12 AWG.
 - e. Color: Gray body, orange switch.
 - f. Spacing: 0.25 inch, maximum.
 - g. Manufacturer and Product: Entrelec; Type M4/6.SN.T.
6. Terminal Block, Fused, 24V dc:
- a. Rated Voltage: 600V dc.
 - b. Rated Current: 16-amp.
 - c. Wire Size: No. 22 to 10 AWG.
 - d. Rated Wire Size: No. 10 AWG.
 - e. Color: Gray body.
 - f. Fuse: 0.25 inch by 1.25 inches.
 - g. Indication: LED diode 24V dc.
 - h. Spacing: 0.512 inch, maximum.
 - i. Manufacturer and Product: Entrelec; Type M10/13T.SFL.

7. Terminal Block, Fused, 120V ac:
 - a. Rated Voltage: 600V ac.
 - b. Rated Current: 16-amp.
 - c. Wire Size: No. 22 to 10 AWG.
 - d. Rated Wire Size: No. 10 AWG.
 - e. Color: Gray body.
 - f. Fuse: 0.25 inch by 1.25 inches.
 - g. Indication: Neon Lamp 110V ac.
 - h. Leakage Current: 1.8 mA, maximum.
 - i. Spacing: 0.512 inch, maximum
 - j. Manufacturer and Product: Entrelec; Type M10/13T.SFL.
 8. Terminal Block, Fused, 120V ac, High Current:
 - a. Rated Voltage: 600V ac.
 - b. Rated Current: 35 amps.
 - c. Wire Size: No. 18 to 8 AWG.
 - d. Rated Wire Size: No. 8 AWG.
 - e. Color: Gray.
 - f. Fuse: 13/32 inch by 1.5 inches.
 - g. Spacing: 0.95 inch, maximum.
 - h. Manufacturer and Product: Entrelec; Type MB10/24.SF.
- F. Grounding of Enclosures:
1. Furnish isolated copper grounding bus for signal and shield ground connections.
 2. Ground bus grounded at a common signal ground point in accordance with National Electrical Code requirements.
 3. Single Point Ground for Each Analog Loop:
 - a. Locate at dc power supply for loop.
 - b. Use to ground wire shields for loop.
 4. Ground terminal block rails to ground bus.
- G. Analog Signal Isolators: Furnish signal isolation for analog signals that are sent from one enclosure to another. Do not wire in series instruments on different panels, cabinets, or enclosures.
- H. Power Distribution within Panels:
1. Feeder Circuits:
 - a. One or more 120V ac, 60-Hz feeder circuits as shown on Drawings.
 - b. Make provisions for feeder circuit conduit entry.
 - c. Furnish terminal board for termination of wires.

2. Power Panel: Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
 - a. Locate to provide clear view of and access to breakers when door is open.
 - b. Breaker sizes: Coordinate such that fault in branch circuit will blow only branch breaker but not trip the main breaker.
 - 1) Branch Circuit Breaker: 15 amps at 250V ac.
 - c. Breaker Manufacturers and Products: Refer to Division 26, Electrical.
 3. Circuit Wiring: P&IDs and Control Diagrams on Drawings show function only. Use following rules for actual circuit wiring:
 - a. Devices on Single Circuit: 20, maximum.
 - b. Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.
 - c. Branch Circuit Loading: 12 amperes continuous, maximum.
 - d. Panel Lighting and Service Outlets: Put on separate 15-amp, 120V ac branch circuit.
 - e. Provide 120V ac plugmold for panel components with line cords.
- I. Signal Distribution:
1. Within Panels: 4 to 20 mA dc signals may be distributed as 1 to 5V dc.
 2. Outside Panels: Isolated 4 to 20 mA dc only.
 3. All signal wiring twisted in shielded pairs.
- J. Signal Switching:
1. Use dry circuit type relays or switches.
 2. No interruption of 4 to 20 mA loops during switching.
 3. Switching Transients in Associated Signal Circuit:
 - a. 4 to 20 mA dc Signals: 0.2 mA, maximum.
 - b. 1 to 5V dc Signals: 0.05V, maximum.
- K. Relays:
1. General:
 - a. Relay Mounting: Plug-in type socket.
 - b. Relay Enclosure: Furnish dust cover.
 - c. Socket Type: Screw terminal interface with wiring.
 - d. Socket Mounting: Rail.
 - e. Provide holddown clips.
 2. Signal Switching Relay:
 - a. Type: Dry circuit.
 - b. Contact Arrangement: 2 Form C contacts.

- c. Contact Rating: 0 to 5 amps at 28V dc or 120V ac.
 - d. Contact Material: Gold or silver.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 0.9 watts (dc), 1.2VA (ac).
 - g. Expected Mechanical Life: 10,000,000 operations.
 - h. Expected Electrical Life at Rated Load: 100,000 operations.
 - i. Indication Type: Neon or LED indicator lamp.
 - j. Seal Type: Hermetically sealed case.
 - k. Manufacturer and Product: Potter and Brumfield; Series KH/KHA.
3. Control Circuit Switching Relay, Nonlatching:
- a. Type: Compact general-purpose plug-in.
 - b. Contact Arrangement: 3 Form C contacts.
 - c. Contact Rating: 10A at 28V dc or 240V ac.
 - d. Contact Material: Silver cadmium oxide alloy.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
 - g. Expected Mechanical Life: 10,000,000 operations.
 - h. Expected Electrical Life at Rated Load: 100,000 operations.
 - i. Indication Type: Neon or LED indicator lamp.
 - j. Push to test button.
 - k. Manufacturer and Product: Potter and Brumfield; Series KUP.
4. Control Circuit Switching Relay, Latching:
- a. Type: Dual coil mechanical latching relay.
 - b. Contact Arrangement: 2 Form C contacts.
 - c. Contact Rating: 10A at 28V dc or 120V ac.
 - d. Contact Material: Silver cadmium oxide alloy.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 2.7 watts (dc), 5.3VA (ac).
 - g. Expected Mechanical Life: 500,000 operations.
 - h. Expected Electrical Life at Rated Load: 50,000 operations.
 - i. Manufacturer and Product: Potter and Brumfield; Series KB/KBP.
5. Control Circuit Switching Relay, Time Delay:
- a. Type: Adjustable time delay relay.
 - b. Contact Arrangement: 2 Form C contacts.
 - c. Contact Rating: 10A at 240V ac.
 - 1) Contact Material: Silver cadmium oxide alloy.
 - d. Coil Voltage: As noted or shown.
 - e. Operating Temperature: Minus 10 to 55 degrees C.
 - f. Repeatability: Plus or minus 2 percent.
 - g. Delay Time Range: Select range such that time delay setpoint fall between 20 to 80 percent of range.
 - h. Time Delay Set Point: As noted or shown.
 - i. Mode of Operation: As noted or shown.

- j. Adjustment Type: Integral potentiometer with knob external to dust cover.
- k. Manufacturer and Products: Potter and Brumfield:
 - 1) Series CB for 0.1 second to 100 minute delay time ranges.
 - 2) Series CK for 0.1 to 120 second delay time ranges.

L. Power Supplies:

- 1. Furnish to power instruments requiring external dc power, including two-wire transmitters and dc relays.
- 2. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
- 3. Provide output over voltage and over current protective devices to:
 - a. Protect instruments from damage due to power supply failure.
 - b. Protect power supply from damage due to external failure.
- 4. Enclosures: NEMA 1 in accordance with NEMA 250.
- 5. Mount such that dissipated heat does not adversely affect other components.
- 6. Fuses: For each dc supply line to each individual two-wire transmitter.
 - a. Type: Indicating.
 - b. Mount so fuses can be easily seen and replaced.

M. Internal Panel Lights for Freestanding Panels:

- 1. Type: Switched 100-watt incandescent back-of-panel lights.
- 2. Quantity: One light for every 4 feet of panel width.
- 3. Mounting: Inside and in the top of back-of-panel area.
- 4. Protective metal shield for lights.

N. Service Outlets for Freestanding Panels:

- 1. Type: Three-wire, 120-volt, 15-ampere, GFCI duplex receptacles.
- 2. Quantity:
 - a. For panels 4 feet wide and smaller: One.
 - b. For panels wider than 4 feet: One for every 4 feet of panel width, two minimum per panel.
- 3. Mounting: Evenly spaced along back-of-panel area.

- O. Standard Pushbutton Colors and Incriptions: Use following color code and inscriptions for pushbuttons, unless otherwise noted in Article Supplements.

Tag Function	Inscription(s)	Color
OO	ON OFF	Black Black
OC	OPEN CLOSE	Black Black
OCA	OPEN CLOSE AUTO	Black Black Black
OOA	ON OFF AUTO	Black Black Black
MA	MANUAL AUTO	Black Black
SS	START STOP	Black Black
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

- a. Lettering Color:
- 1) Black on white and yellow buttons.
 - 2) White on black, red, and green buttons.

- P. Standard Light Colors and Incriptions: Use following color code and inscriptions for service legends and lens colors for indicating lights, unless otherwise noted in Article Supplements.

Tag Function	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Green
FAIL	FAIL	Amber
HIGH	HIGH	Red
AUTO	AUTO	White

SIP-SOUTHSIDE BLVD. INTERTIE TO DEERWOOD III WTP

Tag Function	Inscription(s)	Color
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow

1. Lettering Color:
 - a. Black on white and amber lenses.
 - b. White on red and green lenses.

2.06 SPARE PARTS

Description	Percent of Each Type and Size Used	No Less Than
dc power supplies	20	2
Fuses	20	5
Relays	20	3
Terminal Blocks	10	10

2.07 EXPENDABLES

Item	Quantity
Corrosion-inhibiting vapor capsules	Manufacturer's recommended 2-year supply

2.08 FABRICATION

- A. General:
 1. Panels with external dimensions and instruments arrangement as shown on Drawings.
 2. Panel Construction and Interior Wiring: In accordance with the National Electrical Code, state and local codes, NEMA, ANSI, UL, and ICECA.
 3. Fabricate panels, install instruments, wire, and plumb, at the PICS factory.
 4. Electrical Work: In accordance with Division 26, Electrical.
- B. Factory Assembly: Assemble panels at the manufacturer's factory. No fabrication other than correction of minor defects or minor transit damage shall be done on panels at Site.

- C. UL Listing Mark for Enclosures: Mark stating “Listed Enclosed Industrial Control Panel” per UL 508A.

- D. Wiring within PICS Panels:
 - 1. Restrain by plastic ties or ducts or metal raceways.
 - 2. Hinge Wiring: Secure at each end so that bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.
 - 3. Arrange wiring neatly, cut to proper length, and remove surplus wire.
 - 4. Abrasion protection for wire bundles which pass through holes or across edges of sheet metal.
 - 5. Connections to Screw Type Terminals:
 - a. Locking-fork-tongue or ring-tongue lugs.
 - b. Use manufacturer’s recommended tool with required sized anvil to make crimp lug terminations.
 - c. Wires terminated in a crimp lug, maximum of one.
 - d. Lugs installed on a screw terminal, maximum of two.
 - 6. Connections to Compression Clamp Type Terminals:
 - a. Strip, prepare, and install wires in accordance with terminal manufacturer’s recommendations.
 - b. Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.
 - 7. Splicing and tapping of wires, allowed only at device terminals or terminal blocks.
 - 8. Terminate 24V dc and analog signal circuits on separate terminal block from ac circuit terminal blocks.
 - 9. Separate analog and dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
 - 10. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.
 - 11. Plastic Wire Ducts Fill: Do not exceed manufacturer’s recommendation.

