



ADDENDUM NO. 1

DATE: February 18, 2025
PROJECT: Ouachita Water Treatment Plant Waste Residual Lagoons
Hot Springs, Arkansas

BID DATE: February 24, 2025, 2:00 PM

This Addendum forms a part of the Contract Documents and modifies the original documents provided to Bidders, as noted below. Acknowledge receipt of this Addendum in the space provided in the BID FORM. Failure to do so may subject the Bidder to disqualification.

Item No. 1. Specifications – Section 260500:

A. See added specification Section 260500: Common Work Results for Electrical.

Item No. 2. Specifications – Section 261230:

A. See added specification Section 261230: 600 -Volt or Less Wires and Cables.

Item No. 3. Specifications – Section 261300:

A. See added specification Section 261300: Conduits.

Item No. 4. Specifications – Section 261330:

A. See added specification Section 261330: Duct Banks.

Item No. 5. Specifications – Section 261500:

A. See added specification Section 261500: Low Voltage Wire Connections .

Item No. 6. Specifications – Section 262850:

A. See added specification Section 262850: Surge Protection Devices.

Item No. 7. Drawings – Cover Page:

A. See revised Cover Page.

Item No. 8. Drawings – Sheet 26:

- A. See revised Sheet 26 Detail A Hydromatic Duplex Grinder Pump.
- B. See additional Detail D - AV Flow Meter.

Item No. 9. Drawings – Sheet E1:

- A. See added Sheet E1.

Item No. 10. Drawings – Sheet E2:

- A. See added Sheet E2.

Item No. 11. Drawings – Sheet E3:

- A. See added Sheet E3.

Item No. 12. Drawings – Sheet E4:

- A. See Added Sheet E4.

Item No. 13. Informational Purposes:

- A. The geotechnical investigation of the site is available per request for informational purposes only.

END OF ITEMS

All other provisions of the Contract Documents remain unchanged. Acknowledge receipt of this addendum on the Bid Form. Bids will be received at Hot Springs City Hall in the Board Chambers, 133 Convention Boulevard, Hot Springs, AR 71901 until 2:00 PM February 24, 2025.



Matthew D. Dunn, PE (Crist Engineers, Inc.)

2/18/25

Date

SECTION 260500

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. General requirements applicable to all Electrical Work.
2. General requirements for electrical submittals.
3. Interfaces to equipment, instruments, and other components:
4. The Drawings, Specifications, and overall design are based on preliminary information furnished by various equipment manufacturers which identify a minimum scope of supply from the manufacturers. This information pertains to, but is not limited to, instruments, control devices, electrical equipment, packaged mechanical systems, and control equipment provided with mechanical systems.
5. Provide all material and labor needed to install the actual equipment furnished, and include all costs to add any additional conduit, wiring, terminals, or other electrical hardware to the Work, which may be necessary to make a complete, functional installation based on the actual equipment furnished:
 - a. Make all changes necessary to meet the manufacturer's wiring requirements.
 - b. Submit all such changes and additions to the Engineer for acceptance.
6. Review the complete set of Drawings and Specifications in order to ensure that all items related to the electrical power and control systems are completely accounted for. Include any such items that appear on the Drawings or in the Specifications from another discipline in the scope of Work:
 - a. If a conflict between Drawings and Specifications is discovered, refer conflict to the Engineer as soon as possible for resolution.
7. Loop drawings:
 - a. Provide all electrical information required in the preparation of loop drawings including, but not limited to:
 - 1) Conduit numbers and associated signal(s) contained within each conduit.
 - 2) Wire numbers.
 - 3) Equipment terminal numbers.
 - 4) Junction boxes and signal(s) contained within each junction box.
 - 5) Equipment power sources, and associated circuit numbers.
 - 6) As-built drawings detailing wiring.

- B. All electrical equipment and systems for the entire Project must comply with the requirements of the Electrical Specifications, whether referenced in the individual Equipment Specifications or not:
 - 1. The requirements of the Electrical Specifications apply to all Electrical Work specified in other sections.
 - 2. Inform all vendors supplying electrical equipment or systems of the requirements of the Electrical Specifications.
 - 3. Owner is not responsible for any additional costs due to the failure of Contractor to notify all subcontractors and suppliers of the Electrical Specifications requirements.
- C. Contract Documents:
 - 1. General:
 - a. The Drawings and Specifications are complementary and are to be used together in order to fully describe the Work.
 - 2. Specifications:
 - a. The General and Supplementary Conditions of the Contract Documents govern the Work.
 - b. These requirements are in addition to all General Requirements.
 - 3. Contract Drawings:
 - a. The Electrical Drawings show desired locations, arrangements, and components of the Electrical Work in a diagrammatic manner.
 - b. Locations of equipment, control devices, instruments, boxes, panels, etc. are approximate only; exercise professional judgment in executing the Work to ensure the best possible installation:
 - c. The equipment locations and dimensions indicated on the Drawings are approximate. Use the shop drawings to determine the proper layout, foundation, and pad requirements, etc. for final installation. Coordinate with all subcontractors to ensure that all electrical equipment is compatible with other equipment and space requirements. Make changes required to accommodate differences in equipment dimensions.
 - d. The Contractor has the freedom to select any of the named manufacturers identified in the individual specification sections; however, the Engineer has designed the spatial equipment layout based upon a single manufacturer and has not confirmed that every named manufacturer's equipment fits in the allotted space. It is the Contractor's responsibility to ensure that the equipment being furnished fits within the defined space.
 - e. Installation details:
 - 1) The Contract Drawings include typical installation details the Contractor is to use to complete the Electrical Work. For cases where a typical detail does not apply, develop installation details that may be necessary for completing the Work, and submit these details for review by the Engineer.
 - 2) Not all typical installation details are referenced within the Drawing set. Apply and use typical details where appropriate.
 - 4. Schematic diagrams:

- a. All controls are shown de-energized.
- b. Schematic diagrams show control function only. Incorporate other necessary functions for proper operation and protection of the system.
- c. Add slave relays, where required, to provide all necessary contacts for the control system or where needed to function as interposing relays for control voltage coordination, equipment coordination, or control system voltage drop considerations.
- d. Mount all devices shown on motor controller schematic diagrams in the controller compartment enclosure, unless otherwise noted or indicated.
- e. Schematic diagrams are to be used in conjunction with the descriptive operating sequences in the Contract Documents. Combine all information and furnish a coordinated and fully functional control system.

1.2 REFERENCES

A. Code compliance:

- 1. As specified in the section for Regulatory Requirements.
The publications are referred to in the text by the basic designation only. The latest edition accepted by the Authority Having Jurisdiction of referenced publications in effect at the time of the bid governs.
- 2. The standards listed are hereby incorporated into this Section.
 - a. American National Standards Institute (ANSI).
 - b. American Society of Civil Engineers (ASCE):
 - c. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
 - d. ASTM International (ASTM).
 - e. Illuminating Engineering Society (IES).
 - f. Institute of Electrical and Electronics Engineers (IEEE).
 - g. Insulated Cable Engineers Association (ICEA).
 - h. International Code Council (ICC):
 - i. International Code Council Evaluation Service (ICC-ES).
 - j. AC 156 - Acceptance Criteria for Seismic Certification by Shake Table Testing of Non-Structural Components (ICC-ES AC 156).
 - k. International Society of Automation (ISA).
 - l. National Electrical Manufacturers Association (NEMA):
 - m. 250 - Enclosures for Electrical Equipment (1000 V Maximum).
 - n. National Fire Protection Association (NFPA):
 - o. 70 - National Electrical Code (NEC).
 - p. National Institute of Standards and Technology (NIST).
 - q. Underwriters' Laboratories, Inc. (UL).
 - r. Compliance with laws and regulations: As specified in Document 00700 - General Conditions.

1.3 DEFINITIONS

A. Definitions of terms and other electrical and instrumentation considerations as set forth by:

1. IEEE.
2. NETA.
3. IES.
4. ISA.
5. NEC.
6. NEMA.
7. NFPA.
8. NIST.
9. Specific definitions:
10. FAT: Factory acceptance test.
11. LCS: Local Control Station
12. ICSC: Instrumentation and controls subcontractor.
13. LCP: Local control panel: Operator interface panel that may contain an HMI, pilot type control devices, operator interface devices, control relays, etc. and does not contain a PLC or RIO.
14. PCM: Process control module: An enclosure containing any of the following devices: PLC, RTU, or RIO.
15. PCIS: Process control and instrumentation system.
16. RTU: Remote telemetry unit: A controller typically consisting of a PLC, and a means for remote communications. The remote communications devices typically are radios, modems, etc.
17. Space: That portion of the switchgear, motor control center, panelboard, switchboard or control panel that does not physically contain a device but is capable of accepting a device with no modifications to the equipment, i.e., provide all standoffs, bus, and hardware, as part of the space.
18. Spare: That portion of the switchgear, motor control center, panelboard, switchboard or control panel that physically contains a device with no load connections to be made.
19. VCP: Vendor control panel: Control panels that are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, OIT, HMI, etc.
20. Unequipped space: That portion of the switchgear, motor control center, panelboard, switchboard or control panel that does not physically contain a device, standoff, bus, hardware, or other equipment.

1.4 SYSTEM DESCRIPTION

A. General requirements:

1. The Work includes everything necessary for and incidental to executing and completing the Electrical Work indicated on the Drawings and specified in the Specifications and reasonably inferable there from:
 - a. The Electrical Drawings are schematic in nature; use the Structural, Architectural, Mechanical, and Civil Drawings for all dimensions and scaling purposes.

2. It is the intent of these Specifications that the entire electrical power, instrumentation, and control system be complete and operable. Provide all necessary material and labor for the complete system from source of power to final utilization equipment, including all connections, testing, calibration of equipment furnished by others as well as equipment furnished by the Contractor, whether or not specifically mentioned but which are necessary for successful operation.
3. Provide all Electrical Work, including conduit, field wiring, and connections by the electrical subcontractor under the provisions of the Electrical Specifications for all aspects of the Work.
4. Coordinate all aspects of the Work with the electrical subcontractor and other subcontractors before bidding in order to ensure that all costs associated with a complete installation are included. The Owner is not responsible for any change orders due to lack of coordination of the Work between the Contractor, the electrical subcontractor, the other subcontractors or suppliers.
5. Portions of this Project involve installation in existing facilities and interfaces to existing circuits, power systems, controls, and equipment:
 - a. Perform and document comprehensive and detailed field investigations of existing conditions (circuits, power systems, controls, equipment, etc.) before starting any Work. Determine all information necessary to document, interface with, modify, upgrade, or replace existing circuits, power systems, controls, and equipment.
 - b. Provide and document interface with, modifications to, upgrades, or replacement of existing circuits, power systems, controls, and equipment.
 - c. Provide all trenching, forming, rebar, concrete, back filling, hard surface removal and replacement, for all items associated with the Electrical Work and installation:
 - 1) As specified in the Contract Documents.

B. Operating facility:

1. The Facility is an operating facility. Portions of this facility must remain fully functional throughout the entire construction period. In consideration of this requirement, comply with the following guidelines:
 - a. All outages must be of minimal duration and fully coordinated and agreed to by the Owner. Adjust the construction schedule to meet the requirements of the Owner. All changes in schedule and any needs to reschedule are included in the Work.
 - b. As weather and water demand conditions dictate, re-adjust the construction schedule to meet the demands placed upon Owner by its users.
 - c. Coordinate the construction and power renovation, bear all costs, so that all existing facilities can continue operation throughout construction.
 - d. According to individual circumstances and in compliance with the Drawings, extend or replace conduit and cable connections from existing locations.
 - e. The standards of documentation, instrument tagging, cable and conductor ferruling, terminal identification and labeling that apply to the new installation apply equally to the existing installation which forms part of the modified system.

1.5 SUBMITTALS

A. General:

1. Instruct all equipment suppliers of submittals and operation and maintenance manuals of the requirements in this Section.
 2. Furnish the submittals required by each section in the Electrical Specifications.
 3. Adhere to the wiring numbering scheme specified in the section for Identification for Electrical Systems throughout the Project:
 4. Uniquely number each wire.
 5. Wire numbers must appear on all Equipment Drawings.
 6. Use equipment and instrument tags, as indicated on the Drawings, for all submittals.
- B. Seismic requirements:
1. Provide electrical equipment with construction and anchorage to supporting structures designed to resist site seismic loads based on the seismic design criteria in Specifications.
 2. For equipment installed in structures designated as seismic design category C, D, E or F, prepare and submit the following:
 - a. Statement of seismic qualification, and special seismic certification:
 - 1) "Statement of seismic qualification:" Provide manufacturer's statement that the equipment satisfies the seismic design requirements of the building code indicated in the section for Regulatory Requirements, including the requirements of ASCE 7, Chapter 13.
 - 2) "Special seismic certification:" Provide manufacturer's certification that the equipment, when subjected to shake table testing in accordance with ICC-ES AC 156, meets the "Post-Test Functional Compliance Verification" requirements of ICC-ES AC 156 for "Components with $I_p = 1.5$." Compliance shall include both operability and containment of hazardous materials as appropriate to the unit being tested.
 - b. Substantiating test data: With seismic qualification and special seismic certification statements, submit results of testing in accordance with ICC-ES AC 156.
 - c. Anchoring design calculations and details:
 - 1) Submit project-specific drawings and supporting calculations, prepared and sealed by a professional engineer licensed in the state where the Project is being constructed, and showing details for anchoring electrical equipment to its supports and for anchoring supports provided with the equipment to the structure. Prepare calculations in accordance with the requirements of the section for Seismic Design Criteria.
 - 2) Exemptions: A "statement of seismic qualification" and a "special seismic certification" are not required for the following equipment:
 - d. Temporary or moveable equipment.
 - 1) Equipment anchored to the structure and having a total weight of 20 pounds or less.
 - 2) Distribution equipment anchored to the structure and having a total unit weight of 3 pounds per linear foot, or less.
- C. Submittal organization:
1. First page:
 - a. Specification section reference.

- b. Name and telephone number of individual who reviewed submittal before delivery to Engineer.
 - c. Name and telephone number of individual who is primarily responsible for the development of the submittal.
 - d. Place for Contractor's review stamp and comments.
2. Next pages:
- a. Provide confirmation of specification compliance:
 - 1) Specification section: Include with each submittal a copy of the relevant specification section.
 - 2) Indicate in the left margin, next to each pertinent paragraph, either compliance with a check (✓) or deviation with a consecutive number (1, 2, 3).
 - 3) Provide a list of all numbered deviations with a clear explanation and reason for the deviation.
 - b. Include a response in writing to each of the Engineer's comments or questions for submittal packages which are re-submitted:
 - 1) In the order that the comments or questions were presented throughout the submittal.
 - 2) Referenced by index section and page number on which the comment appeared.
 - c. Acceptable responses to Engineer's comments are either:
 - 1) Engineer's comment or change is accepted and appropriate changes are made.
 - 2) Explain why comment is not accepted or requested change is not made.
 - 3) Explain how requirement will be satisfied in lieu of comment or change requested by Engineer.
 - d. Any re-submittal, which does not contain responses to the Engineer's previous comments shall be returned for Revision and Re-submittal.
 - e. No further review by the Engineer will be performed until a response for previous comments has been received.
3. Remaining pages:
- a. Actual submittal data:
 - 1) Organize submittals in exactly the same order as the items are referenced, listed, and/or organized in the specification section.
 - 2) For submittals that cover multiple devices used in different areas under the same specification section, the submittal for the individual devices must list the area where the device is intended to be used.

D. Submittal requirements:

- 1. Furnish submittals that are fully indexed with a tabbed divider for every component.
- 2. Sequentially number pages within the tabbed sections. Submittals and operation and maintenance manuals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.
- 3. Edit all submittals and operation and maintenance manuals so that the submittal specifically applies to only the equipment furnished.

4. Neatly cross out all extraneous text, options, models, etc. that do not apply to the equipment being furnished, so that the information remaining is only applicable to the equipment being furnished.
5. Submit copies of shop drawings, and product data:
 - a. Show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers, and all other pertinent details.
6. Where submittals are required, provide a separate submittal for each specification section. In order to expedite construction, the Contractor may make more than 1 submittal per specification section, but a single submittal may not cover more than 1 specification section:
 - a. The only exception to this requirement is when 1 specification section covers the requirements for a component of equipment specified in another section. (For example, circuit breakers are a component of switchgear. The switchgear submittal must also contain data for the associated circuit breakers, even though they are covered in a different specification section.)
7. Exceptions to Specifications and Drawings:
 - a. Include a list of proposed exceptions to the Specifications and Drawings along with a detailed explanation of each.
 - b. If there is insufficient explanation for the exception or deviation, the submittal will be returned requiring revision and re-submittal.
 - c. Acceptance of any exception is at the sole discretion of the Engineer.
 - d. Provide all items (materials, features, functions, performance, etc.) required by the Contract Documents that are not accepted as exceptions.
 - e. Replace all items that do not meet the requirements of the Contract Documents, which were not previously accepted as exceptions, even if the submittals contained information indicating the failure to meet the requirements.
8. Specific submittal requirements:
 - a. Shop drawings:
 - 1) Required for materials and equipment listed in this and other sections.
 - 2) Furnish sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these Specifications.
 - 3) Shop drawings requirements:
 - a) Front, side, and, rear elevations, and top and bottom views, showing all dimensions.
 - b) Locations of conduit entrances and access plates.
 - c) Component layout and identification.
 - d) Schematic and wiring diagrams with wire numbers and terminal identification.
 - e) Connection diagrams, terminal diagrams, internal wiring diagrams, conductor size, etc.
 - f) Anchoring method and leveling criteria, including manufacturer's recommendations for the Project site seismic criteria.
 - g) Weight.