- E. Temperature Control:
 - 1. Freestanding Panels:
 - a. Nonventilated Panels: Size to adequately dissipate heat from equipment mounted inside panel or on panel.
 - b. Ventilated Panels:
 - 1) Furnish with louvers and forced ventilation as required to prevent temperature buildup from equipment mounted inside panel or on panel.
 - 2) For panels with backs against wall, furnish louvers on top and bottom of panel sides.

- 3) For panels without backs against wall, furnish louvers on top and bottom of panel back.
 - 4) Louver Construction: Stamped sheet metal.
 - 5) Ventilation Fans:
 - a) Furnish where required to provide adequate cooling.
 - b) Create positive internal pressure within panel.
 - c) Fan Motor Power: 120V ac, 60-Hz, thermostatically controlled.
 - 6) Air Filters: Washable aluminum, Hoffman Series A-FLT.
2. Refrigerated System: Furnish where heat dissipation cannot be adequately accomplished with natural convection or forced ventilation. Smaller Panels (that are not freestanding): Size to adequately dissipate heat from equipment mounted inside panel or in panel face.
 3. Space Heaters: Thermostatically controlled to maintain internal panel temperatures above dew point.

F. Freestanding Panel Construction:

1. Materials: Sheet steel, unless otherwise shown on Drawings with minimum thickness of 10-gauge, unless otherwise noted.
2. Panel Fronts:
 - a. Fabricated from a single piece of sheet steel, unless otherwise shown on Drawings.
 - b. No seams or bolt heads visible when viewed from front.
 - c. Panel Cutouts: Smoothly finished with rounded edges.
 - d. Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.
3. Internal Framework:
 - a. Structural steel for instrument support and panel bracing.
 - b. Permit panel lifting without racking or distortion.
4. Lifting rings to allow simple, safe rigging and lifting of panel during installation.
5. Adjacent Panels: Securely bolted together so front faces are parallel.
6. Doors: Full height, fully gasketed access doors where shown on Drawings.
 - a. Latches: Three-point, Southco Type 44.
 - b. Handles: "D" ring, foldable type.
 - c. Hinges: Full length, continuous, piano type, steel hinges with stainless steel pins.
 - d. Rear Access Doors: Extend no further than 24 inches beyond panel when opened to 90-degree position.
 - e. Front and Side Access Doors: As shown on Drawings.

G. Factory Finishing:

1. Enclosures:
 - a. Stainless Steel and Aluminum: Not painted.
 - b. Nonmetallic Panels: Similar to steel panels.
 - c. Steel Panels:
 - 1) Sand panel and remove mill scale, rust, grease, and oil.
 - 2) Fill imperfections and sand smooth.
 - 3) Paint panel interior and exterior with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.
 - 4) Sand surfaces lightly between coats.
 - 5) Dry Film Thickness: 3 mils, minimum.
 - 6) Color: Submit color choice to Engineer for approval.
2. Manufacturer's standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment with light gray color.

2.09 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsule Manufacturers:

1. Northern Instruments; Model Zerust VC.
2. Hoffmann Engineering Co; Model A-HCI.
3. Or approved equal.

2.10 SOURCE QUALITY CONTROL

A. Factory Acceptance Test:

1. Scope: Inspect and test entire PICS to ensure it is ready for shipment, installation, and operation.
2. Location: Manufacturer's factory or Engineer approved staging site.
3. Prior to test, Contractor shall submit the following:
 - a. Factory Test Plan: Identifies the equipment, I/O, and logic functions to be tested and the methodology used to test each section.
 - b. Factory Test Agenda: Details the location, meeting time, and testing times on the factory test date.
4. Engineer approval of the factory acceptance test documents above are prerequisites to scheduling and performing the test. Invitation for Engineer and Owner witnessing shall be at least 2 weeks prior to the scheduled test date.

5. Test: Exercise and test all I/O, including spares, and logic functions.
6. Field devices will be simulated by multimeter, jumper, or similar device during test.
7. Test may be witnessed by Owner and/or Engineer. Upon completion of the factory acceptance test, issue copies of the completed test form to Engineer and Owner.

PART 3 EXECUTION

3.01 EXAMINATION

- A. For equipment not provided by PICS, but that directly interfaces with the PICS, verify the following conditions:
 1. Proper installation.
 2. Calibration and adjustment of positioners and I/P transducers.
 3. Correct control action.
 4. Switch settings and dead bands.
 5. Opening and closing speeds and travel stops.
 6. Input and output signals.

3.02 INSTALLATION

- A. Material and Equipment Installation: Retain a copy of manufacturers' instructions at Site, available for review at all times.
- B. Electrical Wiring: As specified in Division 26, Electrical.
- C. Mechanical Systems:
 1. Drawings for PICS Mechanical Systems are diagrammatic and not intended to specifically define element locations or piping and tubing run lengths. Base materials and installations on field measurements.
 2. Copper and Stainless Steel Tubing Support: Continuously supported by an aluminum tubing raceway system.
 3. Plastic Tubing Supports: Except as shown on Drawings, provide continuous support in conduits or by aluminum tubing raceway system.
 4. Install tubing conduit for plastic tubing and tubing raceways parallel with, or at right angles to, structural members of buildings. Make vertical runs straight and plumb.
 5. Tubing and Conduit Bends:
 - a. Tool-formed without flattening, and all of same radius.
 - b. Bend Radius: Equal to or larger than conduit and tubing manufacturer's recommended minimum bend radius.
 - c. Slope instrument connection tubing in accordance with installation details.

- d. Do not run liquid filled instrument tubing immediately over or within a 3-foot plan view clearance of electrical panels, motor starters, or mechanical mounting panel without additional protection. Where tubing must be located in these zones, shield electrical device to prevent water access to electrical equipment.
 - e. Straighten coiled tubing by unrolling on flat surface. Do not pull to straighten.
 - f. Cut tubing square with sharp tubing cutter. Deburr cuts and remove chips. Do not gouge or scratch surface of tubing.
 - g. Blow debris from inside of tubing.
 - h. Make up and install fittings in accordance with manufacturer's recommendations. Verify makeup of tube fittings with manufacturer's inspection gauge.
 - i. Use lubricating compound or TFE tape on stainless steel threads to prevent seizing or galling.
 - j. Run tubing to allow, e.g., clear access to doors, controls, and control panels; and to allow for easy removal of equipment.
 - k. Provide separate support for components in tubing runs.
 - l. Supply expansion loops and use adapters at pipe, valve, or component connections for proper orientation of fitting.
 - m. Keep tubing and conduit runs at least 12 inches from hot pipes.
 - n. Locate and install tubing raceways in accordance with manufacturer's recommendations. Locate tubing to prevent spillage, overflow, or dirt from above.
 - o. Securely attach tubing raceways to building structural members.
6. Enclosure Lifting Rings: Remove rings following installation and plug holes.

D. Removal or Relocation of Materials and Equipment:

- 1. Remove from Site materials that were part of the existing facility but are no longer used, unless otherwise directed by Engineer to deliver to Owner.
- 2. Repair affected surfaces to conform to type, quality, and finish of surrounding surface.

3.03 FIELD FINISHING

- A. Refer to Section 09 90 00, Painting and Coating.

3.04 FIELD QUALITY CONTROL

A. Startup and Testing Team:

1. Thoroughly inspect installation, termination, and adjustment for components and systems.
2. Complete onsite tests.
3. Complete onsite training.
4. Provide startup assistance.

B. Operational Readiness Inspections and Calibrations: Prior to startup, inspect and test to ensure that entire PICS is ready for operation.

1. Loop/Component Inspections and Calibrations:
 - a. Check PICS for proper installation, calibration, and adjustment on a loop-by-loop and component-by-component basis.
 - b. Prepare component calibration sheet for each active component (except simple hand switches, lights, gauges, and similar items).
 - 1) Project name.
 - 2) Loop number.
 - 3) Component tag number.
 - 4) Component code number.
 - 5) Manufacturer for elements.
 - 6) Model number/serial number.
 - 7) Summary of functional requirements, for example:
 - a) Indicators and recorders, scale and chart ranges.
 - b) Transmitters/converters, input and output ranges.
 - c) Computing elements' function.
 - d) Controllers, action (direct/reverse) and control modes (PID).
 - e) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).
 - 8) Calibrations, for example:
 - a) Analog Devices: Actual inputs and outputs at 0, 10, 50, and 100 percent of span, rising and falling.
 - b) Discrete Devices: Actual trip points and reset points.
 - c) Controllers: Mode settings (PID).
 - 9) Space for comments.
 - c. These inspections and calibrations will be spot checked by Engineer.

- C. Performance Acceptance Tests (PAT): These are the activities that Section 01 91 14, Equipment Testing and Facility Startup, refers to as Performance Testing.
1. General:
 - a. Test all PICS elements to demonstrate that PICS satisfies all requirements.
 - b. Test Format: Cause and effect.
 - 1) Person conducting test initiates an input (cause).
 - 2) Specific test requirement is satisfied if correct result (effect) occurs.
 - c. Procedures, Forms, and Checklists:
 - 1) Conduct tests in accordance with, and documented on, Engineer accepted procedures, forms, and checklists.
 - 2) Describe each test item to be performed.
 - 3) Have space after each test item description for sign off by appropriate party after satisfactory completion.
 - d. Required Test Documentation: Test procedures, forms, and checklists. All signed by Engineer and Contractor.
 - e. Conducting Tests:
 - 1) Provide special testing materials, equipment, and software.
 - 2) Wherever possible, perform tests using actual process variables, equipment, and data.
 - 3) If it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation.
 - 4) Define simulation techniques in test procedures.
 - f. Coordinate PICS testing with Owner and affected Subcontractors.
 - 1) Excessive Test Witnessing: Refer to Supplementary Conditions.
 2. Test Requirements:
 - a. Once facility has been started up and is operating, perform a witnessed PAT on complete PICS to demonstrate that it is operating as required. Demonstrate each required function on a paragraph-by-paragraph and loop-by-loop basis.
 - b. Perform local and manual tests for each loop before proceeding to remote and automatic modes.
 - c. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.

- d. Make updated versions of documentation required for PAT available to Engineer at Site, both before and during tests.
- e. Make one copy of O&M manuals available to Engineer at the Site both before and during testing.
- f. Refer to referenced examples of PAT procedures and forms in Article Supplements.

3.05 TRAINING

A. General:

- 1. Provide an integrated training program to meet specific needs of Owner's personnel.
- 2. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
- 3. Provide instruction on two working shift(s) as needed to accommodate the Owner's personnel schedule.
- 4. Owner reserves the right to make and reuse video tapes of training sessions.

B. Operations and Maintenance Training:

- 1. Include a review of O&M manuals and survey of spares, expendables, and test equipment.
- 2. Use equipment similar to that provided or currently owned by Owner.
- 3. Provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics or instrumentation.

C. Operations Training:

- 1. Training Session Duration: One 8-hour instructor days.
- 2. Number of Training Sessions: One.
- 3. Location: Site.
- 4. Content: Conduct training on loop-by-loop basis.
 - a. Loop Functions: Understanding of loop functions, including interlocks for each loop.
 - b. Loop Operation: For example, adjusting process variable set points, AUTO/MANUAL control transfer, AUTO and MANUAL control, annunciator acknowledgement and resetting.
 - c. Interfaces with other control systems.

D. Maintenance Training:

1. Training Session Duration: One 8-hour instructor days.
2. Number of Training Sessions: One.
3. Location: Project Site.
4. Content: Provide training for each type of component and function provided.
 - a. Loop Functions: Understanding details of each loop and how they function.
 - b. Component calibration.
 - c. Adjustments: For example, controller tuning constants, current switch trip points, and similar items.
 - d. Troubleshooting and diagnosis for components.
 - e. Replacing lamps, chart paper, fuses.
 - f. Component removal and replacement.
 - g. Periodic maintenance.

3.06 CLEANING/ADJUSTING

- A. Repair affected surfaces to conform to type, quality, and finish of surrounding surface.
- B. Cleaning:
 1. Prior to closing system using tubing, clear tubing of interior moisture and debris.
 2. Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

3.07 PROTECTION

- A. Protect enclosures and other equipment containing electrical, instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules.
- B. Periodically replace capsules in accordance with capsule manufacturer's recommendations. Replace capsules just prior to Final Payment and Acceptance.

3.08 SUPPLEMENTS

- A. Supplements listed below, following “End of Section,” are part of this Specification.
1. Loop Specifications.
 2. PLC Input and Output List.
 3. Component Specifications.
 4. Component List.
 5. Surge Suppressor Products Table.
 6. Instrument Calibration Sheet: Provides detailed information on each instrument (except simple hand switches, lights, and similar items).
 7. I&C Valve Adjustment Sheet: Each sheet shows detailed information for installation, adjustment, and calibration of a given valve.
 8. Performance Acceptance Test Sheet: Describes the PAT for a given loop. The format is mostly free form.
 - a. Lists the requirements of the loop.
 - b. Briefly describes the test.
 - c. Cites expected results.
 - d. Provides space for check off by witness.

END OF SECTION

LOOP SPECIFICATIONS

1. Summary

The Loop Specifications contained herein describe monitoring and control functions required for integration of new process equipment and operations. Loop Specifications are arranged by facility area and include a summary of major equipment, control modes, PLC logic, and HMI graphics. The Owner's designated System Integrator is responsible for all HMI modifications contained herein. Scope assignment of PLC programming and existing PLC modifications shall be determined at a later phase of this Project.

2. Automation Standards

It is strongly recommended to review all existing Owner standards on SCADA system programming to determine detailed requirements on implementation efforts for this project.

3. Overall SIPS Control Strategy

The Southside Integrated Piping System (SIPS) will distribute partially treated water from the North Grid to ground storage tanks at various South Grid water treatment plants. The purpose of the SIPS is to supplement water supply available at the South Grid water treatment plants and reduce demand on the existing wellfields currently in use. An intertie station will be constructed at each South Grid water treatment plant to receive water from the SIPS. Each intertie station will typically consist of a flow control valve, flowmeter, and pressure transmitter.

At each intertie station, operation of the flow control valve will be initiated from the on-site ground storage tank level. Currently, wells are called to run in sequence to maintain a minimum level in the ground storage tank. Once the SIPS intertie station is connected to the ground storage tank, this distribution line will function as a "lead well". When the plant ground storage tank level drops below the control setpoint, the intertie station flow control valve will open before any of the wells are called to run. Additionally, if both the intertie station and wellfield is active, and the ground storage tank level rises above the high level setpoint, then the wells will drop off before the intertie station flow control valve closes. Therefore, the intertie station will operate in a First-In, Last-Out (FILO) position in the well queue. Additionally, the intertie station logic will respond to the same ground storage tank level interlocks currently incorporated for the well field. If the WTP ground storage level triggers a high-high alarm, then the intertie station valve will be commanded to close completely to prevent overflowing the tank.

Distribution to the intertie stations will be based on flow. During normal operation, the operators at the Ridenour Control room will determine how much flow is directed from the SIPS distribution grid to each water treatment plant. The total flow available in the SIPS is governed by the discharge flow of the existing Arlington Booster Pump Station (ABPS) upstream of the intertie stations. The simplified mass balance representation is defined as:

$$\text{Flow (ABPS)} = \text{Flow (Intertie 1)} + \text{Flow (Intertie 2)} + \dots + \text{Flow (Intertie N)}.$$

Where “N” is the number of water treatment plants with intertie stations on the South Grid. If the total flow demand from the South Grid intertie stations exceeds the flow at the ABPS, then the booster pumps at the ABPS will attempt to increase speed to supply more flow through the SIPS distribution main.

In this project, the Deerwood III WTP will be the first facility to include an intertie station. Detailed control requirements specific to the Deerwood III WTP intertie station are provided in following sections. However, additional facilities have been designated to construct future intertie stations to receive water from the SIPS. Therefore, this Project includes framework for the overall control strategy that assumes all intertie stations have been built and integrated into the Owner SCADA system. As such, a master controller is included in this project and will contain the PLC logic required to meet the control strategy requirements in this section and the section below for satisfactory control of the complete SIPS.

4. Ridenour Control Room

a. SIPS Master PLC

As part of this project, a new Siemens S7-414 PLC will be installed at the Ridenour Operations Building and interfaced with the existing control system network. This new PLC, tagged SIPS-RD-PLC-01 in the Contract Drawings, will serve as the master controller that will determine flow setpoints and communicate valve positions to all intertie stations on the SIPS distribution grid. In this project, only the Deerwood III WTP intertie station will be constructed. However, the overall control strategy shall be applied to the master PLC to accommodate additional future intertie stations as described in the above section.

The master PLC will calculate flow distribution using different methods, depending on the following operator-selected control modes:

- **Basic Flow Sum Mode**

In Basic Sum Mode, the operator assigns a flow setpoint to each intertie station. Once the station becomes active, the master PLC sends the flow setpoint to the intertie station PLC, which in turn performs PID control to govern the valve position. The flow setpoint at the upstream ABPS is updated as each station is brought online with its individual flow setpoint added to the running total.

ABPS Flow Setpoint = Intertie Station 1 Flow Setpoint + Intertie Station 2 Flow Setpoint + ... + Intertie Station N Flow Setpoint

Where N = the number of active intertie stations. An intertie station is considered active once the flow control valve has opened to fill the ground storage tank.

- **Equal Flow Value Mode**

Equal Flow Value Mode is a simple variation of the Basic Flow Sum Mode described above. Instead of entering individual flow setpoints for each individual intertie station, the operator assigns a single station flow setpoint that will be used for any intertie station that becomes active. Once set, the PLC will calculate the demand as:

ABPS Flow Setpoint = Equal Value Setpoint * Number of Active Intertie Stations

Once the first intertie station is active, the intertie WTP PLC will perform PID control to maintain the Equal Value Setpoint and govern the valve position, and the master PLC will issue the flow setpoint to the ABPS. If a second intertie station becomes active, the master PLC will again assign the Equal Value Setpoint to the second station, but the ABPS will be assigned a flow setpoint of twice the equal value setpoint. The process continues for each additional intertie station brought online.

- **Flow Demand Bias Mode**

In Demand Bias Mode, the operator assigns a Total Flow Setpoint that defines the total demand of all intertie stations. Additionally, the operator also selects the proportion (bias) of SIPS flow to be directed to each available intertie station. In this mode, the master PLC calculates a unique demand for each intertie station that comes online. PLC sample calculations are described below:

Intertie Station A Flow Setpoint = Total Flow Setpoint * Intertie Station A Bias Percentage

Intertie Station B Flow Setpoint = Total Flow Setpoint * Intertie Station B Bias Percentage

Intertie Station C Flow Setpoint = Total Flow Setpoint * Intertie Station C Bias Percentage

ABPS Flow Setpoint = Intertie Station A Flow Setpoint + Intertie Station B Flow Setpoint + Intertie Station C Flow

Once the intertie station and ABPS flow setpoints are calculated, the master PLC transmits the command values to the respective WTP or pump station PLC. It is not required for every intertie station with a bias value to be active. For example, suppose two intertie stations were assigned bias values of 70 percent and 30 percent, and the total flow was set at 10000 GPM. If only station 1 is active, then the flow demand will be 7000 GPM at both the intertie station and upstream booster station. Once the second station comes online, that station will receive a 3000 GPM setpoint while the booster station receives 10000 GPM. However, if a bias value is not entered for an active intertie station, the associated flow control valve will remain closed. A programmed limit will prevent the combined bias percentages exceeding 100 percent or assigning a value less than 0 percent.

The bias percentage values may be entered using one of the following methods on the HMI control faceplate:

- The operator directly enters a percentage value between 0-100.
 - The operator adjusts the slider bars on the HMI faceplate, which correspond to a percentage value.
 - The operator enters the base loading values of the respective WTPs for CUP deficit compliance. The PLC will use these values to automatically determine the resulting bias demand of each online intertie station.
- **Decoupled Pressure Control Mode**

In Decoupled Mode, the master PLC does not attempt any mass balance calculations to determine the flow setpoint at the ABPS. Instead, the pumps will operate to maintain the distribution pressure feeding the intertie stations. As the intertie station valves open to draw off water, the grid pressure will decrease over time. Once the measured pressure at the ABPS falls below the setpoint value for a set period of time, the pumps will be called to run and ramp up speed to increase pressure. The pressure setpoint is completely decoupled from the flow setpoints to the intertie stations. As such, Decoupled Mode can be used with any flow control mode described above. The operator will simply have the option to enable or disable Decoupled Mode on the HMI.

Most Open Valve Control

It is assumed that the South Grid water treatment plants furthest downstream from the ABPS will experience the largest pressure drop on the distribution line. The larger pressure drop may prevent distribution water from adequately reaching the plant's intertie station if other stations further upstream have open valves. Therefore, the intertie station control valve will gradually open as the most open valve (MOV) to minimize pressure loss, while the remaining upstream intertie valves are modulated to maintain their respective flow setpoints.

Determination of the most open valve will be based on determined by the master PLC based on the furthest active intertie station in use. To determine this in the PLC logic, each intertie station will be hardcoded a ranking indicating how far each station is from the ABPS discharge. For example, the closest station may be assigned a value of 1, the next closest 2, and so on. The PLC will use the last ranked active intertie station as the MOV. If an intertie station that was designated as the MOV is closed or taken out of service, then the PLC will re-evaluate the current set of active intertie stations and assign a new MOV based on the ranking system.