- Common Work Results for Electrical
February 4, 2025

1. Provide Record Documents of all Electrical Drawings.
 2. Record Drawing requirements:
 - a. Update Record Drawings weekly.
 - b. Record Drawings must be fully updated as a condition of the monthly progress payments.
 - c. Submit Record Drawings upon completion of the Work for final review.
 - d. Clearly and neatly show all changes including the following:
 - 1) All existing pipe, conduit, wire, instruments or other structures encountered or uncovered during construction.
 3. Shop drawings:
 - a. Upon completion of the Work, update all shop drawings to indicate the final as-built configuration of the systems:
 - b. Provide as-built shop drawings for all electrical equipment on 11-inch by 17-inch paper.
 - c. Size all drawings to be readable and legible on 11-17-inch media.
 - d. Provide electronic copies of these documents on CD-ROM or DVD disks in PDF format.
 4. Review and corrections:
 - a. Correct any record documents or other documents found to be incomplete, not accurate, of poor quality, or containing errors.
 - b. Promptly correct and re-submit record documents returned for correction.
- J. Test reports:
1. Include the following:
 - a. A description of the test.
 - b. List of equipment used.
 - c. Name of the person conducting the test.
 - d. Date and time the test was conducted.
 - e. All raw data collected.
 - f. Calculated results.
 2. Each report signed by the person responsible for the test.
 3. Additional requirements for field acceptance test reports are specified in the section for Field Electrical Acceptance Tests.
- K. Calculations:
1. Where required by specific Electrical Specifications:
 - a. Because these calculations are being provided by a registered professional engineer, they will be reviewed for form, format, and content but will not be reviewed for accuracy and calculation means.

1.6 QUALITY ASSURANCE

- A. Furnish all equipment listed by and bearing the label of UL or of an independent testing laboratory acceptable to the Engineer and the Authority Having Jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. As specified in the section for Product Requirements.
- B. Shipping precautions:
 - 1. After completion of shop assembly and successful factory testing, pack all equipment in protective crates, and enclose in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture.
 - 2. Place dehumidifiers, when required, inside the polyethylene coverings.
 - 3. Skid-mount the equipment for final transport.
 - 4. Provide lifting rings for moving without removing protective covering.
 - 5. Display boxed weight on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.
- C. Delivery and inspection:
 - 1. Deliver products in undamaged condition, in manufacturer's original container or packaging with identifying labels intact and legible. Include date of manufacture on label.
- D. Special instructions:
 - 1. Securely attach special instructions for proper field handling, storage, and installation to each piece of equipment before packaging and shipment.

1.8 PROJECT OR SITE CONDITIONS

- A. Site conditions:
 - 1. Provide an electrical, instrumentation and control system, including all equipment, raceways, and any other components required for a complete installation that meets the environmental conditions for the Site as specified in the General Requirements and below.
 - 2. Seismic load resistance:
 - a. Provide electrical equipment with construction and anchorage to supporting structures designed to resist site seismic loads as specified in Specifications.
 - 3. Wind load resistance:
 - a. Provide electrical equipment with construction and anchorage to supporting structures designed to resist site wind loads as specified in Specifications.
 - 4. Altitude, temperature and humidity:
 - a. As specified in Specifications.
 - b. Provide all electrical components and equipment fully rated for continuous operation at this altitude, with no additional derating factors applied.
 - c. Provide additional temperature conditioning equipment to maintain all equipment in non-conditioned spaces subject to these ambient temperatures, with a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature, as determined by the equipment manufacturer's guidelines:
 - d. Provide all power conduits wiring for these devices (e.g. heaters, fans, etc.) whether indicated on the Drawings or not.
 - 5. Outdoor installations:

- a. Provide electrical, instrumentation and control equipment suitable for operation in the ambient conditions where the equipment is located.
- b. Provide heating, cooling, and dehumidifying devices incorporated into and included with electrical equipment, instrumentation and control panels to maintain the enclosures within the rated environmental operating ranges as specified in this Section for the equipment:
- c. Provide all wiring necessary to power these devices.
- d. Provide enclosures for electrical, instrumentation and control equipment, regardless of supplier or subcontractor furnishing the equipment, that meet the requirements outlined in NEMA Standard 250 for the following types of enclosures:
 - 1) NEMA Type 1: Intended for indoor use, primarily to provide a degree of protection from accidental contact with energized parts or equipment.
 - 2) NEMA Type 4: Intended for indoor or outdoor use, primarily to protect equipment from exposure to windblown dust and rain, splashing or hose directed water, ice formation and freezing.
 - 3) NEMA Type 4X: Made from corrosion resistant materials and are intended for indoor or outdoor use, primarily to protect equipment from exposure to windblown dust and rain, splashing or hose directed water, ice formation and freezing, and corrosion. Provide specific materials as specified or indicated on the Drawings.
 - 4) NEMA Type 12: Intended for indoor use, primarily to provide a degree of protection from dust, falling dirt and dripping non-corrosive liquids.
 - 5) NEMA Type 7: Intended for installation in locations where explosive or combustible gas or vapors may be present (Class I Division 1 or Class I Division 2) meeting the requirements outlined in the section for Hazardous Classified Area Construction.

6. Plant area Electrical Work requirements:

- a. Provide all Electrical Work in accordance with the following table, unless otherwise specifically indicated on the Drawings:

PLANT AREA	NEMA ENCLOSURE TYPE	EXPOSED CONDUIT TYPE	ENVIRONMENT W = WET D = DAMP C = CLEAN/DRY X = CORROSIVE H = HAZARDOUS	SUPPORT MATERIALS
Indoor Conditioned Spaces	NEMA 1	Galvanized rigid steel	C	Stainless steel
Above lay-in ceilings	NEMA 1	EMT	C	Stainless steel
Indoor Non-Conditioned Spaces	NEMA 1	Galvanized rigid steel	C	Stainless steel
Below Grade/Vault	NEMA Type 7	Galvanized rigid steel	H	Stainless steel
Outdoor	NEMA 3R	Galvanized rigid steel	W	Stainless steel

PLANT AREA	NEMA ENCLOSURE TYPE	EXPOSED CONDUIT TYPE	ENVIRONMENT W = WET D = DAMP C = CLEAN/DRY X = CORROSIVE H = HAZARDOUS	SUPPORT MATERIALS
Classified Areas	NEMA Type 7	Galvanized rigid steel	H	Stainless steel

Modify exposed conduit runs as specified in the section for Conduits.

1.9 SEQUENCING (NOT USED)

1.10 SCHEDULING

A. General:

1. Testing requirements are specified in the section for Field Electrical Acceptance Tests and other sections.

B. Pre-submittal conference:

1. Before producing any submittals, schedule a pre-submittal conference for the purposes of reviewing the entire Project, equipment, control philosophy, schedules, and submittal requirements.
2. Contractor, electrical subcontractor, all suppliers, and individual equipment manufacturers furnishing major pieces of equipment must attend.

C. Factory acceptance testing (FAT):

1. Where FAT is required for equipment covered by these Specifications, notify the Engineer in writing when the equipment is completed and ready for factory inspection and testing:
2. Indicate the desired dates for inspection and testing.
3. Schedule the FAT after approval of the FAT procedures submittal:
 - a. Submit a copy of the test procedures including all forms at least 21 days before any scheduled test date.
 - b. Notify the Engineer of the scheduled tests a minimum of 15 days before the date of the test.

1.11 WARRANTY

- A. Warrant the Electrical Work as specified in General Conditions:
- B. Provide additional warranty as specified in the individual Electrical Specifications.

1.12 SYSTEM START-UP

- A. Replace or modify equipment, software, and materials that do not achieve design requirements after installation in order to attain compliance with the design requirements:
- B. Following replacement or modification, retest the system and perform additional testing to place the complete system in satisfactory operation and obtain compliance acceptance from the Engineer.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE

- A. Before Substantial Completion, perform all maintenance activities required by any sections of the Specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems in service.
- B. Furnish all spare parts as required by other sections of the Specifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Provide similar items of same manufacturer throughout the electrical and instrumentation portion of the Project.
- B. Allowable manufacturers are specified in individual Electrical Specifications.

2.2 EXISTING PRODUCTS (NOT USED)

2.3 MATERIALS

- A. Furnish all materials under this Contract that are new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these products and that bear all approvals and labels as required by the Specifications.
- B. Provide materials complying with the applicable industrial standard as specified in General Conditions.
- C. Stainless steel:
 - 1. Where stainless steel is indicated or used for any portion of the Electrical Work, provide a non-magnetic, corrosion-resistant alloy, ANSI Type 316, satin finish.
 - 2. Provide exposed screws of the same alloys.
 - 3. Provide finished material free of any burrs or sharp edges.
 - 4. Use only stainless steel hardware, when chemically compatible, in all areas that are or could be in contact with corrosive chemicals.
 - 5. Use stainless steel hardware, when chemically compatible, in all chemical areas or areas requiring NEMA Type 4X construction.
 - 6. Do not use stainless steel in any area containing chlorine, gas or solution, chlorine products or ferric chloride.

2.4 MANUFACTURED UNITS (NOT USED)

2.5 EQUIPMENT (NOT USED)

2.6 COMPONENTS (NOT USED)

2.7 ACCESSORIES (NOT USED)

2.8 MIXES (NOT USED)

2.9 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

- A. Provide all equipment that is new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these products.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The electrical subcontractor is encouraged to visit the site to examine the premises completely before bidding.
- B. **Review the site conditions and examine all shop drawings for the various items of equipment in order to determine exact routing and final terminations for all wiring and cables.**
- C. It is the electrical subcontractor's responsibility to be fully familiar with the existing conditions and local requirements and regulations.
- D. Comply with pre-bid conference requirements as specified in Instructions to Bidders.

3.2 PREPARATION (NOT USED)

3.3 INSTALLATION

- A. Equipment locations shown on Electrical Drawings may change due to variations in equipment size or minor changes made by others during construction:
- B. Verify all dimensions indicated on the Drawings:
 - 1. Actual field conditions govern all final installed locations, distances, and levels.
- C. Review all Contract Documents and approved equipment shop drawings and coordinate Work as necessary to adjust to all conditions that arise due to such changes.
- D. Make minor changes in location of equipment before rough in, as directed by the Owner or Engineer.
- E. Provide a complete electrical system:
 - 1. Install all extra conduits, cables, and interfaces as may be necessary to provide a complete and operating electrical system.
 - 2. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.
- F. Cutting and patching:
 - 1. Perform all cutting, patching, channeling, core drilling, and fitting required for the Electrical Work, except as otherwise directed:
 - 2. Secure the permission of the Engineer before performing any operation likely to affect the strength of a structural member such as drilling, cutting or piercing:
 - 3. Before cutting, channeling, or core drilling any surface, ensure that no penetration of any other systems will be made:
 - a. Verify that area is clear and free of conduits, cables, piping, ductwork, post-tensioning cables, etc.
 - b. Use tone-locate system or X-ray to ensure that area is clear of obstructions.
 - c. Review the complete Drawing set to ensure that there are no conflicts or coordination problems before cutting, channeling, or core drilling any surface.

4. Perform all patching to the same quality and appearance as the original work. Employ the proper tradesmen to secure the desired results. Seal around all conduits, wires, and cables penetrating walls, ceilings, and floors in all locations with a fire stop material, typically:
 - a. 3M: CP 25WB+: Caulk.
 - b. 3M: Fire Barrier: Putty.
5. Install all conduits and equipment in such a manner as to avoid all obstructions and to preserve headroom and keep openings and passageways clear:
 - a. Install all conduits and equipment in accordance with working space requirements in accordance with the NEC.
 - b. This includes any panel, disconnect switch or other equipment that can be energized while open exposing live parts regardless of whether it is likely to require examination or has serviceable parts.
 - c. Where the Drawings do not show dimensions for locating equipment, install equipment in the approximate locations indicated on the Drawings.
 - d. Adjust equipment locations as necessary to avoid any obstruction or interferences.
 - e. Where an obstruction interferes with equipment operation or safe access, relocate the equipment.
 - f. Where the Drawings do not indicate the exact mounting and/or supporting method to be used, use materials and methods similar to the mounting details indicated on the Drawings.
- G. Earthwork and concrete:
 1. Install all trenching, shoring, concrete, backfilling, grading and resurfacing associated with the Electrical Work:
 - a. Requirements as specified in the Contract Documents.
- H. Roof penetrations:
 1. Seal conduit penetrations in accordance with roofing manufacturer's instructions.
- I. Terminations:
 1. Provide and terminate all conductors required to interconnect power, controls, instruments, panels, and all other equipment.
- J. Miscellaneous installation requirements:
 1. In case of interference between electrical equipment indicated on the Drawings and the other equipment, notify the Engineer as specified in General Conditions.
 2. Location of manholes and pullboxes indicated on the Drawings are approximate. Coordinate exact location of manholes and pullboxes with Mechanical and Civil Work.
 3. Provide additional manholes or pullboxes to those shown where they are required to make a workable installation.
 4. Circuits of different service voltage:
 - a. Voltage and service levels:
 - b. Medium voltage: greater than 1.0 kV.
 - c. Low voltage: 120 V to 480 V.
 - d. Instrumentation: Less than 50 VDC.

- e. Install different service voltage circuits in separate raceways, and junction boxes.
- 5. In manholes, install all cables operating at less than 50 VDC in PVC coated flexible metallic conduit, with corrosion resistant fittings.
- 6. Labeling:
- K. Equipment tie-downs:
 - 1. Anchor all instruments, control panels, and equipment by methods that comply with seismic and wind bracing criteria, which apply to the Site.
 - 2. **ALL CONTROL PANELS MUST BE PERMANENTLY MOUNTED AND TIED DOWN TO STRUCTURES IN ACCORDANCE WITH THE PROJECT SEISMIC CRITERIA.**
- 3.4 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)
- 3.5 REPAIR/RESTORATION (NOT USED)
- 3.6 RE-INSTALLATION (NOT USED)
- 3.7 FIELD QUALITY CONTROL
 - A. Inspection:
 - 1. Provide any assistance necessary to support inspection activities.
 - 2. Engineer inspections may include, but are not limited to, the following:
 - 3. Inspect equipment and materials for physical damage.
 - 4. Inspect installation for compliance with the Drawings and Specifications.
 - 5. Inspect installation for obstructions and adequate clearances around equipment.
 - 6. Inspect equipment installation for proper leveling, alignment, anchorage, and assembly.
 - 7. Inspect equipment nameplate data to verify compliance with design requirements.
 - 8. Inspect raceway installation for quality workmanship and adequate support.
 - 9. Inspect cable terminations.
 - 10. Inspection activities conducted during construction do not satisfy inspection or testing requirements specified in the section for Field Electrical Acceptance Tests.
 - B. Field acceptance testing (Functional Testing):
 - 1. Notify the Engineer when the Electrical Work is ready for field acceptance testing.
 - 2. Perform the field acceptance tests as specified in the section for Field Electrical Acceptance Tests.
 - 3. Record results of the required tests along with the date of test:
 - 4. Use conduit identification numbers to indicate portion of circuit tested.
 - C. Workmanship:
 - 1. Leave wiring in panels, manholes, boxes, and other locations neat, clean, and organized:
 - 2. Neatly coil and label spare wiring lengths.
 - 3. Shorten, re-terminate, and re-label excessive used as well as spare wire and cable lengths, as determined by the Engineer.

3.8 ADJUSTING (NOT USED)

3.9 CLEANING

- A. Remove all foreign material and restore all damaged finishes to the satisfaction of the Engineer and Owner.
- B. Clean and vacuum all enclosures to remove all metal filings, surplus insulation and any visible dirt, dust or other matter before energization of the equipment or system start-up:
- C. Use of compressors or air blowers for cleaning is not acceptable.
- D. As specified in other sections of the Contract Documents.

3.10 PROTECTION

- A. Protect all Work from damage or degradation until Substantial Completion.
- B. Maintain all surfaces to be painted in a clean and smooth condition.

3.11 SCHEDULES (NOT USED)

END OF SECTION

SECTION 261230

600-VOLT OR LESS WIRES AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. 600 volt class or less wire and cable.