The MOV control method will also be implemented to maximize energy efficiency. The master PLC will attempt to open the intertie station valves as much as possible, in turn ramping up the drive speeds of the ABPS pumps. This logic prevents "burning head", such as attempting to pass flow through a mostly closed valve, or running pump drives at low, inefficient speeds.

i. Communication Control Strategy

The master PLC will communicate with each South Grid water treatment plant that includes a SIPS intertie valve station, in addition to the Arlington Booster Pump Station PLC, over the existing wide area fiber network. The following general rules will be applied for polling communications to each remote site:

- Data polling between the master PLC and the remote sites will be performed in a round-robin sequence.
- The master PLC will only attempt to read or write process data from an intertie station that is In Service. If a station has been placed out of service, then the master PLC will skip this station in the polling queue.
- The communications block will contain a step sequence that triggers a read or write to a specific site. When the read or write function is complete, then the step number increases, and the next site read or write begins.
- Each step will include a communications timeout that will automatically advance the polling step if the remote site is unresponsive. The specific timeout allotted will be determined during performance acceptance testing, but the time should be fast enough to prevent deadtime from other controlled intertie stations.
 - If the timeout occurs in the step, the master PLC logs this skip and continues in the sequence.
 - If the timeout occurs in a set number of consecutive polling cycles, then the master PLC will generate an alarm that communications are lost to the remote site.

ii. Miscellaneous Functions

Upon loss of communications with an active intertie station, the master PLC will maintain the valve position currently assigned to the lost station and will not attempt to automatically redistribute or recalculate flows to other active stations. Conversely, if the master PLC fails and communications are lost to all remote intertie stations, the respective PLC at each site will maintain its last commanded valve position setpoint to maintain flow until communications are restored.

If the operator determines that an intertie station cannot be actively called, such as the station needing maintenance or unavailable from an outage, the operator may elect to place an intertie station out of service. The master PLC receives the command to place the station out of service and will consequently command the flow control valve to close. Additionally, the flow setpoint previously assigned to the intertie station will be cleared. Once the intertie station is available for duty, then the operator may place the station back into service and assign a new flow setpoint.

It is possible that flow may exist at an intertie station without being controlled by the master PLC logic. Example scenarios include:

- The valve is commanded to move in Remote Manual.
- The valve is opened in the field (Local) using the actuator controller, solenoids, hand wheel or other manually adjusted device.
- The valve is leaking and flow is moving past a supposedly closed valve.

The master PLC will not attempt to control flow to an intertie station valve unless the station is placed In Service on the Ridenour Control Room HMI, and the valve must be placed in Remote Automatic. If a non-zero flow is measured at an intertie station that is Out of Service, a warning indication will be generated on the HMI screen.

b. Visualization

A new graphic screen will be created at the Ridenour Control Room HMI to provide an overview of the SIPS distribution network. The screen will display live status of every intertie station connected to the grid, in addition to the upstream ABPS. At minimum, the HMI screen will provide the following monitoring and control functions:

- Position of each intertie flow control valve in units of percent open.
- Operating mode of each intertie flow control valve (Local, Remote Manual, Remote Automatic).
- Current flow and pressure at each intertie line.
- Current flow setpoint being issued from the master PLC to each intertie station.
- Control mode currently in use for the SIPS master control method (Basic Sum, Demand Bias, and Equal Value).
- Enabled or Disabled Status of the Decoupled Pressure Control Mode for the ABPS.
- In/Out of Service status of each station.
- Current level at each South Grid water treatment plant.
- Current flow at the ABPS.
- Current pressure at the ABPS, including the last entered pressure control setpoint from Decoupled mode.
- Current flow setpoint being issued from the master PLC to the ABPS.
- Current flow readings from Briarwood and Comm Hall. These are existing tags to be re-displayed on this new screen.

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- Alarms
 - SIPS flow demand exceeding available flow at ABPS.
 - Insufficient flow at intertie station (measured flow is below flow setpoint).
 - Communication failure with an intertie station.
 - Communication failure with the ABPS.
 - Low and Low-Low ground storage tank level at each water treatment plant.
- HMI Controls
 - Provide a button to create a popup for the SIPS master control modes.
 - Provide radial selector for the following control modes: Basic Sum, Demand Bias, and Equal Value).
 - Provide an Enable/Disable soft button for the Decoupled Pressure Control Mode.
 - When Basic Sum mode is selected, provide user-adjustable fields for the flow setpoint at each individual intertie station.
 - When Demand Bias mode is selected, provide slider bars and base loading values for adjusting the bias percentage value for each intertie station between 0-100 percent. Radial selection shall be applied to choose between manual adjustment of demand bias (slider or percent entry) and automatic calculation of CUP deficit (base loading method). Additionally, provide user-adjustable field for the total demand flow setpoint.
 - When Equal Value mode is selected, provide a user-adjustable field for the per-station flow setpoint.
 - In all modes except for Decoupled mode, display the ABPS flow setpoint calculated by the master PLC.
 - When Decoupled mode is active, provide a pressure setpoint entry field for the desired grid pressure.
 - When a control mode is selected, and the desired values have been entered on the faceplate, a button to Apply changes will be pressed to send the operator-entered values to the master PLC. Exiting the faceplate before pressing Apply will cancel any pending changes in control mode or setpoint values.

Provide a second graphic screen or popup that displays all flow totals from the intertie stations.

5. Deerwood III WTP Intertie Station

a. Overview:

The Deerwood III WTP will include a new intertie station as part of this Project. This intertie station is used to transfer water from the off-site Arlington Booster Pump Station to the existing on-site Ground Storage Tank No. 3. The existing ground storage tank includes a level transmitter that is interfaced with the existing WTP PLC. The tank water level reading is used for automatic sequencing of wells tied to the WTP, as well as alarms generated for high level and low level conditions. The new intertie station consists of the following major process components:

- Flow Control Valve [SIPS-DW-FCV-01], including:
 - Local/Remote Hand Switch [SIPS-DW-HS-01]
 - Position Indicator and Transmitter [SIPS-DW-ZIT-01]
 - Electronic Position Controller [SIPS-DW-ZC-01]
- Magnetic Flowmeter [SIPS-DW-FIT-01]
- Gauge Pressure Transmitter [SIPS-DW-PIT-01]

All of the above component signals will be wired to the new Remote I/O panel [SIPS-DW-CP-01] located at the intertie station. The RIO panel will be connected to the existing WTP PLC control panel via Profibus DP over fiber-optic datalink. Programming modifications will be applied to the existing WTP PLC to allow for SCADA system integration of the new intertie station equipment and instrumentation.

b. Flow Control Valve Operation

SIPS-DW-FCV-01 is a hydraulic-actuated globe valve with modular flow control capability. Two solenoids are operated on the hydraulic lines to open or close the valve to a set position. The valve can be operated locally at the valve actuator, or remotely in either Manual or Automatic mode from the SCADA system. Selection of local or remote control is determined by the Local/Remote hand switch SIPS-DW-HS-01 located near the valve actuator.

When the valve is in local mode, the flow control valve position is changed by directly operating the pilot solenoids on the valve actuator. The valve position cannot be modified by the SCADA system while in local mode, but the valve position will still be actively monitored and displayed on the Ridenour Control Room HMI.

In Remote Manual mode, the flow control valve position is set by the operator at the Ridenour Control Room HMI. On the HMI, the operator will enter a percent open value on the valve control faceplate. This percentage value is issued to the Deerwood III WTP PLC, which will operate either the Open or Close pilot solenoid until the desired position is met.

In Remote Automatic mode, the flow control valve position is ultimately governed by the new SIPS Master PLC at the Ridenour Operations Building to achieve a desired flow setpoint. The flow setpoint is entered by the operator on the Ridenour Control Room HMI. Refer to the section above for the different methods of entering the intertie flow setpoints. Once a valid flow setpoint is determined by the SIPS Master PLC, this value is transmitted to the Deerwood WTP PLC, which will adjust the flow control valve position until the desired flow is achieved via PID control.

c. Existing Deerwood III WTP PLC Modifications

As part of the new intertie station installation, the existing WTP PLC will be modified to perform the following major functions:

- Reconfigure hardware configuration in program to include and assign the new RIO station.
 - Include Profibus DP interface with new flowmeter SIPS-DW-FIT-01.
 - Include Profibus DP interface with new analyzers located at SIPS-DW-FP-01.
- Create PLC tags and/or UDT's for new objects associated with the intertie station and interface with the Ridenour Control Room HMI.
 - Flow control valve (modulating)
 - Instruments
 - Flow
 - Pressure
 - Analyzers
 - Discrete/Digital Alarms
 - Analyzer Panel Flow Switch
 - RIO Control Panel
 - High Temperature
 - Panel Intrusion
 - Loss of 120VAC Power
 - UPS Fault
 - UPS Low Battery

- Create functions or function blocks for remote operation logic for the intertie station.
 - Modify well alternation logic so that the intertie station flow control valve is first called to open when the ground storage tank level drops below the control setpoint. If the tank level continues to drop, then the first well (Lag 1) will be called to run.
 - Similarly, provide logic to close the intertie station flow control valve if the ground storage tank level is high and all other wells are offline.
- Create communication blocks for data exchange with new flowmeter SIPS-DW-FIT-01.
 - Refer to I/O List for data points.
- Create communication blocks for data exchange with SIPS master PLC to perform intertie controls.
 - Read valve position setpoint value from master PLC.
 - Read flow setpoint value from master PLC.
 - Write valve position feedback value to master PLC.

d. Miscellaneous Control Functions

Upon loss of signal between the new RIO and the valve actuator's pilot solenoids, the valve will remain at its last commanded position until the signals are restored or if the valve is taken into local operation. However, upon loss of hydraulic pressure, the valve will fail into the closed position.

If communications are severed between the SIPS Master PLC at the Ridenour Operations Building and the Deerwood III WTP PLC, then the WTP PLC will use the last commanded flow setpoint and maintain control of the valve to meet the flow setpoint until communications are restored with the master PLC. In the event of a communications failure, an alarm will be generated at the Ridenour Control Room HMI indicating a loss of communications to the Deerwood III WTP PLC.

Likewise, if communications are severed between the Deerwood III WTP PLC and the new RIO station, then the digital output module will clear the Open and Close travel signals, maintaining the last position of the flow control valve until communications are restored. In the event of a communications failure, an alarm will be generated at the Ridenour Control Room HMI indicating a loss of communications to the intertie station RIO.

If the existing level transmitter reading for Ground Storage Tank No. 3 triggers a high-high level alarm, the WTP PLC will command the intertie station valve to close completely.