1.2 REFERENCES

- A. As specified in the Common Work Results for Electrical section.
- B. ASTM International (ASTM):
 - 1. B3 - Standard Specification for Soft or Annealed Copper Wire.
 - 2. B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- C. CSA International (CSA).
- D. Insulated Cable Engineers Association (ICEA):
 - 1. NEMA WC 70/ICEA S-95-658-1999 - Standard for Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
 - 2. NEMA WC 57/ICEA S-73-532 - Standard for Control, Thermocouple Extension, and Instrumentation Cables.
- E. National Fire Protection Association (NFPA):
 - 1. 72 - National Fire Alarm and Signaling Code.
 - 2. 101 - Life Safety Code.
- F. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
 - 1. 568-C.2 - Balanced Twisted-Pair Telecommunication Cabling and Components Standard.
 - 2. 569-B – Commercial Building Standards for Telecommunications Pathways and Spaces.
 - 3. 1005 – Industrial Cabling Standard.
- G. Underwriter's Laboratories Inc., (UL):
 - 1. 44 - Thermoset-Insulated Wires and Cables.
 - 2. 1277 - Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
 - 3. 1424 - Standard for Cables for Power-Limited Fire-Alarm Circuits.
 - 4. 1569 - Standard for Metal-Clad Cables.
 - 5. 2196 - Standard for Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control, and Data Cables.
 - 6. 2225 - Standard for Cables and Cable-Fittings for Use in Hazardous (Classified) Locations.

1.3 DEFINITIONS

- A. As specified in the Common Work Results for Electrical section.

- B. Specific definitions and abbreviations:
 - 1. AWG: American wire gauge.
 - 2. BCCS: Bare copper-covered steel.
 - 3. CPE: Chlorinated polyethylene.
 - 4. FEP: Fluorinated ethylene propylene.
 - 5. FHDPE: Foam high-density polyethylene.
 - 6. FPE: Foam polyethylene.
 - 7. OD: Outside diameter.
 - 8. PVC: Polyvinyl chloride.
 - 9. XHHW: Cross-linked high heat water resistant insulated wire.
- C. Definitions of terms and other electrical considerations as set forth in the:
 - 1. ASTM.
 - 2. ICEA.

1.4 SYSTEM DESCRIPTION

- A. Furnish and install the complete wire and cable system.

1.5 SUBMITTALS

- A. Furnish submittals as specified in the Common Work Results for Electrical section.
- B. Product data:
 - 1. Manufacturer of wire and cable.
 - 2. Insulation:
 - a. Type.
 - b. Voltage class.
 - 3. AWG size.
 - 4. Conductor material.
 - 5. Pulling compounds.
- C. Shop drawings:
 - 1. Show splice locations.
 - a. For each proposed splice location provide written justification describing why the splice is necessary.
- D. Test reports:
 - 1. Submit test reports for meg-ohm tests.
- E. Calculations:
 - 1. Submit cable pulling calculations to the Engineer for review and comment for all cables that will be installed using mechanical pulling equipment. Show that the maximum cable tension and sidewall pressure will not exceed manufacturer recommended values:
 - a. Provide a table showing the manufacturer's recommended maximum cable tension and sidewall pressure for each cable type and size included in the calculations.
 - b. Submit the calculations to the Engineer a minimum of 2 weeks before conduit installation.

1.6 QUALITY ASSURANCE

- A. As specified in the Common Work Results for Electrical section.

- B. All wires and cables shall be UL listed and labeled.
- 1.7 DELIVERY, STORAGE, AND HANDLING
 - A. As specified in the Common Work Results for Electrical section.
- 1.8 PROJECT OR SITE CONDITIONS (NOT USED)
- 1.9 SEQUENCING (NOT USED)
- 1.10 SCHEDULING (NOT USED)
- 1.11 WARRANTY
 - A. As specified in the Common Work Results for Electrical section.
- 1.12 SYSTEM START-UP
 - A. As specified in the Common Work Results for Electrical section.
- 1.13 OWNER`S INSTRUCTIONS (NOT USED)
- 1.14 MAINTENANCE (NOT USED)

PART 2 - PRODUCTS

- 2.1 MANUFACTURERS
 - A. One of the following or equal:
 - 1. 600 volt class wire and cable:
 - a. General Cable.
 - b. Okonite Co.
 - c. Southwire Co.
 - d. Service Wire.
 - 2. Instrumentation class wire and cable:
 - a. Alpha Wire Co.
 - b. Belden CDT.
 - c. General Cable.
 - d. Okonite Co.
 - e. Rockbestos Surprenant Cable Corp.
 - 3. Network cables:
 - a. General Cable.
 - b. Belden.
 - c. CommScope.
- 2.2 EXISTING PRODUCTS (NOT USED)
- 2.3 MATERIALS
 - A. Conductors:
 - 1. Copper in accordance with ASTM B3.

2.4 MANUFACTURED UNITS

A. General:

1. Provide new wires and cables manufactured within 1 year of the date of delivery to the Site.
2. Permanently mark each wire and cable with the following at 24-inch intervals:
 - a. AWG size.
 - b. Voltage rating.
 - c. Insulation type.
 - d. UL symbol.
 - e. Month and year of manufacture.
 - f. Manufacturer's name.
3. Identify and mark wire and cable as specified in the Identification for Electrical Systems section:
 - a. Use integral color insulation for #2 AWG and smaller wire.
 - b. Wrap colored tape around cable larger than #2 AWG.

B. 600 volt class wire and cable:

1. Provide AWG or kcmil sizes as indicated on the Drawings:
 - a. When not indicated on the Drawings, size wire as follows:
 - 1) In accordance with the NEC:
 - a) Use 75 degree Celsius ampacity ratings.
 - b) Ampacity rating after all derating factors, equal to or greater than rating of the overcurrent device.
 - 2) Provide #12 AWG minimum for power conductors.
 - 3) Provide #14 AWG minimum for control conductors.
2. Provide Class B stranding in accordance with ASTM B8:
 - a. Provide Class C stranding where extra flexibility is required.
3. Insulation:
 - a. XHHW-2.
 - b. 90 degree Celsius rating.
4. Multiconductor cables:
 - a. Number and size of conductors as indicated on the Drawings.
 - b. Individual conductors with XHHW-2 insulation.
 - c. Overall PVC jacket.
 - d. Tray cable rated.
 - e. Color-coding for control wire in accordance with ICEA Method 1, E-2 in accordance with NEMA WC 57/ICEA S-73-532.
 - f. Ground conductor: Insulated, green:
 - 1) Sized in accordance with NEC.

C. Instrumentation class cable:

1. Type TC.
2. Suitable for use in wet locations.
3. Voltage rating: 600 volts.
4. Temperature rating:
 - a. 90 degree Celsius rating in dry locations.
 - b. 75 degree Celsius rating in wet locations.
5. Conductors:
 - a. Insulation:
 - 1) Flame-retardant PVC, 15 mils nominal thickness, with nylon jacket 4 mils nominal thickness.

- b. #16 AWG stranded and tinned.
 - c. Color code: ICEA Method 1:
 - 1) Pair: Black and white.
 - 2) Triad: Black, white and red.
 - 3) Multiple pairs or triads:
 - a) Color-coded and numbered.
 - 6. Drain wire:
 - a. #18 AWG.
 - b. Stranded, tinned.
 - 7. Jacket:
 - a. Flame retardant, moisture and sunlight resistant PVC.
 - b. Ripcord laid longitudinally under jacket to facilitate removal.
 - 8. Shielding:
 - a. Individual pair/triad:
 - 1) Minimum 1.35-mil double-faced aluminum foil-polyester tape overlapped to provide 100 percent coverage.
 - b. Multiple pair or triad shielding:
 - 1) Group shield: Minimum 1.35-mil double-faced aluminum foil-polyester tape overlapped to provide 100 percent coverage.
 - 2) Completely isolate group shields from each other.
 - 3) Cable shield: 2.35 mils double-faced aluminum and synthetic polymer backed tape overlapped to provide 100 percent coverage.
 - c. All shielding to be in contact with the drain wire.
- D. Network cables:
 - 1. Category 5e:
 - a. General:
 - 1) Provide Cat 5e cables meeting the standards set by TIA/EIA-568-C.2 and verified by third-party testing laboratory.
 - b. Conductors:
 - 1) #24 AWG solid bare annealed copper.
 - c. Insulation:
 - 1) Polyolefin.
 - 2) 4 non-bonded twisted pair cables formed into a cable core.
 - d. Shielding: None.
 - e. Color code (T568B):
 - 1) Pair 1: White/blue stripe and blue.
 - 2) Pair 2: White/orange stripe and orange.
 - 3) Pair 3: White/green stripe and green.
 - 4) Pair 4: White/brown stripe and brown.
 - f. Outer jacket:
 - 1) PVC with ripcord.
 - g. Electrical characteristics
 - 1) Voltage rating: 600VAC.

2.5 EQUIPMENT (NOT USED)

2.6 COMPONENTS (NOT USED)

2.7 ACCESSORIES

A. Wire ties:

1. One of the following or equal:
 - a. T&B, "Ty-Rap" cable ties.
 - b. Panduit, cable ties.
- B. Wire markers:
 1. As specified in the Identification for Electrical Systems section.
- 2.8 MIXES (NOT USED)
- 2.9 FABRICATION (NOT USED)
- 2.10 FINISHES (NOT USED)
- 2.11 SOURCE QUALITY CONTROL
 - A. Assembly and testing of cable shall comply with the applicable requirements of ICEA S-95-658-1999.
 - B. Test Type XHHW-2 in accordance with the requirements of UL 44.

PART 3 EXECUTION

- 3.1 EXAMINATION (NOT USED)
- 3.2 PREPARATION (NOT USED)
- 3.3 INSTALLATION
 - A. As specified in the Common Work Results for Electrical section.
 - B. Color-coding:
 1. Color-coding shall be consistent throughout the facility.
 2. The following color code shall be followed for all 240/120 volt and 208/120 volt systems:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Single phase system: Black for 1 hot leg, red for the other.
 - e. Neutral: White.
 - f. High phase or wild leg: Orange.
 - g. Equipment ground: Green.
 3. The following color code shall be followed for all 480/277 volt systems:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Neutral: Gray.
 - e. Equipment ground: Green.
 4. The following color code shall be followed for all 120 VAC control wiring:
 - a. Power: Red.
 - b. Neutral: White.
 5. The following color code shall be followed for all general purpose DC control circuits:
 - a. Grounded conductors: White with blue stripe.

- b. Ungrounded conductors: Blue.
- 6. Switch legs shall be violet. 3-way switch runners shall be pink.
- 7. Wires in intrinsically safe circuits shall be light blue.
- 8. Wire colors shall be implemented in the following methods:
 - a. Wires manufactured of the desired color.
 - b. Continuously spiral wrap the first 6 inches of the wire from the termination point with colored tape:
 - 1) Colored tape shall be wrapped to overlap 1/2 of the width of the tape.
- C. Install conductors only after the conduit installation is complete, and all enclosures have been vacuumed clean, and the affected conduits have been swabbed clean and dry:
 - 1. Install wires only in approved raceways.
 - 2. Do not install wire:
 - a. In incomplete conduit runs.
 - b. Until after the concrete work and plastering is completed.
- D. Properly coat wires and cables with pulling compound before pulling into conduits:
 - 1. For all #4 AWG and larger, use an approved wire-pulling lubricant while cable is being installed in conduit:
 - a. Ideal Products.
 - b. Polywater Products.
 - c. 3M Products.
 - d. Greenlee Products.
 - e. Or equal as recommended by cable manufacturer.
 - f. Do not use oil, grease, or similar substances.
- E. Cable pulling:
 - 1. Prevent mechanical damage to conductors during installation.
 - 2. For cables #1 AWG and smaller, install cables by hand.
 - 3. For cables larger than #1 AWG, power pulling winches may be used if they have cable tension monitoring equipment.
 - 4. Provide documentation that maximum cable pulling tension was no more than 75 percent of the maximum recommended level as published by the cable manufacturer. If exceeded, the Engineer may, at his discretion, require replacement of the cable.
 - 5. Ensure cable pulling crews have all calculations and cable pulling limitations while pulling cable.
 - 6. Make splices or add a junction box or pullbox where required to prevent cable pulling tension or sidewall pressure from exceeding 75 percent of manufacturer's recommendation for the specified cable size:
 - a. Make splices in manholes or pull boxes only.
 - b. Leave sufficient slack to make proper connections.
- F. Use smooth-rolling sheaves and rollers when pulling cable into cable tray to keep pulling tension and bending radius within manufacturer's recommendations.
- G. Install and terminate all wire in accordance with manufacturer's recommendations.
- H. Neatly arrange and lace conductors in all switchboards, panelboards, pull boxes, and terminal cabinets by means of wire ties:
 - 1. Do not lace wires in gutter or panel channel.
 - 2. Install all wire ties with a flush cutting wire tie installation tool:
 - a. Use a tool with an adjustable tension setting.
 - 3. Do not leave sharp edges on wire ties.

- I. Terminate stranded conductors on equipment box lugs such that all conductor strands are confined within the lug:
 - 1. Use ring type lugs if box lugs are not available on the equipment.
- J. Lighting circuits:
 - 1. Each circuit shall have a dedicated neutral.
- K. Splices:
 - 1. Provide continuous circuits from origin to termination whenever possible:
 - a. Obtain Engineer's approval prior to making any splices.
 - 2. Lighting and receptacle circuit conductors may be spliced without prior approval from the Engineer.
 - 3. Where splices are necessary because of extremely long wire or cable lengths that exceed standard manufactured lengths:
 - a. Splice box NEMA rating requirements as specified in the Common Work Results for Electrical section.
 - b. Make splices in labeled junction boxes for power conductors.
 - c. Make splices for control and instrument conductors in terminal boxes:
 - 1) Provide terminal boards with setscrew pressure connectors, with spade or ring lug connectors.
 - 4. Power and control conductors routed in common raceways may be spliced in common junction boxes.
 - 5. Clearly label junction and terminal boxes containing splices with the word "SPlice LOCATED WITHIN".
 - 6. Leave sufficient slack at junction boxes and termination boxes to make proper splices and connections. Do not pull splices into conduits.
 - 7. Install splices with compression type butt splices and insulate using a heat-shrink sleeve:
 - a. In NEMA Type 4 or NEMA Type 4X areas, provide heat-shrink sleeves that are listed for submersible applications.
 - 8. Splices in below grade pull boxes, in any box subject to flooding, and in wet areas shall be made waterproof using:
 - a. A heat shrink insulating system listed for submersible applications.
 - b. Or an epoxy resin splicing kit.
- L. Apply wire markers to all wires at each end after being installed in the conduit and before meg-ohm testing and termination.
- M. Instrumentation class cable:
 - 1. Install instrumentation class cables in separate raceway systems from power cables:
 - a. Install instrument cable in metallic conduit within non-dedicated manholes or pull boxes.
 - b. Install cable without splices between instruments or between field devices and instrument enclosures or panels.
 - 2. Do not make intermediate terminations, except in designated terminal boxes as indicated on the Drawings.
 - 3. Shield grounding requirements as specified in the Grounding and Bonding section.
- N. Copper Ethernet cables:
 - 1. Comply with TIA/EIA-568-C.2.
 - 2. Pathways:

- a. For initial installation, the maximum fill capacity for pathways (i.e. conduit, raceways, trays, baskets) is 40 percent. The maximum fill capacity of 60 percent is allowed to accommodate future additions after initial installation.
 - b. Conduit should be run in the most direct route possible with no more than two 90 degree bends between pull boxes and serve no more than 3 outlet boxes.
3. Cable bend radius:
 - a. Proper cable bend radius control must be maintained throughout the pathways. The bend radius needs to be at a minimum 10 times the cable diameter.
4. Cable pulling:
 - a. Provide cable pulling swivel system to prevent winding and tangling of rope and cables during pull.
 - b. The maximum pulling tension is not to exceed manufacturer recommendations. Cable installation should not in any way deform the cable jacket.
 - c. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
5. Cable management:
 - a. Organize and manage cables for quick and easy moves, adds and changes.
6. Testing:
 - a. All cables and termination hardware shall be 100 percent tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of TIA/EIA-568-C.1 Section 11.
 - 1) All pairs of each installed cable shall be verified prior to system acceptance.
 - 2) Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100 percent useable conductors in all cables installed.
 - b. All twisted-pair copper cable links shall be tested for compliance to the requirements in TIA/EIA/568-C.2 for the appropriate Category of cabling installed.
 - c. All cables shall be tested in accordance with the contract documents, TIA/EIA standards, and best industry practice.
 - d. The field test equipment shall meet the requirements of TIA/EIA-568-C. The appropriate level III tester shall be used to verify Category 6 cabling.
 - e. Visually inspect UTP jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-C.1.
 - f. Visually inspect cable placement, cable termination, grounding and bonding, equipment and labeling of all components.
 - g. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors.
 - 1) Test operation of shorting bars in connection blocks.
 - 2) Test cables after termination but not cross-connection.
 - a) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C.2.
 - (1) Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex.
 - (2) Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
7. Separation from EMI sources:

- a. Comply with TIA/EIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 - b. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches
 - c. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
 - d. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
 - e. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
- O. Multi-conductor cable:
- 1. Where cable is not routed in conduit with a separate ground conductor, use 1 conductor in the cable as a ground conductor:
 - a) Use an internal ground conductor, if it is no smaller than as indicated on the Drawings and in accordance with NEC requirements for equipment ground conductor size.
 - b) Where 2 parallel cables are used, and the internal ground conductor in each cable does not meet NEC requirements for the combined circuit, use 4-conductor cable, with one of the full-sized conductors serving as ground.
- P. Armored cable:
- 1. Where 2 parallel cables are used, and the internal ground conductor in each cable does not meet NEC requirements for the combined circuit, use 4-conductor cable, with 1 of the full-sized conductors serving as ground.
 - 2. The cable armor is not acceptable as a ground conductor.
 - 3. Where armored cable terminates at a device, switchboard, panel, etc., use armored cable connector.
 - 4. Where armored cable run continues in conduit, strip jacket and armor for portions in conduit, and terminate cable and jacket with an armored cable connector threaded into a coupling or conduit box.
- Q. Signal cable:
- 1. Separate and isolate electrical signal cables from sources of electrical noise and power cables by minimum 12 inches.
- R. Submersible cable in wet wells:
- 1. Provide Kellem's grip or stainless steel wire mesh to support cable weight and avoid stress on insulation.
- S. Wiring allowances:

1. Equipment locations may vary slightly from the drawings. Include an allowance for necessary conductors and terminations for motorized equipment, electrical outlets, fixtures, communication outlets, instruments, and devices within 10 linear feet of locations indicated on the Drawings.
2. Locations for pull boxes, manholes, and duct banks may vary slightly from the drawings. Include an allowance for necessary conductors and related materials to provide conductors to all pull boxes, manholes and duct banks within 20 linear feet of locations indicated on the Drawings.

3.4 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.5 REPAIR/RESTORATION (NOT USED)

3.6 RE-INSTALLATION (NOT USED)

3.7 COMMISSIONING

3.8 FIELD QUALITY CONTROL

A. As specified in the Common Work Results for Electrical section.

B. Grounding:

1. As specified in the Grounding and Bonding section.

3.9 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in the Common Work Results for Electrical section.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16130

CONDUITS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Metallic conduits.
 - 2. Nonmetallic conduits.
 - 3. Conduit bodies.
 - 4. Conduit fittings and accessories.
 - 5. Conduit installation.

1.2 REFERENCES

- A. As specified in the Common Work Results for Electrical section.
- B. American National Standards Institute (ANSI):
 - 1. C80.1 - Electrical Rigid Steel Conduit.
 - 2. C80.3 - Steel Electrical Metallic Tubing.
 - 3. C80.5 - Electrical Rigid Aluminum Conduit.
 - 4. C80.6 - Electrical Intermediate Metal Conduit.
- C. National Electrical Manufacturer's Association (NEMA):
 - 1. RN-1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Steel Conduit.
 - 2. TC2 - Electrical Polyvinyl Chloride (PVC) Conduit.
 - 3. TC3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
 - 4. TC7 - Smooth-Wall Coilable Electrical Polyethylene Conduit.
 - 5. TC13 - Electrical Nonmetallic Tubing.
 - 6. TC14 - Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
- D. Underwriters Laboratories (UL):
 - 1. 1 - Standard for Flexible Metal Conduit.
 - 2. 6 - Standard for Electrical Rigid Metal Conduit - Steel.
 - 3. 6A - Standard for Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel.
 - 4. 360 - Standard for Liquidtight Flexible Steel Conduit.
 - 5. 651 - Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
 - 6. 651B - Standard for Continuous Length HDPE Conduit.
 - 7. 797 - Standard for Electrical Metallic Tubing - Steel.
 - 8. 1242 - Standard for Electrical Intermediate Metal Conduit - Steel.
 - 9. 1653 - Standard for Electrical Nonmetallic Tubing.
 - 10. 1660 - Standard for Liquidtight Flexible Nonmetallic Conduit.
 - 11. 1684 - Standard for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

1.3 DEFINITIONS

- A. As specified in the Common Work Results for Electrical section.
- B. Specific definitions and abbreviations:

1. Conduit bodies: A separate portion of a conduit system that provides access through a removable cover to the interior of the system at a junction of 2 or more conduit sections. Includes, but not limited to, Shapes C, E, LB, T, X, etc.
2. Conduit fitting: An accessory that primarily serves a mechanical purpose. Includes, but not limited to, bushings, locknuts, hubs, couplings, reducers, etc.
3. GRC: Galvanized rigid steel conduit.
4. PCS: Polyvinyl chloride (PVC) coated rigid steel conduit.
5. EMT: Electrical metallic tubing.
6. PVC: Polyvinyl chloride rigid nonmetallic conduit.
7. SLT: Sealtight-liquidtight flexible conduit.
8. EFLX: Explosion proof flexible conduit.
9. RAC: Rigid aluminum conduit.
10. NPT: National pipe thread.

1.4 SUBMITTALS

- A. Furnish submittals as specified in the Common Work Results for Electrical section.
- B. Product data:
 1. Furnish complete manufacturer's catalog sheets for every type and size of conduit, fitting, conduit body, and accessories to be used on the Project.
 2. Furnish complete manufacturer's recommended special tools to be used for installation if required.
- C. Certifications:
 1. Furnish PVC-coated conduit manufacturer's certification for each installer.
- D. Record Documents:
 1. Incorporate all changes in conduit routing on electrical plan drawings.
 2. Dimension underground and concealed conduits from building lines.
 3. Furnish hard copy drawings.

1.5 QUALITY ASSURANCE

- A. As specified in the Common Work Results for Electrical section.
- B. All conduits, conduit bodies, and fittings shall be UL listed and labeled.
- C. Every installer of PVC-coated metallic conduit shall be certified by the manufacturer for installation of the conduit.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. As specified in the Common Work Results for Electrical section.
- B. Do not expose non-metallic conduit to direct sunlight.
- C. Do not store conduit in direct contact with the ground.
- D. Do not store aluminum conduit in contact with concrete.

1.7 PROJECT OR SITE CONDITIONS

- A. As specified in the Common Work Results for Electrical section.

1.8 SEQUENCING

- A. Before installing any conduit or locating any device box:
 - 1. Examine the complete set of Drawings and Specifications, and all applicable shop drawings.
 - 2. Verify all dimensions and space requirements and make any minor adjustments to the conduit system as required to avoid conflicts with the building structure, other equipment, or the work of other trades.

1.9 SCHEDULING (NOT USED)

1.10 WARRANTY

- A. As specified in the Common Work Results for Electrical section.

1.11 SYSTEM START-UP

- A. As specified in the Common Work Results for Electrical section.

1.12 OWNER'S INSTRUCTIONS (NOT USED)

1.13 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Galvanized rigid steel conduit:
 - 1. One of the following or equal:
 - a. Western Tube and Conduit.
 - b. Allied Tube and Conduit.
 - c. Wheatland Tube Co.
- B. PVC-coated rigid steel conduit:
 - 1. One of the following or equal:
 - a. Robroy Ind.
 - b. Ocal, Inc.
 - c. Calbond.
 - d. Allied.
 - e. NEC, Inc. BlackGuard.
- C. Sealtight-liquidtight flexible conduit:
 - 1. One of the following or equal:
 - a. Southwire.
 - b. AFC Cable Systems.
 - c. Electri-Flex Co.
 - d. Anaconda.
- D. Explosion proof flexible conduit:
 - 1. One of the following or equal:
 - a. Appleton.
 - b. Crouse-Hinds.
 - c. Hubbell Killark.

- E. Conduit bodies:

1. One of the following or equal:
 - a. Crouse-Hinds.
 - b. Appleton.
 - c. O-Z/Gedney.
 - d. Ocal, Inc.
 - e. Robroy Ind.
 - f. Calbond.
 - g. Carlon.

- F. Joint compound:
 1. The following or equal:
 - a. Thomas and Betts.

- G. Galvanized rigid steel conduit expansion fittings:
 1. One of the following or equal:
 - a. Crouse-Hinds.
 - b. Appleton.
 - c. O-Z/Gedney.

- H. PVC-coated rigid steel conduit expansion fittings:
 1. One of the following or equal:
 - a. Ocal, Inc.
 - b. Robroy Ind.
 - c. NEC, Inc. BlackGuard.

- I. Conduit sleeve:
 1. One of the following or equal:
 - a. Crouse-Hinds.
 - b. Appleton.
 - c. O-Z/Gedney.

- J. Conduit seals:
 1. One of the following or equal:
 - a. Appleton.
 - b. Crouse-Hinds.
 - c. O-Z/Gedney.

- K. Conduit hangers and supports:
 1. As specified in the Hangers and Supports section.

- L. Conduit through wall and floor seals:
 1. The following or equal:
 - a. O-Z/Gedney:
 - 1) Type "WSK."
 - 2) Type "CSM."

2.2 SYSTEM DESCRIPTION

- A. Provide conduits, conduit bodies, fittings, junction boxes, and all necessary components, whether or not indicated on the Drawings, as required, to install a complete electrical raceway system.

2.3 EXISTING PRODUCTS (NOT USED)

2.4 MATERIALS (NOT USED)

2.5 MANUFACTURED UNITS (NOT USED)

2.6 EQUIPMENT (NOT USED)

2.7 COMPONENTS

A. GRC:

1. All threads: NPT standard conduit threads with a 3/4-inch taper per foot:
 - a. Running conduit threads are not acceptable.
2. Hot-dip galvanized inside and out:
 - a. Ensures complete coverage and heats the zinc and steel to a temperature that ensures the zinc alloys with the steel over the entire surface.
 - b. Electro-galvanizing is not acceptable.
3. Manufactured in accordance with:
 - a. UL-6.
 - b. ANSI C80.1.

B. PCS:

1. The steel conduit, before PVC coating, shall be new, unused, hot-dip galvanized material, conforming to the requirements for Type GRC.
2. Coated conduit NEMA Standard RN-1:
 - a. The galvanized coating may not be disturbed or reduced in thickness during the cleaning and preparatory process.
3. Factory-bonded PVC jacket:
 - a. The exterior galvanized surfaces shall be coated with primer before PVC coating to ensure a bond between the zinc substrate and the PVC coating.
 - b. Nominal thickness of the exterior PVC coating shall be 0.040 inch except where part configuration or application of the piece dictates otherwise.
 - c. PVC coating on conduits and associated fittings shall have no sags, blisters, lumps, or other surface defects and shall be free of holes and holidays.
 - d. The PVC adhesive bond on conduits and fittings shall be greater than the tensile strength of the PVC plastic coating:
 - 1) Confirm bond with certified test results.
4. A urethane coating shall be uniformly and consistently applied to the interior of all conduits and fittings:
 - a. Nominal thickness of 0.002 inch.
 - b. Conduits having areas with thin or no coating are not acceptable.
 - c. All threads shall be coated with urethane.
5. The PVC exterior and urethane interior coatings applied to the conduits shall afford sufficient flexibility to permit field bending without cracking or flaking at temperature above 30 degrees Fahrenheit (-1 degree Celsius).
6. PCS conduit bodies and fittings:
 - a. Malleable iron.
 - b. The conduit body, before PVC coating, shall be new, unused material and shall conform to appropriate UL standards.
 - c. The PVC coating on the outside of conduit bodies shall be 0.040-inch thick and have a series of ribs to protect the coating from tool damage during installation.
 - d. 0.002-inch interior urethane coating.
 - e. Utilize the PVC coating as an integral part of the gasket design.
 - f. Stainless steel cover screw heads shall be encapsulated with plastic to ensure corrosion protection.

- g. A PVC sleeve extending 1 conduit diameter or 2 inches, whichever is less, shall be formed at each female conduit opening.
 - 1) The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used.
 - 2) The sleeve shall provide a vapor- and moisture resistant seal at every connection.
- C. SLT:
- 1. Temperature rated for use in the ambient temperature at the installed location but not less than the following:
 - a. General purpose:
 - 1) Temperature range: -20 degrees Celsius to +80 degrees Celsius.
 - b. Oil-resistant:
 - 1) Temperature range: -20 degrees Celsius to +60 degrees Celsius.
 - 2. Sunlight-resistant, weatherproof, and watertight.
 - 3. Manufactured from single strip steel, hot-dip galvanized on all 4 sides before conduit fabrication.
 - 4. Strip steel spiral wound resulting in an interior that is smooth and clean for easy wire pulling.
 - 5. Overall PVC jacket.
 - 6. With integral copper ground wire, built in the core, in conduit trade sizes 1/2 inch through 1-1/4 inch.
- D. EFLX:
- 1. Suitable for the hazardous Class and Group where installed:
 - a. As specified in the Common Work Results for Electrical section.
 - 2. Metallic braid shall provide continuous electrical path.
 - 3. Stainless steel construction.
 - 4. Provide fittings and unions as required for the installation.
- E. PVC:
- 1. Extruded from virgin PVC compound:
 - a. Schedule 40 unless otherwise specified.
 - b. Schedule 80 extra-heavy wall where specified.
 - 2. Rated for 90 degrees Celsius conductors or cable.
 - 3. Rated for use in direct sunlight.
- F. Conduit bodies:
- 1. Material consistent with conduit type:
 - a. Malleable iron bodies and covers when used with Type GRC.
 - b. Cast aluminum bodies and covers when used with Type RAC.
 - c. PVC bodies and covers when used with Type PVC.
 - d. PVC-coated malleable iron bodies and covers when used with Type PCS.
 - 2. Conduit bodies to conform to Form 8, Mark 9, or Mogul design:
 - a. Mogul design conforming to NEC requirements for bending space for large conductors for conduit trade sizes of 1 inch and larger with conductors #4 AWG and larger, or where required for wire-bending space.
 - 3. Gasketed covers attached to bodies with stainless steel screws secured to threaded holes in conduit body.

2.8 ACCESSORIES

- A. Connectors and fittings:
 - 1. Manufactured with compatible materials to the corresponding conduit.
- B. Insulated throat metallic bushings:

1. Construction:
 - a. Malleable iron or zinc-plated steel when used with steel conduit.
 - b. Aluminum when used with aluminum conduit.
 - c. Positive metallic conduit end stop.
 - d. Integrally molded non-combustible phenolic-insulated surfaces rated at 150 degrees Celsius.
 - e. Use fully insulated bushings on nonmetallic conduit system made of high-impact 150 degrees Celsius rated non-combustible thermosetting phenolic.
- C. Insulated grounding bushings:
 1. Construction:
 - a. Malleable iron or steel, zinc-plated, with a positive metallic end stop.
 - b. Integrally molded non-combustible phenolic-insulated surfaces rated at 150 degrees Celsius.
 - c. Tin-plated copper grounding saddle for use with copper or aluminum conductors.
- D. Electrical unions (Erickson Couplings):
 1. Construction:
 - a. Malleable iron for use with steel conduit.
 - b. Aluminum for use with aluminum conduit.
 - c. Concrete tight, 3-piece construction.
 - d. Rated for Class I Division 1 Group D in hazardous areas.
- E. SLT fittings:
 1. Construction:
 - a. Malleable iron.
 - b. Furnished with locknut and sealing ring.
 - c. Liquidtight, raintight, oiltight.
 - d. Insulated throat.
 - e. Furnish as straight, 45-degree elbows, and 90-degree elbows.
 - f. Designed to prevent sleeving:
 - 1) Verify complete bonding of the raceway jacket to the plastic gasket seal.
 - g. Equipped with grounding device to provide ground continuity irrespective of raceway core construction. Grounding device, if inserted into raceway and directly in contact with conductors, shall have rolled-over edges for sizes under 5 inches.
 - h. Where terminated into a threadless opening using a threaded hub fitting, a suitable moisture-resistant/oil-resistant synthetic rubber gasket shall be provided between the outside of the box or enclosure and the fitting shoulder. Gasket shall be adequately protected by and permanently bonded to a metallic retainer.
 2. Corrosion-resistant and outdoor SLT fittings:
 - a. Construction:
 - 1) PVC-coated liquidtight fittings with a bonded 0.040-inch thick PVC coating on the metal connector to form a seal around the SLT conduit.
 - 2) Insulated throat and an integral sealing ring.
- F. Hubs for threaded attachment of steel conduit to sheet metal enclosures:
 1. Construction:
 - a. Insulated throat.
 - b. PVC-coated when used in corrosive areas.
 - c. Bonding locknut.
 - d. Recessed neoprene o-ring to ensure watertight and dusttight connector.
 - e. 1/2-inch through 1-1/4-inch steel zinc electroplated.
 - f. 1-1/2-inch through 6-inch malleable iron zinc plated.
 - g. Aluminum with aluminum conduit.
 2. Usage:

- a. All conduits in damp, wet, outdoor, and corrosive areas shall use threaded hubs for connections to sheet metal enclosures.
- G. Sealing fittings:
 - 1. Construction:
 - a. 40-percent wire fill capacity.
 - b. PVC-coated when used in corrosive areas.
 - c. Malleable ductile iron with steel conduit.
 - d. Aluminum with aluminum conduit.
 - e. Type EYDX where drains are required.
 - f. Type EYSX where drains are not required.
 - g. UL listed for use in Class I, Division 1, Groups A, B, C, D; Class I, Division 2, Groups A, B, C, D; and Class II, Divisions 1 and 2, Groups E, F, and G.
 - 2. Sealing compound:
 - a. Fiber filler and cement as recommended by the sealing fitting manufacturer.
 - b. Approved for the conditions and use.
 - 1) Not affected by surrounding atmosphere or liquids.
 - c. Melting point shall be 200 degrees Fahrenheit minimum.
- H. PVC fittings:
 - 1. Materials:
 - a. All devices shall be made of PVC, using the same materials as used for Type PVC conduit.
 - b. All metal hardware shall be stainless steel.
- I. Through wall and floor seals:
 - 1. Materials:
 - a. Body: Casting of malleable or ductile iron with a hot-dip galvanized finish Aluminum.
 - b. Grommet: Neoprene.
 - c. Pressure rings: PVC-coated steel.
 - d. Disc material: PVC-coated steel.
- J. Expansion/deflection couplings:
 - 1. Use to compensate for movement in any directions between 2 conduit ends where they connect.
 - 2. Shall allow movement of 3/4 inch from the normal in all directions.
 - 3. Shall allow angular movement for a deflection of 30 degrees from normal in any direction.
 - 4. Constructed to maintain electrical continuity of the conduit system.
 - 5. Materials:
 - a. End couplings: Bronze or galvanized ductile iron.
 - b. Sleeve: Neoprene.
 - c. Bands: Stainless steel.
 - d. Bonding jumper: Tinned copper braid.
- K. Expansion couplings:
 - 1. Shall allow for expansion and contraction of conduit:
 - a. Permitting 8-inch movement, 4 inches in either direction.
 - 2. Constructed to maintain electrical continuity of the conduit system.
 - 3. Materials:
 - a. Head: Malleable or ductile iron.
 - b. Sleeve: Steel.
 - c. Insulating bushing: Phenolic.
 - d. Finish: Hot-dip galvanized.
 - e. Aluminum when used with Type RAC.

f. PVC-coated when used with Type PCS.