The new RIO control panel will include additional signals to monitor internal components and generate an alarm at the Ridenour Control Room HMI if any of the following conditions occur:

- Control Panel Intrusion: Alarm generates if the panel door is opened and the door switch button is no longer pressed, de-energizing the switch circuit.
- Control Panel High Temperature: Alarm generates if the measured temperature within the enclosure exceeds the maximum allowable threshold. The alarm condition will energize the signal circuit.
- Loss of Feed Power: The incoming 120VAC power at the RIO panel will energize a relay; the alarm generates if the power is lost and the relay de-energizes.
- UPS Fault: Alarm generates from the panel UPS if it encounters an internal fault. The alarm condition will de-energize the signal circuit.
- UPS Low Battery: Alarm generates from the panel UPS if the enclosed battery drains below the device's minimum allowable threshold. The alarm condition will energize the signal circuit.

e. Visualization

On the Ridenour Control Room HMI, a new graphic screen will be created to show the live status of the Deerwood III Intertie Station. The new screen will contain the following displays and operator controls:

- Intertie station flow control valve
 - Position reading (in units of percent open)
 - Position command (in units of percent open)
 - Color indication of fully open (RED) or fully closed (GREEN) including accompanying text or abbreviation (OPEN or CLOSED).
 - Local/Remote status
 - Manual/Auto status
- Intertie line flowmeter
 - Flow reading, GPM
 - Flow totalizer reading, Gallons
- Intertie line pressure transmitter
 - Line pressure reading, PSIG

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- Analyzers
 - Dissolved Oxygen reading, ppm.
 - UV Transmittance reading, %UVT.
 - pH reading, unitless.
 - Oxidation-Reduction Potential Reading, mV
 - Turbidity reading, NTU.
 - Include at least one sample temperature reading based on the integrated temperature sensors included with the analyzer instruments. Display in degrees Fahrenheit.
- Alarms
 - Flowmeter
 - Transmitter Loss of Communications
 - Empty Pipe Detection
 - Reverse Flow Detection
 - General Alarm
 - Low-Low Flow
 - Low Flow
 - Line pressure transmitter
 - Transmitter Hardware Fault
 - Low-Low Pressure
 - Low Pressure
 - High Pressure
 - High-High Pressure
 - Analyzers
 - Dissolved Oxygen transmitter fault.
 - UV Transmittance transmitter fault.
 - ORP/pH transmitter fault.
 - Turbidity transmitter fault.
 - Low flow alarm status from SIPS-DW-FSL-01.

- RIO Communication Failure
- RIO Panel
 - High Temperature
 - Loss of 120VAC Power
 - UPS Fault
 - UPS Low Battery
 - Panel Intrusion
- WTP Communication Failure
- Misc.
 - Flow setpoint in automatic mode.
 - Provide a navigation button on the intertie station screen to access the master SIPS control screen described in the above section.

Additionally, the existing Deerwood III WTP graphics screen at the Ridenour Control Room HMI will be modified to include the intertie station in the well queue command popup. The intertie station will be shown as the “lead well” in the queue.

6. Arlington Booster Pump Station

a. Overview:

The Arlington Booster Pump Station will be configured to provide the SIPS supply water to the intertie stations downstream. The station consists of three variable speed pumps and existing instrumentation measuring line pressure and discharge flow rate.

b. Existing Arlington Booster Pump PLC Modifications

As part of the new intertie station implementation, the existing PLC at the Arlington Booster Pump Station will be modified to perform the following major functions:

- Create communication blocks to interface with the new SIPS master PLC.
 - Read ABPS flow rate and grid pressure setpoint from the master PLC.
 - Write ABPS flow rate feedback and pressure reading to the master PLC.

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- Modify existing pump control logic to perform PID controls to achieve the desired flow rate issued by the master PLC.
 - Currently, the ABPS operates in automatic mode to maintain a pressure setpoint and utilizes an automatic control scheme to start, stop, and ramp multiple pumps. The flow control loop will implement the same method of starting and stopping pumps, as well as ramping multiple pumps in parallel.
 - When Decoupled Pressure Control Mode is active, the ABPS PID controller will instead run off pressure. The pressure setpoint from the master PLC will be controlled against the measured line pressure at the pump station.

END OF LOOP SPECIFICATIONS

SIPS-DW-RIO-01 I/O LIST								
DWG	Tag	Equipment Description	I/O Function	DI	DO	AI	AO	Network (Soft I/O)
N-001	SIPS-DW-FCV-01	SIPS Intertie Station Flow Control Valve	In Remote Status	1				
N-001	SIPS-DW-FCV-01	SIPS Intertie Station Flow Control Valve	Open Travel Command		1			
N-001	SIPS-DW-FCV-01	SIPS Intertie Station Flow Control Valve	Close Travel Command		1			
N-001	SIPS-DW-FCV-01	SIPS Intertie Station Flow Control Valve	Position Feedback			1		
N-001	SIPS-DW-FIT-01	SIPS Intertie Station Flow Transmitter	Flow Rate Feedback (PROFIBUS READ)					1
N-001	SIPS-DW-FIT-01	SIPS Intertie Station Flow Transmitter	Flow Totalizer Feedback (PROFIBUS READ)					1
N-001	SIPS-DW-FIT-01	SIPS Intertie Station Flow Transmitter	Reset Flow Totalizer Command (PROFIBUS WRITE)					1
N-001	SIPS-DW-FIT-01	SIPS Intertie Station Flow Transmitter	Empty Pipe Detection (PROFIBUS READ)					1
N-001	SIPS-DW-FIT-01	SIPS Intertie Station Flow Transmitter	Reverse Flow Detection (PROFIBUS READ)					1
N-001	SIPS-DW-FIT-01	SIPS Intertie Station Flow Transmitter	General Alarm/Warning (PROFIBUS READ)					1
N-001	SIPS-DW-PIT-01	SIPS Intertie Station Line Pressure Transmitter	Pressure			1		
N-001	SIPS-DW-CP-01	SIPS Intertie Station Remote I/O Panel	Panel Intrusion	1				
N-001	SIPS-DW-CP-01	SIPS Intertie Station Remote I/O Panel	120VAC Power Failure	1				
N-001	SIPS-DW-CP-01	SIPS Intertie Station Remote I/O Panel	UPS Low Battery	1				
N-001	SIPS-DW-CP-01	SIPS Intertie Station Remote I/O Panel	UPS Fault	1				
N-001	SIPS-DW-CP-01	SIPS Intertie Station Remote I/O Panel	Panel High Temperature	1				
			I/O Totals	6	2	2	0	6

COMPONENT SPECIFICATIONS

A. A31 Dissolved Oxygen Analyzer:

1. General:
 - a. Function: Measure, indicate, and transmit dissolved oxygen (DO) content of process stream.
 - b. Type: Electrode flow cell.
 - c. Parts: Element, flow cell, transmitter, interconnecting cable, and accessories.
2. Performance:
 - a. Process Fluid: Water, unless otherwise noted.
 - b. Range: As Noted.
3. Features:
 - a. Automatic temperature and pressure compensation.
4. Element:
 - a. Type: Flow Cell.
5. Transmitter:
 - a. Material of Construction: Cast aluminum.
 - b. IP 66 ingress rating.
 - c. Power: 120V ac, 60Hz.
 - d. Output: Profibus DP.
6. Manufacturers and Products:
 - a. Swan Monitor AMI Oxysafe.
 - b. No substitutions.

B. A33 Microbial Analyzer.

1. General:
 - a. Function: Measure and indicate microbial content of process stream.
 - b. Type: Cytometer.
 - c. Parts: Sampling device and associated accessories.
2. Performance:
 - a. Process Fluid: Water, unless otherwise noted.
 - b. Ambient Temperature Rating: 15 degrees C to 40 degrees C.
 - c. Ambient Humidity Rating: 20 to 80 percent relative.
3. Features:
 - a. Automated sampling, dilution, incubation, and pH adjustment.
 - b. Sampling Frequency: Five minutes.
 - c. Maximum Result Time: 15 minutes.
 - d. Incubation temperature: 25 degrees C to 45 degrees C.

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4. Sampling Device:
 - a. Microbial parameters:
 - 1) Total cell count.
 - 2) Intact cell count
 - b. Power Input: 120V ac, 60Hz.
 - c. Wall Mount.
5. Manufacturers and Products:
 - a. onCyt OC-300.
 - b. No substitutions.

C. A35 Turbidity Analyzer:

1. General:
 - a. Function: Measure, indicate, and transmit turbidity of process stream.
 - b. Type: Non-contact nephelometer using a white light LED light source.
 - c. Parts: Turbidity element, transmitter, interconnecting cable, and accessories.
2. Performance:
 - a. Range: As noted.
 - b. Accuracy: Either plus or minus 2 percent of reading or plus or minus 0.02 NTU, whichever is greater.
 - c. Response Time: T90 in 3 minutes.
3. Element:
 - a. Type: Photocell, nephelometric principle of light scattering.
 - b. Sample Flow: 20 liters to 60 liters per hour.
 - c. Sample Temperature Range: up to 104 degrees F.
 - d. Materials: Corrosion-resistant materials for wetted parts.
 - e. Process Connections:
 - 1) Sample Inlet: 1/4-inch NPTF.
 - 2) Drain: 1/2-inch NPTF with automatic valve.
 - f. Mounting:
 - 1) Wall Mount installation. Use manufacturer standard mounting brackets and install per manufacturer instructions.
 - 2) Mount unit on polymer board in instrument room. Refer to Drawings for general layout details.
4. Transmitter:
 - a. Configuration: Remote to sensor. Mount on wall space above element with manufacturer's interconnecting cable.
 - b. Ambient Temperature: 0 degrees C to 50 degrees C.
 - c. Humidity: 10 to 90 percent, non-condensing.
 - d. Display: Backlit LCD display.

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- e. Navigation: Keypad.
 - f. Power Supply: Voltage 100 to 240V ac, 50/60-Hz.
 - g. Outputs: Profibus DP.
 - 5. Accessories and Options:
 - a. Include integrated degasser for bubble elimination.
 - b. Include integrated flow sensor with configurable alarm output.
 - 6. Manufacturers and Products:
 - a. Swan Analytical; Monitor AMI Turbiwell Power, Auto-Drain Option.
 - b. No substitutions.
- D. A37 pH and ORP Element and Transmitter:
- 1. General:
 - a. Function: Measure, indicate, and transmit pH and ORP of process fluid.
 - b. Parts: Element, analyzer/transmitter, interconnecting cable, and noted ancillaries.
 - 2. Performance:
 - a. Range: As noted.
 - b. Operating Temperature: 0 degrees C to 50 degrees C.
 - 3. Element:
 - a. Process Connection: plug PG 13.5.
 - b. Case Material: Isotactic polypropylene, PPO.
 - c. Process Fluid: Water, unless otherwise noted.
 - d. Wetted Materials: Compatible with process fluid.
 - e. Electrode Type: KCL-gel (without AgCl) with platinum pin, unless otherwise noted.
 - f. Reference System: Ag/AgCL.
 - g. Enclosure:
 - 1) Type: IP 68.
 - h. Interconnecting Cable: Length as required.
 - 4. Transmitter:
 - a. Measuring Range (pH): 0 to 14 pH.
 - b. Measuring Range (ORP) Minus 500 to 1500 mv.
 - c. Ambient Temperature: Minus 10 degrees C to 50 degrees C.
 - d. Humidity: 10 to 90 percent, non-condensing.
 - e. Display: Backlit LCD display, 75 by 45 mm, for reading of measurement, operating status, sample temperature, and sample flow.
 - f. Navigation: Keypad.
 - g. Power Supply:
 - 1) Voltage 100 to 240V ac, 50/60-Hz.
 - 2) Power Consumption: max 30 VA.