L. Conduit markers:

1. As specified in the Identification for Electrical Systems section.

2.9 MIXES (NOT USED)

2.10 FABRICATION (NOT USED)

2.11 FINISHES (NOT USED)

2.12 SOURCE QUALITY CONTROL

A. As specified in the Common Work Results for Electrical section.

PART 3 EXECUTION

3.1 EXAMINATION (NOT USED)

3.2 PREPARATION (NOT USED)

3.3 INSTALLATION

A. As specified in the Common Work Results for Electrical section.

B. General:

1. Conduit routing:

a. The electrical drawings are diagrammatic in nature:

- 1) Install conduit runs as specified with schematic representation indicated on the Drawings and as specified.
- 2) Modify conduit runs to suit field conditions, as accepted by the Engineer:
 - a) Make changes in conduit locations that are consistent with the design intent but are dimensionally different, or routing to bypass obstructions.
 - b) Make changes in conduit routing due to the relocation of equipment.
- 3) The electrical drawings do not indicate all required junction boxes and pull boxes:
 - a) Provide junction boxes and pull boxes to facilitate wire pulling as required:
 - (1) To meet cable manufacturer's pulling tension requirements.
 - (2) To limit total conduit bends between pull locations.
 - b) Install junction boxes and pull boxes at locations acceptable to the Engineer.

b. The Contractor is responsible for any deviations in general location, conduit size, routing, or changes to the conduit schedule without the express written approval or direction by the Engineer:

- 1) The Engineer is the sole source in determining whether the change is constituted as a deviation:
- 2) Perform any changes resulting in additional conduits, or extra work from such deviations.
- 3) Incorporate any deviations on the Record Documents.

2. Use only tools recommended by the conduit manufacturer for assembling the conduit system.

3. Provide adequate clearances from high-temperature surfaces for all conduit runs. Provide minimum clearances as follows:
 - a. Clearance of 6 inches from surfaces 113 degrees Fahrenheit to 149 degrees Fahrenheit.
 - b. Clearance of 12 inches from surfaces greater than 149 degrees Fahrenheit.
 - c. Keep conduits at least 6 inches from the coverings on hot water and steam pipes, 18 inches from the coverings on flues and breechings, and 12 inches from fuel lines and gas lines.
 - d. Where it is necessary to route conduits close to high-temperature surfaces, provide a high-reflectance thermal barrier between the conduit and the surface.
4. Support conduit runs on water-bearing walls a minimum of 7/8-inch away from wall on an accepted preformed channel:
 - a. Do not run conduits within water-bearing walls unless otherwise indicated on the Drawings.
5. Do not install 1-inch or larger conduits in or through structural members unless approved by the Engineer.
6. Run conduits exposed to view parallel with or at right angles to structural members, walls, or lines of the building:
 - a. Install straight and true conduit runs with uniform and symmetrical elbows, offsets, and bends.
 - b. Make changes in direction with long radius bends or with conduit bodies.
7. Install conduits with total conduit bends between pull locations less than or equal to 270 degrees.
8. Route all exposed conduits to preserve headroom, access space and work space, and to prevent tripping hazards and clearance problems:
 - a. Install conduit runs so that runs do not interfere with proper and safe operation of equipment and do not block or interfere with ingress or egress, including equipment-removal hatches.
 - b. Route conduits to avoid drains or other gravity lines. Where conflicts occur, relocate the conduit as required.
9. When installing conduits through existing slabs or walls, make provisions for locating any possible conflicting items where the conduit is to penetrate. Use tone signal or X-ray methods to make certain that no penetrations will be made into the existing conduits, piping, cables, post-tensioning cables, etc.
10. Plug conduits brought into pull boxes, manholes, handholes, and other openings until used to prevent entrance of moisture.
11. Install conduits through wall and floor seals where indicated on the Drawings.
12. For existing and new 2-inch and larger conduit runs, snake conduits with a conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of nominal diameter of the conduit:
 - a. Remove and replace conduits through which mandrel will not pass.
13. Provide all sleeves and openings required for the passage of electrical raceways or cables even when these openings or sleeves are not specifically indicated on the Drawings.
14. Install complete conduit systems before conductors are installed.
15. Provide metallic conduits terminating in transformer, switchgear, motor control center, or other equipment conduit windows with grounding bushings and ground with a minimum No. 6 AWG ground wire.
16. Underground conduits:
 - a. Install underground conduits, including conduit runs below slabs-on-grade in sand backfilled duct bank construction:
 - 1) As specified in the Duct Banks section.
 - b. Make underground conduit size transitions at handholes and manholes.
 - c. Install spare conduits in underground duct banks towards top center of runs to allow for ease of installation of future cables as conduits enter underground manholes and handholes.

- d. Seal around conduit penetrations of below grade walls with a mechanical seal.
- C. Lighting and receptacle conduits:
- 1. Provide conduit runs for lighting and receptacle circuits, whether or not indicated on the Drawings:
 - 2. Install conduits in accordance with the requirements of this Section unless otherwise indicated.
 - 3. Minimum conduit size:
 - a. 3/4-inch for exposed conduits.
 - b. 1-inch for underground or in-slab conduits.
 - 4. Provide conduit materials for the installed location as specified in the Common Work Results for Electrical section.
- D. Hazardous areas:
- 1. As specified in the Common Work Results for Electrical section for hazardous areas and specific Class and Division.
 - 2. As specified in the Hazardous Classified Area Construction section for hazardous area conduit installation requirements.
- E. Conduit usage:
- 1. Exposed conduits:
 - a. Rigid conduit:
 - 1) Install the rigid conduit type for each location as specified in the Common Work Results for Electrical section.
 - 2) Minimum size: 3/4-inch.
 - b. Flexible conduit:
 - 1) Use flexible conduit for final connections between rigid conduit and motors, vibrating equipment, instruments, control equipment, or where required for equipment servicing:
 - a) Use Type SLT with rigid metallic conduit.
 - b) Use Type EFLX in Class I Division 1 locations.
 - 2) Minimum size: 3/4-inch:
 - a) 1/2 when required for connection to instruments.
 - 3) Maximum length:
 - a) Fixed equipment:

Conduit Trade Size	Flexible Conduit Length (inch)
3/4	18
1	18
1-1/4	18
1-1/2	18
2	36
2-1/2	36
3	36
3-1/2	38
4	40

- b) Removable instruments or hinged equipment:
 - (1) As required to allow complete removal or full movement without disconnecting or stressing the conduit.

2. Concrete-encased and embedded conduits:
 - a. Straight runs and bends less than 45 degrees:
 - 1) Type PVC Schedule 40.
 - b. Bends with total deflection greater than 45 degrees;
 - 1) PCS,
 - c. Entering and exiting duct bank, underground or embedded conduit runs a minimum 12 inches above and below grade, finished floor, or entering equipment:
 - 1) PCS.
 - d. Minimum size:
 - 1) 2-inch in duct banks.
 - 2) 1-inch for in-slab conduits.
 - 3) Provide conduit fittings to enlarge the conduit from the exposed size in the conduit schedule as required.
 3. Below-slab conduits:
 - a. Type PCS.
 - b. Minimum size: 1-inch.
 4. PVC-coated rigid metallic conduit:
 - a. Use specifically manufactured or machined threading dies to manufacturer's specifications to accommodate the PVC jacket.
 5. GRC:
 - a. Conduit shall be cut square and reamed before threading.
- F. Conduit joints and bends:
1. General:
 - a. Where conduit is underground, under slabs on grade, exposed to the weather, or in NEMA Type 4 or NEMA Type 4X locations, make joints liquidtight.
 - b. Keep bends and offsets in conduit runs to an absolute minimum.
 - c. All bends shall be symmetrical.
 - d. The following conduit systems shall use large-radius sweep elbows:
 - 1) Underground conduits.
 - 2) Conduits containing fiber optic cables.
 - e. Provide large-radius factory-made bends for 1-1/4-inch trade size or larger.
 - f. Make field bends with a radius of not less than the requirements found in the NEC:
 - 1) The minimum bending radius of the cable must be less than the radius of the conduit bend.
 - 2) Make all field bends with power bending equipment or manual benders specifically intended for the purpose:
 - a) Make bends so that the conduit is not damaged and the internal diameter is not effectively reduced.
 - b) For the serving utilities, make bends to meet their requirements.
 - g. Replace all deformed, flattened, or kinked conduit.
 2. Threaded conduit:
 - a. Cut threads on rigid metallic conduit with a standard conduit-cutting die that provides a 3/4-inch per foot taper and to a length such that all bare metal exposed by the threading operation is completely covered by the couplings or fittings used. In addition, cut the lengths of the thread such that all joints become secure and wrench-tight just preceding the point where the conduit ends would butt together in couplings or where conduit ends would butt into the ends or shoulders of other fittings.
 - b. Thoroughly ream conduit after threads have been cut to remove burrs.
 - c. Use bushings or conduit fittings at conduit terminations.
 - d. On exposed conduits, repair scratches and other defects with galvanizing repair stick, Enterprise Galvanizing "Galvabar™," or CRC "Zinc It."
 - e. Coat conduit threads with an approved electrically conductive sealant and corrosion inhibitor that is not harmful to the conductor insulation:

- 1) Apply to the male threads and tighten joints securely.
 - 2) Clean excess sealant from exposed threads after assembly.
 - f. Securely tighten all threaded connections.
 - g. Any exposed threaded surfaces must be cleaned and coated with a galvanizing solution so that all exposed surfaces have a galvanized protective coating.
 3. PVC:
 - a. Use approved solvent-weld cement specifically manufactured for the purpose. Spray-type cement is not allowed.
 - b. Apply heat for bends so that conduit does not distort or discolor. Use a spring mandrel as required to ensure full inside diameter at all bends:
 - 1) Utilize a heater specifically for PVC conduit as recommended by the conduit manufacturer.
- G. Conduit sealing and drainage:
1. Conduit drainage and sealing other than required for hazardous and classified areas:
 - a. Provide sealing and drainage in vertical drops of long (in excess of 20 feet), exterior, above-grade conduit runs at the points at which the conduit enters buildings, switchgear, control panels, lighting panelboards, and other similar enclosures.
 - b. Provide seal fittings with drains in vertical drops directly above grade for exterior and above-grade conduit runs that are extended below grade.
 - c. Provide conduit seals with drains in areas of high humidity and rapidly changing temperatures:
 - 1) Where portions of an interior raceway pass through walls, ceilings, or floors that separate adjacent areas having widely different temperatures.
 - d. Provide conduit seals similar to O-Z/Gedney (Type CSM) on all conduits between corrosive and non-corrosive areas.
 - e. Seal one end only of all underground conduits at highest point with O-Z/Gedney sealing (non-hazardous) filling, or equal.
 2. Install seals with drains at any location along conduit runs where moisture may condense or accumulate. This requirement includes, but is not limited to, the following locations: control panels, junction boxes, pullboxes, or low points of the conduit.
- H. Conduit supports:
1. General:
 - a. Provide appropriate hangers, supports, fasteners, and seismic restraints to suit applications:
 - 1) As specified in the Hangers and Supports section.
 - 2) Provide support materials consistent with the type of conduit being installed as specified in the Common Work Results for Electrical section.
 - b. Support conduit at the intervals required by the NEC.
 - c. Perforated strap and plumbers tape are not acceptable for conduit supports.
 2. Conduit on concrete or masonry:
 - a. Use 1-hole malleable iron straps with metallic or plastic expansion anchors and screws or support from preset inserts.
 - b. Use preset inserts in concrete when possible.
 - c. Use pipe spacers (clamp backs) in wet locations.
 3. Suspended conduit:
 - a. Use malleable-iron factory-made split-hinged pipe rings with threaded suspension rods sized for the weight to be carried (minimum 3/8-inch diameter), Kindorf, or equal.
 - b. For grouped conduits, construct racks with threaded rods and tiered angle iron or preformed channel cross members. Clamp each conduit individually to a cross member. Where rods are more than 2-feet long, provide rigid sway bracing.
 4. Supports at structural steel members:
 - a. Use beam clamps.

- b. Drilling or welding may be used only as specified or with approval of the Engineer.
 - 5. PVC-coated rigid metal systems:
 - a. Provide right-angle beam clamps and "U" bolts specially formed and sized to snugly fit the outside diameter of the coated conduit. Provide "U" bolts with PVC-encapsulated nuts that cover the exposed portions of the threads.
 - b. Securely fasten exposed conduits with Type 316 stainless steel clamps or straps.
 - I. Expansion or expansion/deflection fittings:
 - 1. General:
 - a. Align expansion coupling with the conduit run to prevent binding.
 - b. Follow manufacturer's instructions to set the piston opening.
 - c. Install expansion fittings across concrete expansion joints and at other locations where necessary to compensate for thermal or mechanical expansion and contraction.
 - d. Furnish fittings of the same material as the conduit system.
 - 2. For metallic conduit, provide expansion or expansion/deflection couplings, as appropriate, where:
 - a. Install expansion fittings a minimum of every 200 feet in straight conduit runs.
 - J. Empty conduits:
 - 1. Provide a polyethylene rope rated at 250 pounds tensile strength in each empty conduit more than 10 feet in length.
 - 2. Seal ends of all conduits with approved, manufactured conduit seals, caps, or plugs immediately after installation:
 - a. Keep ends sealed until immediately before pulling conductors.
 - K. Miscellaneous:
 - 1. Seal roof penetrations for raceways and other items that penetrate the roof in accordance with roofing manufacturer's instructions and as indicated on the Drawings.
 - 2. Provide electrical unions at all points of union between ends of rigid conduit systems that cannot otherwise be coupled:
 - a. Running threads and threadless couplings are not allowed.
 - 3. Replace any conduits installed that the Engineer determines do not meet the requirements of this Specification.
- 3.4 ERECTION, INSTALLATION, APPLICATIONS, CONSTRUCTION (NOT USED)
- 3.5 REPAIR/RESTORATION (NOT USED)
- 3.6 RE-INSTALLATION (NOT USED)
- 3.7 COMMISSIONING (NOT USED)
- 3.8 FIELD QUALITY CONTROL
- A. As specified in the Common Work Results for Electrical section.

3.9 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in the Common Work Results for Electrical section.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 261330

DUCT BANKS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Electrical underground duct banks.
 - 2. Duct bank installation requirements.

1.02 REFERENCES

- A. As specified in the Common Work Results for Electrical section.

1.03 DEFINITIONS

- A. As specified in the Common Work Results for Electrical section.

1.04 SYSTEM DESCRIPTION

- A. Provide trenching, forming, , spacers, conduit, sand, backfill, and compaction necessary for the complete installation of the duct banks.
- B. Provide (sand backfilled) duct banks for all conduits installed below grade, on the site, below structures, or in contact with the earth, unless otherwise indicated on the Drawings.

1.05 SUBMITTALS

- A. Furnish submittals as specified in the Submittal Procedures section and the Common Work Results for Electrical section.
- B. Product data:
 - 1. PVC conduit spacers.
 - 2. Detectable underground marking tape.
 - 3. Pull line.
- C. Shop drawings:
 - 1. Submit site plan drawings of duct banks including underground profiles indicating all underground utilities.
 - 2. For duct bank routings crossing under building footers or foundations alternative to designed routings indicated on the Drawings:
 - a. Submit shop drawings detailing the new building footer crossing locations and plan drawings labeling all equipment to be installed on top of the new routing for approval by the project Structural Engineer.

1.06 QUALITY ASSURANCE

- A. As specified in the Common Work Results for Electrical section.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. As specified in the Common Work Results for Electrical section.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in the Common Work Results for Electrical section.

1.09 SEQUENCING

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in the Common Work Results for Electrical section.

1.12 SYSTEM START-UP

A. As specified in the Common Work Results for Electrical section.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Conduit spacers:

1. One of the following or equal:
 - a. Carlon Snap-Loc.
 - b. Cantex.
 - c. Osburn Associates, Inc.

B. Detectable underground marking tape:

1. One of the following or equal:
 - a. Blackburn Manufacturing Co.
 - b. Pro-Line Safety Products.
 - c. Panduit.

C. Pull line:

1. One of the following or equal:
 - a. Arnco.
 - b. Greenlee.
 - c. Osburn Associates, Inc.

D. Duct seal:

1. The following or equal:
 - a. OZ Gedney type DUX.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Provide conduit as specified in the Conduits section:

1. Use duct suitable for use with 194 degree Fahrenheit rated conductors.

2.04 MANUFACTURED UNITS

- A. Conduit spacers:
 - 1. Provide conduit spacers recommended by the conduit manufacturer or specified above.
 - 2. Saddle type.
 - 3. Non-metallic, non-corrosive, non-conductive.
 - 4. Interlocking type:
 - a. Vertical interlocking.
 - b. Horizontal interlocking.
 - 5. Suitable for concrete encasement.
 - 6. Molded-in rebar holder.
 - 7. Accommodates 2-inch through 6-inch conduit sizes.
 - 8. Relieves the conduit from both horizontal and vertical stresses.
- B. Pull line:
 - 1. Minimum 1/4-inch wide, flat design.
 - 2. Polyester.
 - 3. Minimum pulling strength 1,200 pounds.
- C. Detectable marking tape:
 - 1. Provide a detectable tape, locatable by a cable or metal detector from above the undisturbed grade.
 - 2. Aluminum core laminated between polyethylene film.
 - 3. 6-inch wide red tape imprinted with black lettering stating "CAUTION - BURIED ELECTRIC LINE BELOW" or equivalent.
- D. Duct seal:
 - 1. Non-hardening sealing compound.
 - 2. Flexible, can be applied by hand.
 - 3. UL Listed for use with installed conductors.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in the Common Work Results for Electrical section.
- B. Duct banks:
 - 1. Install duct banks encased in sand at least 24 inches below finish grade, unless otherwise indicated on the Drawings.
 - 2. Damage minimization:
 - a. Conduit should not be left exposed in an open trench longer than is necessary.
 - b. Protect all underground duct banks against damage during pouring of concrete or backfilling.
 - 3. All plastic conduit fittings to be joined should be exposed to the same temperature conditions for a reasonable length of time before assembly.
 - 4. Provide No. 4/0 American Wire Gauge bare copper ground wire the entire length of duct bank and bond to the grounding system at each end of the duct bank.
 - 5. Install underground ducts to be self-draining:
 - a. Slope duct banks away from buildings to manholes, handholes, or pullboxes.
 - b. Slope duct banks uniformly from manholes, handholes, or pullboxes to manholes, handholes, or pullboxes or both ways from high points between manholes, handholes, or pullboxes.
 - c. Slope a minimum of 1/4 inch per 10 feet.
 - 6. Where new duct banks join to existing manholes, handholes, or pullboxes, make the proper fittings and fabricate the concrete envelopes to ensure smooth durable transitions, as indicated on the Drawings.
 - 7. Install pull line in spare conduits:
 - a. Provide adequate pull line at both ends of conduits to facilitate conductor pulling.
 - b. Cap above ground spare conduit risers at each end with screw-on conduit caps.
- C. Trenching:
 - 1. Trench must be uniformly graded with the bottom, rock free and covered with select material.
 - 2. Whenever possible, use the walls of the trench as forms for concrete encasement:
 - a. Forms are required where the soil is not self-supporting.
 - 3. Avoid damaging existing ducts, conduits, cables, and other utilities.
- D. Duct spacing:
 - 1. Separate conduits with manufactured plastic spacers using a minimum space between the outside surfaces of adjacent conduits of 2 inches, unless otherwise indicated on the Drawings:
 - a. Separate medium voltage ducts a minimum of 7.5 inches on center.
 - 2. Install spacers to maintain uniform spacing of duct assembly a minimum of 4 inches above the bottom of the trench during concrete pour. Install spacers on 8-foot maximum intervals:
 - a. Due to some distortion of conduit from heat, and other means, it may be necessary to install extra spacers within the duct bank:
 - 1) Install the intermediate set of spacers within normal required spacing to maintain the proper horizontal clearance:
 - a) Clearance is required to allow the proper amount of concrete to infiltrate vertically among the duct to ensure proper protection.
 - 3. Spacers shall not be located at the center of a bend:
 - a. Locate spacer in the tangent, free of the coupling on fabricated bends.
 - b. Locate spacers midway between the tangent and the center bend on trench formed sweeps.

- E. Terminating:
 - 1. Use bell ends in duct at entrances into cable vaults.
 - 2. Make conduit entrances into cable vaults tangential to walls of cable vault.
 - 3. Form trapezoidal transitions between duct bank and cable vaults as needed in order to ensure adequate cable bending radius for the duct bank-to-vault transition.
 - 4. Install duct seal in all conduits including spare conduits, at entrance to manholes/handholes, and building/equipment stub-ups. Form by hand to conduit and around cables to develop moisture barrier.
 - 5. New manhole or handhole applications, provide a single opening or "window" per duct bank, sized to accommodate the duct bank envelope.
- F. Marking tape:
 - 1. Install a detectable marking tape 12 inches above the duct bank the entire length of the duct bank.
- 3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)
- 3.05 REPAIR/RESTORATION (NOT USED)
- 3.06 RE-INSTALLATION (NOT USED)
- 3.07 COMMISSIONING (NOT USED)
- 3.08 FIELD QUALITY CONTROL
 - A. As specified in Section 16050 - Common Work Results for Electrical.
- 3.09 ADJUSTING (NOT USED)
- 3.10 CLEANING
 - A. Clean conduits of dirt and debris by use of an appropriately sized steel mandrel no less than 1/2 inch smaller than the inside diameter of the conduit.
- 3.11 PROTECTION
 - A. As specified in Section 16050 - Common Work Results for Electrical.
 - B. Provide shoring and pumping to protect the excavation and safety of workers.
 - C. Protect excavations with barricades as required by applicable safety regulations.
- 3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 261500

LOW VOLTAGE WIRE CONNECTIONS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Wire connecting devices.
 - 2. Terminations.
 - 3. Splices.

1.2 REFERENCES

- A. As specified in the Common Work Results for Electrical section.
- B. ASTM International (ASTM):
 - 1. D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.
- C. CSA International (CSA):
 - 1. C22.2 - No.197-M1983 (R2208) - PVC Insulating Tape.
- D. Underwriters Laboratories, Inc. (UL):
 - 1. 510 - Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.

1.3 DEFINITIONS

- A. As specified in the Common Work Results for Electrical section.

1.4 SYSTEM DESCRIPTION

- A. Provide a complete system of wiring connectors, terminators, fittings, etc. for a complete wiring system suitable for the cables and conductors used.

1.5 SUBMITTALS

- A. Furnish submittals as specified in the Common Work Results for Electrical section.
- B. Product data:
 - 1. Catalog cut sheets.
 - 2. Installation instructions.

1.6 QUALITY ASSURANCE

- A. As specified in the Common Work Results for Electrical section.
- B. All materials shall be UL listed.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. As specified in the Common Work Results for Electrical section.

1.8 PROJECT OR SITE CONDITIONS

A. As specified in the Common Work Results for Electrical section.

1.9 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in the Common Work Results for Electrical section.

1.12 SYSTEM START-UP

A. As specified in the Common Work Results for Electrical section.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers for each type of technology are specified with the equipment in this Section.

2.2 EXISTING PRODUCTS (NOT USED)

2.3 MATERIALS (NOT USED)

2.4 MANUFACTURED UNITS (NOT USED)

2.5 EQUIPMENT

A. Control connections:

1. Use insulated ring type wire terminators for connections to all screw terminals:
 - a. With chamfered/funneled terminal barrel entry.
 - b. Deep internal serrations.
 - c. Long barrel design to reduce electrical resistance and increased insulator-barrel surface area to ensure that the insulator remains in contact with the barrel.
 - d. Electroplated-tin copper conductor.
 - e. Manufacturers: The following or equal:
 - 1) Thomas and Betts, Stakon.
2. For process equipment connections work from manufacturer's drawings.

B. Joints, splices, taps, and connections:

1. 600-volt conductors:
 - a. Use solderless connectors.
 - b. Use only plated copper alloy connectors or lugs:
 - 1) Aluminum connectors or lugs are not acceptable for copper conductors.
 - c. Under those specific conditions where aluminum conductors have been allowed or are specified then the connectors for aluminum conductors shall be specifically designed for that purpose.

- d. For wire Number 10 AWG and smaller use compression splice caps, with insulating caps:
 - 1) Manufacturers: The following or equal:
 - a) Buchanan, 2006S or 2011S, with 2007 or 2014 insulating caps.
 - e. For wire Number 8 AWG and larger, use heavy duty copper compression connectors:
 - 1) Manufacturers: One of the following or equal:
 - a) Burndy.
 - b) Thomas and Betts.
 - f. Heat shrink tubing:
 - 1) Suitable for indoors, outdoors, overhead, direct burial or submerged applications.
 - 2) Minimum shrink ratio: 4 to 1.
 - 3) Continuous operating temperature: -55 degrees Celsius to 110 degrees Celsius.
 - 4) Internally applied adhesive sealant.
 - 5) Cross-linked polyolefin:
 - a) Manufacturers: One of the following or equal:
 - (1) 3M, ITCSN.
 - (2) Thomas & Betts, Shrink-Kon.
 - 2. Instrumentation class cable splices:
 - a. Suitable for indoor, outdoors, weather exposed, direct buried, or submersed applications.
 - b. Utilizing an epoxy, polyurethane, and re-enterable compounds.
 - c. For use with shielded or unshielded plastic- and rubber-jacketed, signal, control, and power cables rated up to 1 kilovolt.
 - d. Two-part mold body with tongue and groove seams and built in spacer webbing.
 - e. Manufacturers: The following or equal:
 - 1) 3M, Scotchcast 72-N.
- C. Insulating tape:
- 1. General purpose insulating tape:
 - a. Minimum 7 mil vinyl tape.
 - b. Suitable for application in an ambient of -18 degrees Celsius (0 degrees Fahrenheit).
 - c. Operating range up to 105 degrees Celsius (220 degrees Fahrenheit).
 - d. Flame retardant, hot- and cold- weather resistant, UV resistant.
 - e. For use as a primary insulation for wire cable splices up to 600 VAC.
 - f. Meeting and complying with:
 - 1) ASTM D3005 Type I.
 - 2) UL 510.
 - 3) CSA C22.2.
 - g. Manufacturers: The following or equal:
 - 1) 3M, Scotch Number Super 33+.
 - 2. General-purpose color-coding tape:
 - a. Minimum 7 mil vinyl tape.
 - b. Suitable for application on PVC and polyethylene jacketed cables.
 - c. For use indoors and outdoors in weather protected enclosures.
 - d. Available with the following colors:
 - 1) Red.
 - 2) Yellow.
 - 3) Blue.
 - 4) Brown.
 - 5) Gray.
 - 6) White.
 - 7) Green.

- 8) Orange.
- 9) Violet.
- e. For use as phase identification, marking, insulating, and harnessing.
- f. Meeting and complying with:
 - 1) UL 510.
 - 2) CSA C22.2.
- g. Manufacturers: The following or equal:
 - 1) 3M, Scotch Number 35.

2.6 COMPONENTS (NOT USED)

2.7 ACCESSORIES (NOT USED)

2.8 MIXES (NOT USED)

2.9 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.1 EXAMINATION (NOT USED)

3.2 PREPARATION (NOT USED)

3.3 INSTALLATION

A. As specified in the Common Work Results for Electrical section.

B. Load connections:

- 1. Connect loads to the circuits as indicated. Color-code all branch circuits as specified in Section 16123 - 600-Volt or Less Wires and Cables.

C. Zero to 600-volt systems:

- 1. Make all connections with the proper tool and die as specified by the device manufacturer.
- 2. Use only tooling and dies manufactured by the device manufacturer.
- 3. Insulate all connections and splices with Scotch 33+ tape and Scotchfill, or pre-molded plastic covers, or heat shrink tubing and caps.
- 4. Number all power and control wires before termination.

D. Motor connections (600 volts and below):

- 1. Terminate all leads and wires with compression type ring lugs.
- 2. Terminations on all motor leads, including leads that are connected together to accommodate the motor voltage, and the machine wires entering the motor terminal box from the power source, shall have ring type compression lugs.
- 3. Cover bolted connectors with a heat shrinkable, cross-linked polyolefin material formed as a single opening boot:
 - a. In damp and wet locations, use a complete kit containing mastic that shall seal out moisture and contamination.
 - b. Shrink cap with low heat as recommended by manufacturer.
- 4. Wire markers shall be readable after boot installation.

- 5. Manufacturers: The following or equal:
 - a. Raychem, MCK.

3.4 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.5 REPAIR/RESTORATION (NOT USED)

3.6 RE-INSTALLATION (NOT USED)

3.7 COMMISSIONING

A. As specified in the Commissioning section.

3.8 FIELD QUALITY CONTROL

A. As specified in the Common Work Results for Electrical section.

3.9 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in the Common Work Results for Electrical section.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 262850

SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. High-energy surge protective devices.

1.2 REFERENCES

- A. As specified in the Common Work Results for Electrical section.
- B. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. C62.41.1 - Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.
 - 2. C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
 - 3. C62.45 - Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.
 - 4. C62.62- Standard Test Specifications for Surge Protective Devices (SPDs) for Use on the Load Side of the Service Equipment in Low Voltage (1000 V and less) AC Power Circuits.
- C. National Electrical Manufacturers Association (NEMA):
 - 1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).
- D. Underwriters Laboratory:
 - 1. 1449, 4th Edition, Standard for Surge Protective Devices.

1.3 DEFINITIONS

- A. As specified in the Common Work Results for Electrical section.
- B. NEMA:
 - 1. Type 1 enclosure in accordance with NEMA 250.
 - 2. Type 4 enclosure in accordance with NEMA 250.
 - 3. Type 4X enclosure in accordance with NEMA 250.
 - 4. Type 12 enclosure in accordance with NEMA 250.
- C. Specific definitions:
 - 1. SPD: Surge protective device.
 - 2. SAD: Silicon avalanche diode.
 - 3. MOV: Metal oxide varistor.
 - 4. MCOV: Maximum continuous operating voltage.
 - 5. I_n: Nominal discharge current.
 - 6. VPR: Voltage protection rating.
 - 7. SCCR: Short circuit current rating.

1.4 SUBMITTALS

- A. Furnish submittals as specified in the Common Work Results for Electrical section.

- B. Product data:
 - 1. Furnish complete product data confirming detailed compliance or exception statements to all provisions of this Section.
 - 2. Manufacturer's catalog cut sheets indicating:
 - a. Manufacturer and model numbers.
 - b. Ratings of each SPD including but not limited to:
 - 1) Short circuit current rating.
 - 2) Nominal discharge current.
 - 3) Maximum continuous operating voltage.
 - 4) Voltage protection rating.
 - 5) System voltage.
 - 6) System frequency.
 - 7) Surge current capacity.
 - 3. Submit independent test data from a nationally recognized testing laboratory verifying the following:
 - a. Overcurrent protection.
 - b. UL 1449.
- C. Shop drawings:
 - 1. Provide electrical and mechanical drawings by the manufacturer that detail:
 - a. Unit dimensions.
 - b. Weights.
 - c. Components.
 - d. Field connection locations.
 - e. Mounting provisions.
 - f. Connection details.
 - g. Wiring diagram.
- D. Operation and maintenance manuals:
 - 1. Provide the manufacturer's manual with installation, start-up, spare parts lists, and operating instructions for the specified system.

1.5 QUALITY ASSURANCE

- A. As specified in the Common Work Results for Electrical section.
- B. Provide SPD units that are designed, manufactured, tested and installed in compliance with the following codes and standards:
 - 1. Institute of Electrical and Electronics Engineers (IEEE C62.41.1, C62.41.2, C62.45, C62.62).
 - 2. Federal Information Processing Standards Publication 94 (FIPS PUB 94).
 - 3. National Electrical Manufacturer Association.
 - 4. National Fire Protection Association (NFPA 20, 75 and 780).
 - 5. National Electric Code (NFPA 70).
 - 6. Underwriters Laboratories (UL 1449 4th Edition and UL 1283).
 - 7. International Electrotechnical Commission (IEC 801).