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- h. Outputs:
 - 1) Profibus DP.
- 5. Enclosure:
 - 1) Material: Aluminum housing for measuring and control transmitter.
 - 2) Rating: IP 66.
- 6. Manufacturers and Products:
 - a. Swan AMI pH-Redox sensor and transmitter.
 - b. No substitutions.

E. A39 UV Transmittance Analyzer:

- 1. General:
 - a. Function:
 - 1) Measure and indicate UV-254 transmittance.
 - b. Parts: Analyzer/transmitter and accessories.
- 2. Performance:
 - a. Species Measured: UV-254.
 - b. Process Fluid: Water, unless otherwise noted.
 - c. Range: As noted.
- 3. Enclosure:
 - a. IP66 ingress rating
 - b. Material of Construction: Cast aluminum.
 - c. Mounting: Wall.
- 4. Output:
 - a. Profibus DP interface.
- 5. Power:
 - a. 120V ac, 50/60-Hz.
- 6. Manufacturer and Product:
 - a. Swan AMI SAC254.
 - b. No substitutions.

F. F4 Flow Element and Transmitter, Electromagnetic:

- 1. General:
 - a. Function: Measure, indicate, and transmit the flow of a conductive process liquid in a full pipe.
 - b. Type:
 - 1) Electromagnetic flowmeter, with operation based on Faraday's Law, utilizing the pulsed dc type coil excitation principle with high impedance electrodes.
 - 2) Full bore meter with magnetic field traversing entire flow-tube cross section.
 - 3) Unacceptable are insert magmeters or multiple single point probes inserted into a spool piece.

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- c. Parts: Flow element, transmitter, interconnecting cables, and mounting hardware. Other parts as noted.
2. Service:
 - a. Stream Fluid:
 - 1) As noted.
 - 2) Suitable for liquids with a minimum conductivity of 20 microS/cm.
 - b. Flow Stream Descriptions: If and as described below.
3. Operating Temperature:
 - a. Element:
 - 1) Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.
 - 2) Process: Minus 5 to 140 degrees F, typical, unless otherwise noted.
 - b. Transmitter:
 - 1) Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.
 - 2) Storage: 15 to 120 degrees F, typical, unless otherwise noted.
4. Performance:
 - a. Flow Range: As noted.
 - b. Accuracy: Plus or minus 0.5 percent of rate for all flows resulting from pipe velocities of 2 to 30 feet per second.
 - c. Turndown Ratio: Minimum of 10 to 1 when flow velocity at minimum flow is at least 1 foot per second.
5. Features:
 - a. Zero stability feature to eliminate the need to stop flow to check zero alignment.
 - b. No obstructions to flow.
 - c. Very low pressure loss.
 - d. Measures bi-directional flow.
6. Process Connection:
 - a. Meter Size (diameter inches): As noted.
 - b. Connection Type: 150-pound ANSI raised-face flanges; AWWA C207, Table 2 Class D; or wafer style depending on meter size, unless otherwise noted.
 - c. Flange Material: Carbon steel, unless otherwise noted.
7. Power (Transmitter): 120V ac, 60-Hz, unless otherwise noted.
8. Element:
 - a. Meter Tube Material: Type 316L stainless steel, unless otherwise noted.
 - b. Liner Material: As Noted.
 - c. Liner Protectors: Covers (or grounding rings) on each end to protect liner during shipment.

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- d. Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.
 - e. Electrode Material: Type 316 stainless steel or Hastelloy C, unless otherwise noted.
 - f. Grounding Ring:
 - 1) Required, unless otherwise noted.
 - 2) Quantity: Two, unless otherwise noted.
 - 3) Material: Type 316 stainless steel, unless otherwise noted.
 - g. Enclosure: NEMA 4X, minimum, unless otherwise noted.
 - h. Submergence:
 - 1) Temporary: If noted.
 - 2) Continuous (up to 10 feet depth), NEMA 6P/IP68: If noted.
 - i. Direct Buried (3 to 10 feet): If noted.
 - j. Hazardous Area Certification:
 - 1) Class 1, Division 2, Groups A, B, C, D: If noted.
 - 2) Class 1, Division 1, Groups A, B, C, D, and FM approved: If noted.
 - 3) Class 1, Division 1, Groups C, D, and FM approved: If noted.
9. Transmitter:
- a. Mounting: Refer to Drawings.
 - b. Display: Required.
 - 1) Digital LCD display, indicating flow rate and total.
 - 2) Bi-directional Flow Display: If noted.
 - a) Forward and reverse flow rate.
 - b) Forward, reverse and net totalization.
 - c. Parameter Adjustments: By keypad or non-intrusive means.
 - d. Enclosure: NEMA 4X, minimum, unless otherwise noted.
 - e. Empty Pipe Detection.
10. Signal Interface (at Transmitter):
- a. Digital Communication:
 - 1) PROFIBUS DP Network Protocol: Required, unless otherwise noted.
 - a) 9-pin RS-485 signal cable connection.
 - b) Provide surge suppression for RS-485 signal as well as single phase 120V ac instrument feed power.
11. Cables:
- a. Types: As recommended by manufacturer.
 - b. Lengths: As required to accommodate device locations.
12. Built-in Diagnostic System:
- a. Features:
 - 1) Field programmable electronics.
 - 2) Self-diagnostics with troubleshooting codes.

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- 3) Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.
 - 4) Initial flow tube calibration and subsequent calibration checks.
13. Factory Calibration:
- a. Calibrated in an ISO 9001 and NIST certified factory.
 - b. Factory flow calibration system must be certified by volume or weight certified calibration devices.
 - c. Factory flow calibration system shall be able to maintain calibration flow rate for at least 5 minutes for repeatability point checks.
14. Manufacturers and Products:
- a. Endress & Hauser; Promag W 500.
 - b. No substitutions.
- G. F16 Flow Element, Rotameter:
1. General:
 - a. Function: Indicate flow rate.
 - b. Type: Variable area; float and tapered tube.
 2. Service Conditions:
 - a. Process Fluid: Water, unless otherwise noted.
 - b. Maximum Operating Temperature: 150 degrees F.
 - c. Maximum Operating Pressure: 100 psig.
 3. Performance:
 - a. Flowrate Range: As noted.
 - b. Accuracy: Plus or minus 5 percent full scale.
 4. Features:
 - a. Nominal Length: 4 inches.
 - b. Float Material: Type 316 stainless steel.
 - c. Tube: Borosilicate glass.
 - d. Seal:
 - 1) Type: O-ring, unless otherwise noted.
 - 2) Material: Buna-N, unless otherwise noted.
 5. Size and Process Connections:
 - a. Connection Type: 1/4 inch FNPT, unless otherwise noted.
 - b. Tube Size: 1/4 inch, unless otherwise noted.
 - c. Connection Material: Type 316 stainless steel, unless otherwise noted.
 - d. Connection Orientation: Vertical, unless otherwise noted.
 6. Signal Interface: None, unless otherwise noted.
 7. Manufacturers and Products:
 - a. Brooks Instruments; 2500 Series.
 - b. No substitutions.

H. F52 Flow Switch, Thermal Dispersion:

1. General:
 - a. Function: Point liquid flow detection and switch actuation.
 - b. Type: Thermal dispersion.
 - c. Parts: Sensor and accessories as noted.
2. Service:
 - a. Process Fluid: As shown on Drawings.
 - b. Process Temperature: Minus 100 degrees F to 250 degrees F.
3. Performance:
 - a. Flow setting: As noted.
 - b. Power supply: 120V ac.
 - c. Signal Output:
 - 1) 8A rated DPDT relay.
 - d. LED for local alarm diagnostics.
4. Installation:
 - a. Insertion length: One inch, unless otherwise noted.
 - b. Install in pipe tee with retractable assembly.
 - c. Process connection: 1/2-inch NPT.
 - d. Integral electronics mounting.
 - e. Weatherproof rated.
 - f. IP66 3/4-inch NPT cable entry.
 - g. Materials of construction: Type 316 stainless steel.
5. Manufacturers and Products:
 - a. Magnetrol; Thermanel TD2 model TMM.
 - b. No substitutions.

I. P4 Pressure Gauge:

1. General:
 - a. Function: Local pressure indication.
 - b. Type: Bourdon tube element.
2. Performance:
 - a. Scale Range: As noted.
 - b. Accuracy: Plus or minus 1 percent of full scale.
3. Features:
 - a. Dial: 4-1/2-inch diameter.
 - b. Pointer Vibration Reduction: Required, unless otherwise noted.
Use the following method.
 - 1) Liquid filled gauge front, unless otherwise noted.
 - a) Glycerine fill, unless otherwise noted.
 - c. Case Material: Black thermoplastic, unless otherwise noted.
 - d. Materials of Wetted Parts (including element, socket/process connection, throttling device (if specified) and secondary components): Stainless steel, unless otherwise noted.

SIP-SOUTHSIDE BLVD. INTERTIE TO DEERWOOD III WTP

- e. Pointer: Adjustable by removing ring and window.
 - f. Window: Glass or acrylic, unless otherwise noted.
 - g. Threaded reinforced polypropylene front ring.
 - h. Case Type: Solid front with blow-out back.
 - 4. Process Connection:
 - a. Mounting: Lower stem, unless otherwise noted.
 - b. Size: 1/2-inch MNPT, unless otherwise noted.
 - 5. Accessories:
 - a. Throttling Device: Required, unless otherwise noted.
 - 1) Type suitable for the intended service.
 - 2) Install in gauge socket bore.
 - 6. Manufacturers and Products:
 - a. Ashcroft; Duragauge Model 1259/Model, 1279/Model, 1279 PLUS!
 - b. No substitutions.
- J. P9 Pressure Transmitter, Electronic:
- 1. General:
 - a. Function: Measure pressure and transmit signal proportional to pressure or level.
 - b. Type: Electronic variable capacitance; two-wire transmitter; “smart electronics.”
 - c. Parts: Pressure connection manifold and transmitter.
 - 2. Performance:
 - a. Range: As noted.
 - b. Maximum Adjustable Range: Noted range shall lie between 40 percent and 80 percent of maximum adjustable range.
 - c. Accuracy: Plus or minus 0.075 percent of span, unless otherwise noted.
 - d. Temperature: Operating range minus 20 degrees F to plus 250 degrees F, minimum.
 - e. Humidity: 0 to 100 percent relative humidity.
 - 3. Features:
 - a. Type: Gauge pressure, unless otherwise noted.
 - b. Damping: Fluid or electronic type with adjustment.
 - c. Indicator: Four-digit LCD indicating noted range.
 - d. Suppressed or Elevated Zero: When noted.
 - e. Materials: Wetted parts including process flanges and drain/vent valves, Type 316 stainless steel, unless otherwise noted.
 - f. Wetted O-Rings: Glass filled TFE, graphite filled PTFE, or Viton, unless otherwise noted.
 - g. Fill Fluid: Silicone, unless otherwise noted.