1.6 DELIVERY, STORAGE, AND HANDLING

- A. As specified in the Common Work Results for Electrical section.

1.7 PROJECT OR SITE CONDITIONS

- A. As specified in the Common Work Results for Electrical section.

1.8 SEQUENCING

- A. Coordinate with and provide SPD equipment to the electrical equipment manufacturer before final assembly and factory testing.

1.9 SCHEDULING (NOT USED)

1.10 WARRANTY

- A. As specified in the Common Work Results for Electrical section.
- B. Extended warranty:
 - 1. Furnish a manufacturer's full 5-year parts and labor warranty from date of shipment against any part failure when installed in compliance with manufacturer's written instructions, UL listing requirements, and any applicable national, state, or local electrical codes.
 - 2. Warranty shall include:
 - a. Direct, factory trained employees must be available within 48 hours for assessment of the problem.
 - b. A 24-hour toll-free 800-number for warranty support.

1.11 SYSTEM START-UP

- A. As specified in the Common Work Results for Electrical section.

1.12 OWNER'S INSTRUCTIONS (NOT USED)

1.13 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. One of the following or equal:
 - 1. Liebert.
 - 2. Eaton.
 - 3. Schneider Electric.
 - 4. General Electric.

2.2 SYSTEM DESCRIPTION

- A. Surge protective devices as an integral component of the electrical equipment or externally mounted as indicated on the Drawings.

2.3 EXISTING PRODUCTS (NOT USED)

2.4 MATERIALS (NOT USED)

2.5 MANUFACTURED UNITS

- A. Provide Type 1 or Type 2 SPD units as required for the locations indicated on the Drawings.
- B. Electrical requirements:
 - 1. SPD ratings are to be consistent with the nominal system operating voltage, phase, and configuration as indicated on the Drawings.
 - 2. MCOV:

- a. For the SPD and all components in the suppression path (including all MOVs, SADs, and selenium cells): Greater than 115 percent of the nominal system operating voltage.
- 3. Operating frequency:
 - a. 47 to 63 hertz.
- 4. SCCR:
 - a. 65 kAIC minimum, but not less than the equipment it is connected to as indicated on the Drawings.
 - b. The SCCR shall be marked on the SPD in accordance with UL 1449 and the NEC.
- 5. Nominal discharge current I_n :
 - a. 20 kA.
- 6. Maximum VPR:

Modes	<u>240/120</u>	<u>208Y/120</u>	480Y/277	480V
L-N, L-G, N-G	900	900	1,500	1,500
L-L	1,200	1,200	2000	2,000

- 7. Peak surge current:
 - a. Service entrance locations:
 - 1) 240 kA per phase minimum.
 - 2) 120 kA per mode minimum.
 - b. Branch locations:
 - 1) 120 kA per phase, minimum.
 - 2) 60 kA per mode minimum.
- C. Protection modes:
 - 1. Provide SPD protection modes as follows:
 - a. Line to Neutral (L-N) where applicable.
 - b. Line to Ground (L-G).
 - c. Neutral to Ground (N-G), where applicable.
- D. Environmental requirements:
 - 1. Storage temperature:
 - a. -40 degrees to 122 degrees Fahrenheit.
 - 2. Operating temperature:
 - a. 32 degrees to 140 Fahrenheit.
 - 3. Relative humidity:
 - a. 5 percent to 95 percent.
 - 4. Audible noise:
 - a. Less than 45 dBA at 5 feet (1.5 m).
 - 5. Operating altitude:
 - a. Zero to 12,000 feet above sea level.
- E. Provide surge protective devices that are suitable for application in IEEE C62.41.1, C62.41.2 Category A, B and C3 environments, as tested to IEEE C62.45.

2.6 EQUIPMENT (NOT USED)

2.7 COMPONENTS

- A. Enclosure:
 - 1. Located in electrical equipment as indicated on the Drawings.
 - 2. External mounting:
 - a. NEMA Type 4X enclosure:
 - 1) No ventilation openings.

- b. Hinged cover requiring a tool for internal access.
 - c. Internal drawing pocket.
 - d. All monitoring indications must be visible without opening the door.
- B. Internal connections:
 - 1. Provide low impedance copper plates for intra-unit connections:
 - a. Attach surge modules using bolted connections to the plates for low impedance connections.
 - 2. Size all connections, conductors, and terminals for the specified surge current capacity.
- C. Surge diversion modules:
 - 1. MOV:
 - a. Where multiple MOVs are used in parallel, utilize computer matched MOVs to within 1 volt variance and tested for manufacturer's defects.
- D. Overcurrent protection:
 - 1. Individually fuse all components, including suppression, filtering, and monitoring components:
 - a. Rated to allow maximum specified nominal discharge current capacity.
 - b. Overcurrent protection that limits specified surge currents is not acceptable.
- E. Connections:
 - 1. Provide terminals to accommodate wire sizes up to #2 AWG.

2.8 ACCESSORIES

- A. Unit status indicators:
 - 1. Provide red and green solid-state indicators, with printed labels, on the front cover to redundantly indicate on-line unit status:
 - a. The absence of the green light and the presence of the red light indicate that surge protection is reduced and service is needed to restore full operation.
 - b. Indicates the status of protection on each mode or phase.
- B. Dry contacts for remote monitoring:
 - 1. Electrically isolated Form C dry contacts (1 A/125 VAC) for remote monitoring of system integrity, and indication of under voltage, phase and/or power loss.
- C. Provide an audible alarm which activates under any fault condition.
 - 1. Provide an alarm On/Off switch to silence the alarm.
 - 2. A visible LED will confirm whether alarm is On or Disabled.
 - 3. Locate both switches and the audible alarm on the unit's front cover.
- D. Provide an integral disconnect switch located in-line with the SPD enclosure:
 - 1. External manual operator.
 - 2. The switch shall disconnect all ungrounded circuit conductors from the SPD.
 - 3. The integral disconnect switch shall be capable of withstanding, without failure, the maximum published surge current magnitude and short circuit current without failure or damage to the switch.
- E. Interconnection cable:
 - 1. Interconnect the SPD to the power system using a manufacturer furnished assembly of low impedance coaxial cables installed in flexible conduit.
 - 2. Cable designed to transmit transients with minimal voltage drop.
 - 3. UL listed.

2.9 MIXES (NOT USED)

- 2.10 FABRICATION (NOT USED)
- 2.11 FINISHES (NOT USED)
- 2.12 SOURCE QUALITY CONTROL
 - A. Permanently affix surge rating to the SPD.
 - B. Perform manufacturer's standard factory test:
 - 1. Perform testing in accordance with UL 1449.

PART 3 EXECUTION

- 3.1 EXAMINATION (NOT USED)
- 3.2 PREPARATION (NOT USED)
- 3.3 INSTALLATION
 - A. As specified in the Common Work Results for Electrical section.
 - B. Follow the manufacturer's recommended installation practices and comply with all applicable codes.
 - C. Special techniques:
 - 1. Install the SPD with as short and straight conductors including ground conductor as practically possible:
 - a. Twist the input conductors together to reduce input conductor inductance.
 - 2. Interconnect the SPD to the power system using a manufacturer supplied interconnection cable consisting of low impedance coaxial cables installed in a flexible conduit.
 - 3. Do not subject SPD to insulation resistance testing.
- 3.4 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)
- 3.5 REPAIR/RESTORATION (NOT USED)
- 3.6 RE-INSTALLATION (NOT USED)
- 3.7 COMMISSIONING
 - A. As specified in the Commissioning section.
- 3.8 FIELD QUALITY CONTROL
 - A. As specified in the Field Electrical Acceptance Tests section.
- 3.9 ADJUSTING (NOT USED)
- 3.10 CLEANING (NOT USED)
- 3.11 PROTECTION
 - A. As specified in the Common Work Results for Electrical section.
- 3.12 SCHEDULES (NOT USED)