SIP-SOUTHSIDE BLVD. INTERTIE TO DEERWOOD III WTP

4. Process Connections:
 - a. Line Size: 1/2 inch or 1/4 inch, selectable.
 - b. Connection Type: FNPT.
 5. Signal Interface:
 - a. 4 to 20 mA dc output for load impedance of 0 to 500 ohms minimum, without load adjustment with 24V dc supply.
 6. Enclosure:
 - a. Type: NEMA 4X, unless otherwise noted.
 - b. Mounting: Refer to Drawings.
 - c. Housing: Modular with separate compartments for electronics and field connections. Epoxy coated aluminum, unless otherwise noted.
 - d. Features:
 - 1) Keypad and LCD display.
 7. Manufacturers and Products:
 - a. Emerson; Rosemount 3051.
 - b. Endress & Hauser; Cerabar PMP51.
 - c. Or approved equal.
- K. Y51 Uninterruptible Power Supply System:
1. General:
 - a. Function: Provides isolated, regulated uninterrupted DC output power during a complete or partial interruption of incoming line power.
 - b. Provide UPS system for the following control panels:
 - 1) SIPS-DW-CP-01.
 - 2) SIPS-RD-CP-01.
 2. Performance:
 - a. Input Power:
 - 1) 120V ac.
 - 2) Buffer period: 1 hour.
 - 3) Connections: Manufacturer's standard, unless otherwise noted.
 - b. Output Power:
 - 1) 24C dc.
 - 2) Nominal Output Current: 5A.
 - 3) Connections: Manufacturer's standard, unless otherwise noted.
 - c. On-line Efficiency: 95 percent minimum, unless otherwise noted.
 - d. Continuous no-break power with no measurable transfer time.
 - e. Operating Temperature: Minus 25 degrees C to 70 degrees C.
 - f. Operating Relative Humidity: 5 percent to 95 percent without condensation.

- g. Lightning and Surge Protection:
 - 1) Pass lightning standard IEEE C62.41 Categories A and B tests.
 - 2) 2000 to 1 attenuation of input spike.
 - 3. Features:
 - a. LED status indicators:
 - 1) Power OK.
 - 2) UPS Active.
 - 3) UPS Charging.
 - 4) Fail/Alarm.
 - b. Signal outputs to PLC:
 - 1) Hardwired:
 - a) UPS Low Battery.
 - b) UPS Fail.
 - c. Physical:
 - 1) DIN rail mount, unless otherwise noted.
 - 2) Polycarbonate housing.
 - 4. Manufacturers and Products:
 - a. Phoenix Contact; TRIO-UPS-2G/1AC/24DC/5.
 - b. Or approved equal.
- L. Y85 Active Termination Resistor:
- 1. Provide an active termination resistor on the last device in a Profibus segment.
 - a. Siemens 6ES7 972-0DA00-0AA0.
 - 2. Refer to Network Block Diagram for Profibus segment topology.
- M. Y88 Optical Link Module:
- 1. General:
 - a. Function: Media converter between PROFIBUS RS-485 and fiber-optic transmission cables.
 - 2. Features:
 - 1) PROFIBUS Transfer Rate: 9.6 kbit/s to 12 Mbit/s.
 - 2) Fiber Optic Attenuation Factor:
 - a) 50 micron: 10dB.
 - b) 62.5 micron: 12dB.
 - 3) Electrical Connection: 9-Pin Sub-D Socket.
 - 4) Optical Connection: Two BFOC Ports.
 - 5) Power:
 - a) Operating Voltage: 24V dc.
 - b) Operating Current: 0.1A.

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- 6) Environmental:
 - a) Operating Temperature Range: 0 to 60 degrees C.
 - b) Storage Temperature Range: Minus 40 to 70 degrees C.
 - c) Relative Humidity: 95 percent.
 - 7) Mounting: DIN-rail.
 3. Manufacturer and Product:
 - a) Siemens; PROFIBUS OLM/G12 V4.0, 6GK1503-3CB00.
 - b) No substitutions.
- N. Y200 Remote I/O System:
1. General:
 - a. Function: Rack-mounted input/output platform networked and assigned to a PLC system.
 - b. Platform Manufacturer and Series:
 - 1) Siemens; SIMATIC ET200M Series.
 - a) Individual component specifications and products are noted below.
 - 2) No substitutions.
 2. Components:
 - a. Communications Module:
 - 1) Function: Communications interface between RIO platform and PLC via network datalink.
 - 2) Connection: Profibus DP.
 - 3) IM153-1; 6ES7153-1AA03-0XB0.
 - b. Analog Inputs:
 - 1) SM 331, 6ES7331-7NF10-0AB0.
 - c. Analog Outputs.
 - 1) SM 332.
 - 2) 4 outputs in 4 channel groups.
 - 3) Programmable as voltage or current output.
 - 4) 16 bit resolution.
 - 5) Electrical isolated between:
 - a) Backplane bus and output channels.
 - b) Output channels.
 - d. Discrete Inputs:
 - 1) SM 321.
 - 2) 16 inputs, electrically isolated in groups of 4.
 - 3) Rated input voltage: 120/230V ac.
 - e. Discrete Outputs:
 - 1) SM 322.
 - 2) 8 outputs, electrically isolated in groups of 1.
 - 3) Rated load voltage: 24V dc to 120V dc, 48V ac to 230V ac.

- f. Rack Power Supply:
 - 1) Voltage: 24V dc.
 - 2) Current: 10A.
 - 3) PS 307, 6ES7307-1KA02-0AA0.

- O. Y400 Programmable Logic Controller System:
 - 1. General:
 - a. Function: Rack-mounted microprocessor-based controller for real-time processing of inputs and outputs.
 - b. Platform Manufacturer and Series:
 - 1) Siemens; SIMATIC S7-400 Series.
 - a) Individual component specifications and products are noted below.
 - 2) No substitutions.
 - 2. Products:
 - a. Central Processing Unit:
 - 1) Work Memory: 4MB.
 - 2) Communications Interface: PROFINET.
 - 3) Memory Card:
 - a) Type: Flash EPROM.
 - 4) CPU-400 Series.
 - b. Rack Power Supply:
 - 1) Voltage: 24V dc.
 - 2) Current: 4A.
 - 3) PS 405, 6ES7405-0DA02-0AA0.

END OF SUPPLEMENT

COMPONENT LIST					
DWG	TAG	QTY	Code	Description	Options (See P&IDs for Options, unless otherwise noted.)
N-001	SIPS-DW-PIT-01	1	P9	Pressure Transmitter, Electronic	Process Range: 0 - 60 psig
N-001	SIPS-DW-FE/FIT-01	1	F4	Flow Element and Transmitter, Electromagnetic	Fluid: Nonpotable Water. Meter Size: 24-inch. Liner: Ebonite Mounting: Remote transmitter. Process Range: 5,000 - 10,000 GPM. Include PROFIBUS DP Communication
N-001	SIPS-DW-CP-01	1	N/A	Control Panel Enclosure, Rack Mounted	Nominal Dimensions: 36"H X 36"W X 18" D. NEMA 4X, Type 316L SS, Powder-Coated White Finish Add interior panel light. Add 120V power receptacle.
N-001	SIPS-DW-RIO-01	1	Y200	Remote I/O System	Siemens SIMATIC ET200M Series. Profibus DP Communications Link.
N-001	SIPS-DW-FP-01	1	N/A	Analyzer Field Panel	Wall mounted plate. Install analyzer flow cells, transmitters, TJB, and associated electronics to plate. Nominal Dimensions: 96" H x 84" W.
N-001	SIPS-DW-AE/AIT-01	1	A31	Dissolved Oxygen Analyzer	Process Range: 0 - 20 ppm. Install manufacturer mounting plate for instrument and affix to SIPS-DW-FP-01 backplane. Provide Profibus DP communications option.

COMPONENT LIST					
DWG	TAG	QTY	Code	Description	Options (See P&IDs for Options, unless otherwise noted.)
N-001	SIPS-DW-PIT-01	1	P9	Pressure Transmitter, Electronic	Process Range: 0 - 60 psig
N-001	SIPS-DW-FE/FIT-01	1	F4	Flow Element and Transmitter, Electromagnetic	Fluid: Nonpotable Water. Meter Size: 24-inch. Liner: Ebonite Mounting: Remote transmitter. Process Range: 5,000 - 10,000 GPM. Include PROFIBUS DP Communication
N-001	SIPS-DW-AE/AIT-02	1	A37	pH and ORP Analyzer	Process Range: 0-14 (pH); -500mV-1500mV (ORP). Install manufacturer mounting plate for instrument and affix to SIPS-DW-FP-01 backplane. Provide Profibus DP communications option.
N-001	SIPS-DW-AE/AIT-03	1	A39	UV Transmittance Analyzer	Process Range: 0-100% UVT. Install manufacturer mounting plate for instrument and affix to SIPS-DW-FP-01 backplane. Provide Profibus DP communications option.
N-001	SIPS-DW-AE/AIT-04	1	A35	Turbidity Analyzer	Process Range: 0-10 NTU. Install manufacturer mounting plate for instrument and affix to SIPS-DW-FP-01 backplane. Provide Profibus DP communications option.
N-001	SIPS-DW-AE-05	1	A33	Microbial Analyzer	Wall mount to analyzer panel SIPS-DW-FP-01 backplane.

COMPONENT LIST					
DWG	TAG	QTY	Code	Description	Options (See P&IDs for Options, unless otherwise noted.)
N-001	SIPS-DW-PIT-01	1	P9	Pressure Transmitter, Electronic	Process Range: 0 - 60 psig
N-001	SIPS-DW-FE/FIT-01	1	F4	Flow Element and Transmitter, Electromagnetic	Fluid: Nonpotable Water. Meter Size: 24-inch. Liner: Ebonite Mounting: Remote transmitter. Process Range: 5,000 - 10,000 GPM. Include PROFIBUS DP Communication
N-001	SIPS-DW-FI-01, SIPS-DW-FI-02, SIPS-DW-FI-03	3	F16	Flow Element, Rotameter	Process Range: 0-5 gph. Wall mount to analyzer panel SIPS-DW-FP-01 backplane.
N-001	SIPS-DW-FI-04	1	F16	Flow Element, Rotameter	Process Range: 0-20 gph. Wall mount to analyzer panel SIPS-DW-FP-01 backplane.
N-001	SIPS-DW-FI-05	1	F16	Flow Element, Rotameter	Process Range: 0-1 gph. Wall mount to analyzer panel SIPS-DW-FP-01 backplane.
N-001	SIPS-DW-PI-01	1	P4	Pressure Gauge	Process Range: 0-15 psi.

COMPONENT LIST					
DWG	TAG	QTY	Code	Description	Options (See P&IDs for Options, unless otherwise noted.)
N-001	SIPS-DW-PIT-01	1	P9	Pressure Transmitter, Electronic	Process Range: 0 - 60 psig
N-001	SIPS-DW-FE/FIT-01	1	F4	Flow Element and Transmitter, Electromagnetic	Fluid: Nonpotable Water. Meter Size: 24-inch. Liner: Ebonite Mounting: Remote transmitter. Process Range: 5,000 - 10,000 GPM. Include PROFIBUS DP Communication
N-001	SIPS-DW-FSL-01	1	F52	Flow Switch, Thermal	Setpoint: 0.1 GPM. Include manufacturer's retractable assembly for removal of the device from the pipe tee without interrupting the process.
N-002	SIPS-RD-CP-01	1	N/A	Control Panel Enclosure, Wall Mounted	Nominal Dimensions: 24"H X 24"W X 18" D. NEMA 1, Mild Steel
N-002	SIPS-DW-RIO-01	1	Y400	Programmable Logic Controller	Siemens SIMATIC S7-400. Include specified CPU memory card. Profinet Communications Link.
N-001	SIPS-DW-UPS-01	1	Y51	Uninterruptible Power Supply	Mounted inside panel SIPS-DW-CP-01.
N-002	SIPS-RD-UPS-01	1	Y51	Uninterruptible Power Supply	Mounted inside panel SIPS-RD-CP-01.

COMPONENT LIST					
DWG	TAG	QTY	Code	Description	Options (See P&IDs for Options, unless otherwise noted.)
N-001	SIPS-DW-PIT-01	1	P9	Pressure Transmitter, Electronic	Process Range: 0 - 60 psig
N-001	SIPS-DW-FE/FIT-01	1	F4	Flow Element and Transmitter, Electromagnetic	Fluid: Nonpotable Water. Meter Size: 24-inch. Liner: Ebonite Mounting: Remote transmitter. Process Range: 5,000 - 10,000 GPM. Include PROFIBUS DP Communication
N-002	SIPS-DW-OLM-01	1	Y88	Optical Link Module - Profibus DP	Mounted inside panel SIPS-DW-CP-01.
N-002	SIPS-DW-OLM-02	1	Y88	Optical Link Module - Profibus DP	Mounted inside existing Deerwood III WTP PLC control panel.

Surge Suppressor Products Table

SS Type	Application	Enclosure/ Mounting	Manufacturer/ Model	Principle of Operation/ Performance Criteria	Comments/ Performance Criteria
1	Protect 120V ac, single-phase power in control panels	NEMA Rating: None Locate inside control panel or instrument enclosure	Citel; DS42S-120	MOV; 40kA Surge Current Rating	Nominal Amp Capacity: 20A; provide parallel units if needed
2	Protect analog signals within control panels	NEMA Rating: None Locate inside panel	Citel; DLAW-24D3	Electrode Gas Tube	Nominal discharge surge current when subject to 8/20 wave form testing: 5kA per path
3	Analog signal of 2-wire transmitters	Field installed in stainless steel pipe nipple adjacent to 2-wire transmitter	Phoenix Contact, S-PT1-2PE-24DC; or approved equal.	Two-Stage 1) Gas-filled electrode 2) Suppressor Diode	Nominal discharge current when subject to 8/20 waveform: 10kA
4	RS-485 Network Signals (PROFIBUS-DP)	NEMA Rating: NEMA 4X Field installed; adjacent to 4-wire transmitter	Citel; DLA-12DBC	Electrode Gas Tube	

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INSTRUMENT CALIBRATION SHEET

Rev.06.05.92

COMPONENT			MANUFACTURER				PROJECT				
Code:			Name:				Number:				
Name:			Model:				Name:				
			Serial #:								
FUNCTIONS											
	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? Y / N			CONTROL? Y / N				
Indicate? Y / N	Chart:			Describe:			Action? direct / reverse				
Record? Y / N	Scale:						Modes? P / I / D				
Transmit/ Convert? Y / N	Input:						SWITCH? Y / N				
	Output:						Unit Range:				
							Differential: fixed/adjustable				
							Reset? automatic / manual				
ANALOG CALIBRATIONS						DISCRETE CALIBRATIONS					Note No.
REQUIRED			AS CALIBRATED			REQUIRED			AS CALIBRATED		
Input	Indicated	Output	Increasing Input		Decreasing Input		Number	Trip Point	Reset Pt.	Trip Point	Reset Pt.
			Indicated	Output	Indicated	Output		(note rising or falling)		(note rising or falling)	
							1.				
							2.				
							3.				
							4.				
							5.				
							6.				
CONTROL MODE SETTINGS:			P:	I:	D:		7.				
#	NOTES:								Component Calibrated and Ready for Startup		
									By:		
									Date:		
									Tag No.:		

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INSTRUMENT CALIBRATION SHEET
EXAMPLE - ANALYZER/TRANSMITTER

Rev.06.05.92

COMPONENT			MANUFACTURER				PROJECT				
Code: A7			Name: Leeds & Northrup				Number: WDC30715.B2				
Name: pH Element & Analyzer/Transmitter			Model: 12429-3-2-1-7				Name: UOSA AWT PHASE 3				
			Serial #: 11553322								
FUNCTIONS											
Indicate? Y Record? N	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? N			CONTROL? N				
	Chart:			Describe:			Action? direct / reverse Modes? P / I / D				
Transmit/ Convert? Y	Scale:	1-14	pH units				SWITCH? N				
	Input:	1-14	pH units				Unit Range: Differential: fixed/adjustable				
	Output:	4-20	mA dc				Reset? automatic / manual				
ANALOG CALIBRATIONS						DISCRETE CALIBRATIONS					Note No
REQUIRED			AS CALIBRATED			REQUIRED			AS CALIBRATED		
Input	Indicated	Output	Increasing Input		Decreasing Input		Number	Trip Point	Reset Pt.	Trip Point	Reset Pt.
			Indicated	Output	Indicated	Output					
1.0	1.0	4.0	1.0	4.0	1.0	3.9	1.	N.A.		N.A.	
2.3	2.3	5.6	2.2	5.5	2.3	5.6	2.				
7.5	7.5	12.0	7.5	11.9	7.5	12.0	3.				
12.7	12.7	18.4	12.7	18.3	12.6	18.3	4.				
14.0	14.0	20.0	14.0	20.0	14.0	20.0	5.				
CONTROL MODE SETTINGS:			P: N.A.	I:	D:		6.				
#	NOTES:										Component Calibrated and Ready for Startup By: J.D. Sewell Date: Jun-6-92 Tag No.: AIT-12-6[pH]
	1. Need to recheck low pH calibration solutions.										

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I&C VALVE ADJUSTMENT SHEET

Rev.06.05.92

PARTS	Project Name:		Project Number:		
Body	Type:		Mfr:		
	Size:		Model:		
	Line Connection:		Serial #:		
Operator	Type:		Mfr:		
	Action:		Model:		
	Travel:		Serial #:		
Positioner	Input Signal:		Mfr:		
	Action:		Model:		
	Cam:		Serial #:		
Pilot Solenoid	Action:		Mfr:		
	Rating:		Model:		
			Serial #:		
I/P Converter	Input:		Mfr:		
	Output:		Model:		
	Action:		Serial #:		
Position Switch	Settings:		Mfr:		
	Contacts:		Model:		
			Serial #:		
Power Supply	Type:		Air Set Mfr:		
	Potential:		Model:		
			Serial #:		
ADJUSTMENTS	Initial	Date	VERIFICATION	Initial	Date
Air Set			Valve Action		
Positioner			Installation		
Position Switches			Wire Connection		
I/P Converter			Tube Connection		
Actual Speed					
REMARKS:				Valve Ready for Startup	
				By:	
				Date:	
				Tag No.:	

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I&C VALVE ADJUSTMENT SHEET
EXAMPLE

Rev.06.05.92

PARTS	Project Name: <i>SFO SEWPCP</i>		Project Number: <i>SFO10145.G2</i>		
Body	Type: <i>Vee-Ball</i>		Mfr: <i>Fisher Controls</i>		
	Size: <i>4-inch</i>		Model: <i>1049763-2</i>		
	Line Connection: <i>159 # ANSI Flanges</i>		Serial #: <i>1003220</i>		
Operator	Type: <i>Pneumatic Diaphragm</i>		Mfr: <i>Fisher Controls</i>		
	Action: <i>Linear - Modulated</i>		Model: <i>4060D</i>		
	Travel: <i>3-inch</i>		Serial #: <i>2007330</i>		
Positioner	Input Signal: <i>3-15 psi</i>		Mfr: <i>Fisher Controls</i>		
	Action: <i>Direct - air to open</i>		Model: <i>20472T</i>		
	Cam: <i>Equal percentage</i>		Serial #: <i>102010</i>		
Pilot Solenoid	Action:		Mfr:		
	Rating: <i>None</i>		Model:		
			Serial #:		
I/P Converter	Input: <i>4-20 mA dc</i>		Mfr: <i>Taylor</i>		
	Output: <i>3-15 psi</i>		Model: <i>10-T-576-3</i>		
	Action: <i>Direct</i>		Serial #: <i>1057-330</i>		
Position Switch	Settings: <i>Closed / Open 5 deg, rising</i>		Mfr: <i>National Switch</i>		
	Contacts: <i>Close / Close</i>		Model: <i>1049-67-3</i>		
			Serial #: <i>156 & 157</i>		
Power Supply	Type: <i>Pneumatic</i>		Air Set Mfr: <i>Air Products</i>		
	Potential: <i>40 psi</i>		Model: <i>3210D</i>		
			Serial #: <i>1107063</i>		
ADJUSTMENTS	Initial	Date	VERIFICATION	Initial	Date
Air Set	<i>JDS</i>	<i>Jun-06-92</i>	Valve Action	<i>JDS</i>	<i>Jun-03-92</i>
Positioner	<i>JDS</i>	<i>Jun-06-92</i>	Installation	<i>JDS</i>	<i>Jun-03-92</i>
Position Switches	<i>JDS</i>	<i>Jun-06-92</i>	Wire Connection	<i>JDS</i>	<i>Jun-04-92</i>
I/P Converter	<i>JDS</i>	<i>Jun-07-92</i>	Tube Connection	<i>JDS</i>	<i>Jun-04-92</i>
Actual Speed	<i>JDS</i>	<i>Jun-07-92</i>			
REMARKS: <i>Valve was initially installed backwards.</i>				Valve Ready for Startup	
<i>Observed to be correctly installed May-25-92</i>				By: <i>J.D. Sewell</i>	
				Date: <i>Jun-07-92</i>	
				Tag No.: <i>FCV-10-2-1</i>	

**DRAWINGS
(BOUND SEPARATELY)**