END OF SECTION

OUACHITA WATER TREATMENT PLANT

WASTE RESIDUALS LAGOONS

PREPARED FOR:
CITY OF HOT SPRINGS
UTILITIES DEPARTMENT

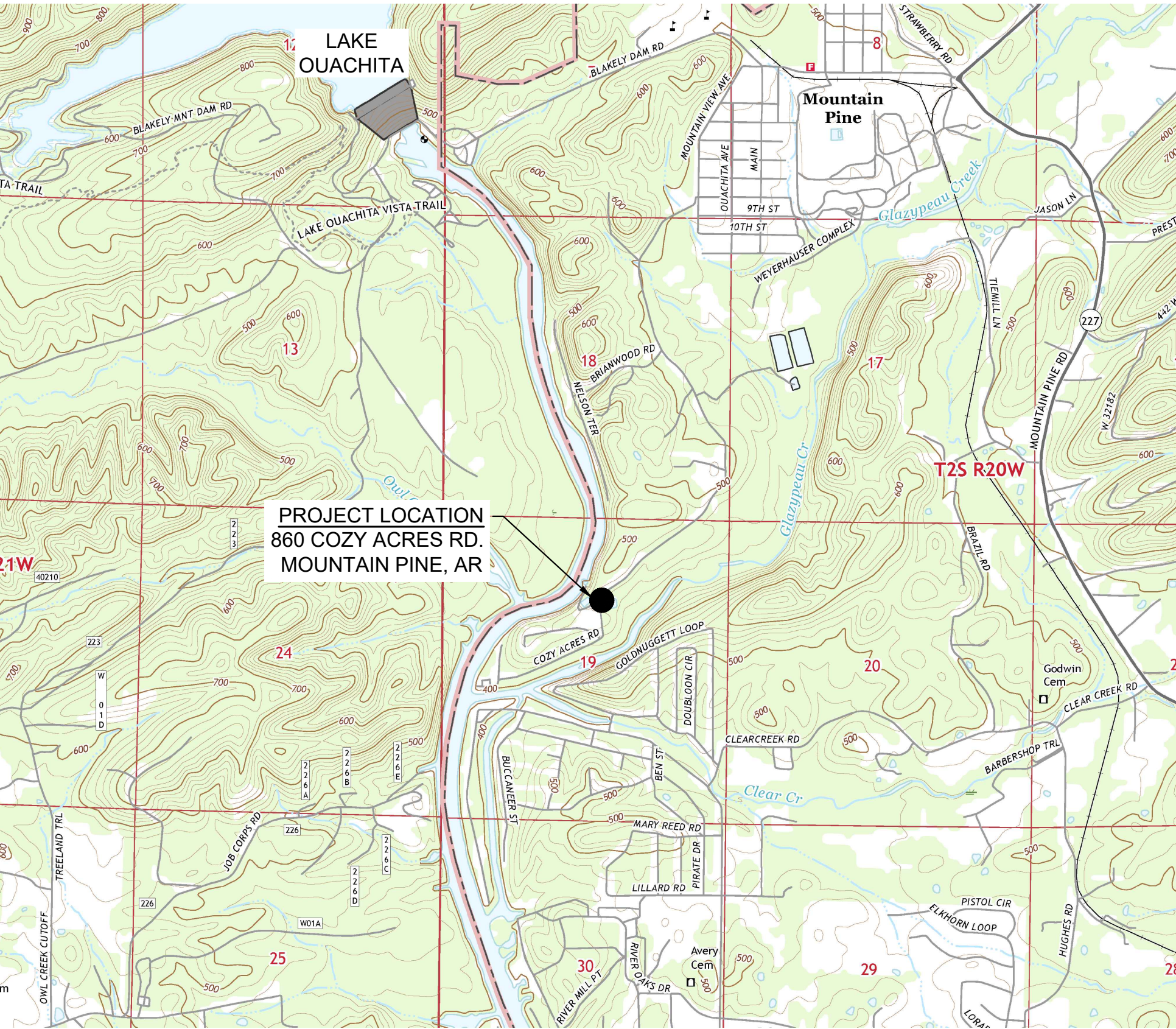


BID SET
JANUARY 2025

CRIST PROJECT NO. 1964



CRIST ENGINEERS, INC.
CONSULTING ENGINEERS
LITTLE ROCK, ARKANSAS



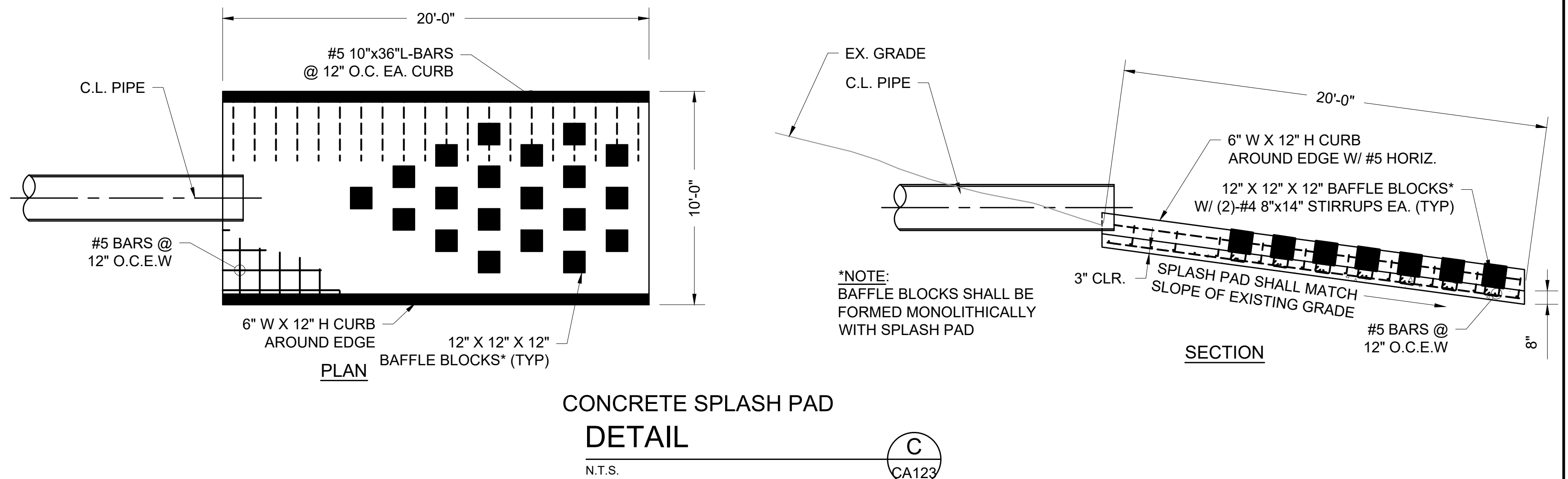
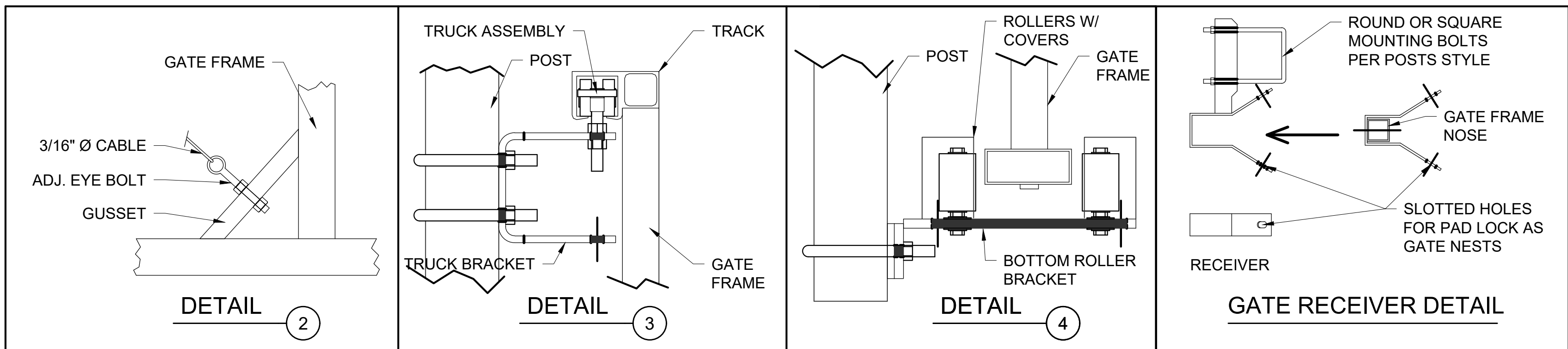
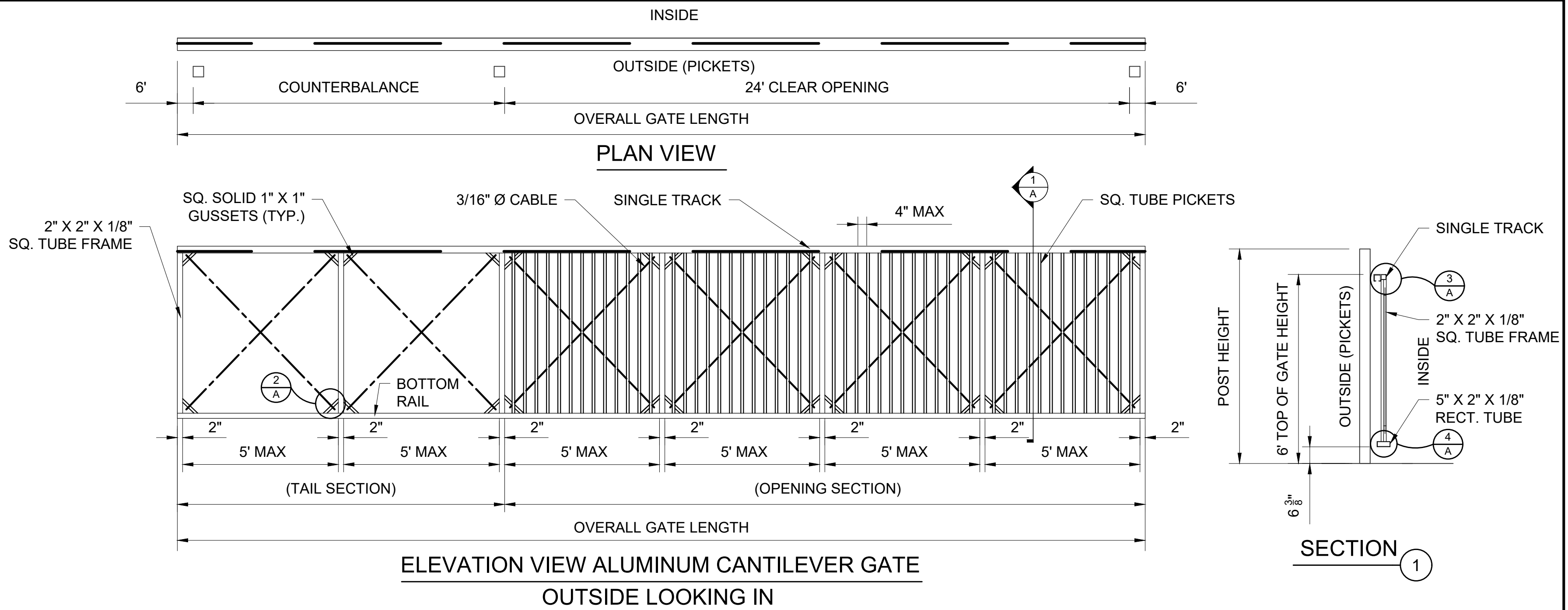
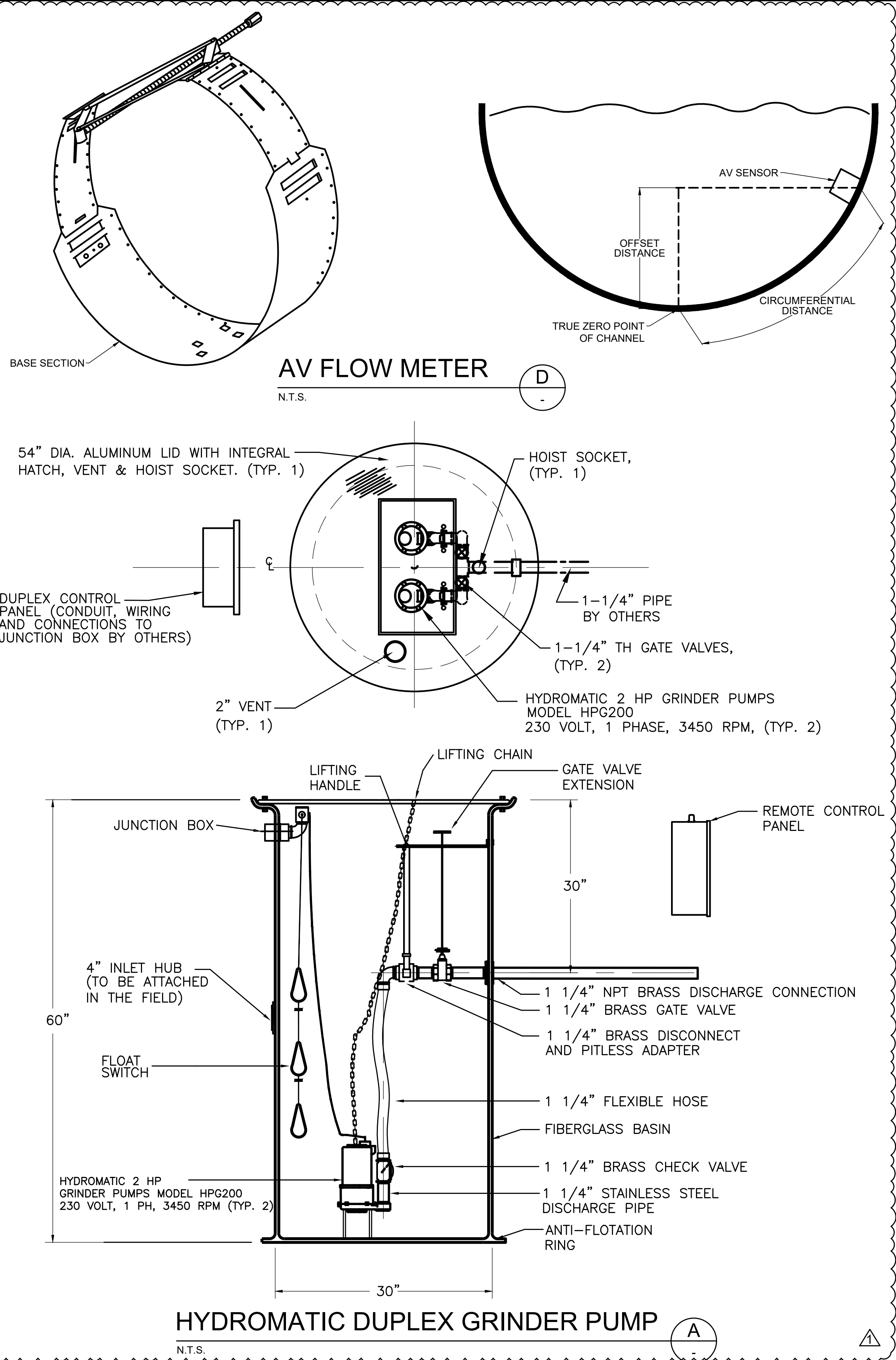
VICINITY MAP
N.T.S.

Sheet List Table

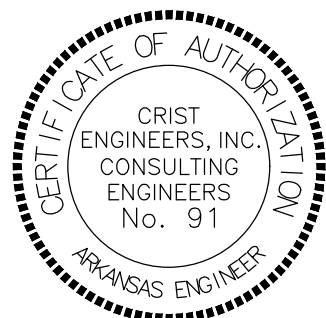
SHEET NUMBER	SHEET TITLE		
--	COVER SHEET	18	RETAINING WALL PLAN & SECTIONS
01	GENERAL NOTES CONTACTS & SHEET INDEX	19	RETAINING WALL SECTIONS
02	EXISTING CONDITIONS	20	DISTRIBUTION BOX DETAIL
03	SITE DEMOLITION PLAN	21	INFLOW JUNCTION BOX DETAILS
04	CLEARING LIMITS PLAN	22	TYPICAL OUTLET JUNCTION BOX
05	ISOLATION PLAN	23	OUTLET STRUCTURE DETAILS
06	PROPOSED SITE PLAN	24	RETAINING WALL DETAILS I
07	SITE LAYOUT	25	CIVIL SITE DETAILS I
08	SITE FENCING PLAN	26	CIVIL SITE DETAILS II
09	GRADING PLAN	27	EROSION CONTROL DETAILS I
10	GRADING ISOMETRIC VIEW	28	EROSION CONTROL DETAILS II
11	FINAL OVERALL GRADING	29	PONDS OUTLET STRUCTURE PLANS - STRUCTURAL
12	FINAL OVERALL GRADING ISOMETRIC VIEW	30	PONDS OUTLET STRUCTURE SECTIONS - STRUCTURAL
13	YARD PIPING	31	JUNCTION BOX PLANS & SECTIONS - STRUCTURAL
14	PLAN AND PROFILES- INFLUENT & LAGOONS TO DRAIN LINE	32	DISTRIBUTION BOX PLANS & SECTIONS - STRUCTURAL
15	PLAN AND PROFILE - DRAIN LINE TO OUTFALL	33	TYPICAL REBAR DETAILS
16	SECTIONS I	E1	ELECTRICAL LEGEND AND ABBREVIATIONS
17	SECTIONS II	E2	ELECTRICAL SITE PLAN
		E3	ELECTRICAL DETAILS
		E4	ONE-LINE DIAGRAM

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REV. NO.	DATE	DRWN	CHKD	REMARKS
1	2/5/25	BAM	MDD	PER REVISED DRAWINGS



0 1"
1" = 1"
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CITY OF HOT SPRINGS	JOB NO.
OUACHITA WATER TREATMENT PLANT WASTE RESIDUALS LAGOONS	1964
BID SET	SHEET NO.
CIVIL SITE DETAILS II	26

POWER, LIGHTING & SYSTEM LEGEND

ABBREVIATIONS

	UNDER CABINET LIGHT FIXTURE
	1x4 FLUORESCENT LIGHT
	2x4 FLUORESCENT LIGHT
	FLUORESCENT LIGHT WITH EMERGENCY LIGHT (EL) BATTERY 1400 LUMENS MINIMUM FOR 2 LAMPS
	2x2 FLUORESCENT LIGHT
	RECESSED LIGHT, UNLESS OTHERWISE SHOWN
	WALL MOUNTED LIGHT—MOUNTING HEIGHT AS INDICATED
	LED EXIT LIGHT, CEILING MOUNTED OR AS INDICATED, DARKENED AREA INDICATES FACE, ARROWS INDICATE DIRECTION OF EGRESS
	EMERGENCY EXIT LIGHT, WALL MOUNT 7'–6" A.F.F. OR AS NOTED
	4 FT. STRIP FLUORESCENT LIGHT
	LIGHT SWITCH, MTD. 4'–0" A.F.F.
	LIGHT SWITCH, 2 POLE, MTD 4'–0" A.F.F.
	LIGHT SWITCH, 3–WAY, MTD. 4'–0" A.F.F.
	LIGHT SWITCH, 4–WAY, MTD. 4'–0" A.F.F.
	LIGHT SWITCH WITH PILOT LIGHT, MTD. 4'–0" A.F.F.
	20 AMP DUPLEX RECEPTACLE MTD. HORIZ. 6" ABOVE COUNTER TOP UNLESS OTHERWISE SHOWN
	20 AMP DUPLEX RECEPTACLE MTD. 18" A.F.F., WITH #12 GROUND WIRE, GFCI INDICATES GROUND FAULT CIRCUIT INTERRUPTER, WP INDICATES WEATHERPROOF WHILE IN USE ENCLOSURE AND COVER
	SINGLE RECEPTACLE, RATINGS AS NOTED
	HP RATED TOGGLE SWITCH, 1 OR 2 POLES AS REQUIRED W/OVERLOADS
	NON–FUSED DISCONNECT SWITCH, SIZE AS NOTED
	COMBINATION DISCONNECT AND MOTOR STARTER, SIZE AS NOTED. FUSED TYPE SHOWN.
	FUSED DISCONNECT SWITCH, SIZE AS NOTED
	PUSHBUTTON STATION, NEMA 4X
	ELECTRICAL PANEL, SURFACE MOUNTED, 5'–6" TO TOP OF ENCLOSURE
	ELECTRICAL PANEL, RECESSED MOUNTED, 5'–6" TO TOP OF ENCLOSURE
	EQUIPMENT CABINET SIZE AS NOTED, RECESSED MOUNTED, 5'–6" TO TOP OF ENCLOSURE
	EQUIPMENT CABINET SIZE AS NOTED, SURFACE MOUNTED, 5'–6" TO TOP OF ENCLOSURE
	HOME RUN TO PANEL, RECEPTACLES AND EQUIPMENT SHALL HAVE GREEN GROUND WIRE. NUMBER OF ARROWS INDICATES NUMBER OF PHASE CONDUCTORS, OR AS SHOWN ON SCHEDULE

	BRANCH CIRCUIT WITH PHASE, NEUTRAL, SWITCHED PHASE AND EQUIPMENT GROUNDING CONDUCTORS
	TELEPHONE OR DATA OUTLET, SINGLE GANG BOX MTD. 18" A.F.F. WITH 3/4"C STUB TO ABOVE LAY–IN CEILING. "W" INDICATES 4'–6" MTD. HEIGHT FOR WALL PHONE.
	3/4" PLYWOOD TELEPHONE BACKBOARD, SIZE AS NOTED, MTD. 5'–6" TO TOP
	JUNCTION BOX 42 CUBIC INCH MINIMUM CAPACITY
	FLOOR TELEPHONE OUTLET, CAST JUNCTION–BOX
	WALL TELEPHONE/DATA OUTLET
	DOOR SWITCH MOUNTED IN DOOR JAMB
	DOOR BUTTON WEATHER PROOF, 50" A.F.F.
	DOOR BUZZER MTD 7'–0" A.F.F.
	HANDHOLE OR MANHOLE, IDENTIFIER SHOWN, REFER TO HANDHOLE OR MANHOLE SCHEDULE FOR SIZE
	CIRCUIT BREAKER, TRIP RATING SHOWN, 3–POLE UNLESS NOTED
	FUSE, CURRENT LIMITING, RATING AS SHOWN
	TRANSFORMER, RATINGS AS SHOWN
	ELECTRIC MOTOR, HORSEPOWER SHOWN
	MOTOR STARTER, SIZE AS SHOWN OR REQUIRED. FVNR UNLESS NOTED
	HAND–OFF–AUTO STARTER CONTROLS
	VARIABLE FREQUENCY DRIVE
	DUCT BANK, IDENTIFIER SHOWN. REFER TO DUCT BANK SCHEDULE FOR SIZE AND CONFIGURATION.
	3/4" x 10' COPPER CLAD GROUND ROD
	SURGE ARRESTOR
	GENERATOR
	ATS
	WEATHERHEAD
	CABLE CONNECTION
	KIRK KEY INTERLOCK
	CLOSE TWO OUT OF THREE
	INTERCEPT CONDUIT. PULL NEW FEEDER THE ENTIRE LENGTH OF CIRCUIT.
	DUCT BANK CIRCUIT DESIGNATION SEE DUCT BANK CONDUIT AND CABLE SCHEDULE

LINE TYPES

	FURNISH + INSTALL NEW
	EXISTING
	DEMOLISH
	AREA/PACKAGE BOUNDARY

A	AMP
ACU	AIR CONDITIONING UNIT
AFF	ABOVE FINISHED FLOOR
AHU	AIR HANDLER UNIT
AIC	AMPS INTERRUPTING CAPACITY
AM	AMP–METER
ANN	ANNUNCIATOR
AP	AERIAL PRIMARY
AS	AERIAL SECONDARY
ATS	AUTOMATIC TRANSFER SWITCH
AUX	AUXILIARY
BFI	BLOWN FUSE INDICATOR
BKR	BREAKER
C	CONDUIT
CGRS	PVC COATED GALVANIZED RIGID STEEL
CKT	CIRCUIT
COM	COMMON
CONT	CONTINUOUS
CP	CONTROL PANEL
CPT	CONTROL POWER TRANSFORMER
CR	CONTROL RELAY
CS	CORD SET
CU	COEFFICIENT OF UTILIZATION
CU	CONDENSING UNIT
DEB	DIRECT EARTH BURIED
EC	EMPTY OR EMBEDDED CONDUIT
EF	EXHAUST FAN
EG	EQUIPMENT GROUND
EGC	EQUIPMENT GROUND CONDUCTOR
EL	ELEVATION
EMT	ELECTRICAL METALLIC TUBING
ETM	ELASPED TIME METER
FA	FIRE ALARM
FAP	FIRE ALARM PANEL
FC	FAN COIL
FLR	FLOOR
FOC	FIBER OPTIC CABLE
FS	FLOAT SWITCH
FT	FEET
FVNR	FULL VOLTAGE NON–REVERSING STARTER
FVR	FULL VOLTAGE REVERSING STARTER
G	GROUND
GFCI	GROUND FAULT CIRCUIT INTERRUPTER
GND	GROUND
GRS	GALVANIZED RIGID STEEL
HOA	HAND–OFF–AUTO
HP	HORSEPOWER OR HEAT PUMP
HR	HOUR
JB	JUNCTION BOX
kVA	KILOVOLT–AMPERE
kVAR	KILOVOLT–AMPERE, REACTIVE
kW	KILOWATT
L	LINE (PHASE)
LA	LIGHTNING ARRESTOR
L.O.	LUGS ONLY
LSI	LONG–TIME, SHORT–TIME, INSTANTANEOUS TRIP UNIT
LV	LOW VOLTAGE
MCB	MAIN CIRCUIT BREAKER
MCC	MOTOR CONTROL CENTER
MCP	MOTOR CIRCUIT PROTECTOR
MFR	MANUFACTURER
MIN	MINIMUM
MLO	MAIN LUGS ONLY
MM	MAINTENANCE MODE (ENERGY–REDUCING MAINTENANCE SWITCHING WITH LOCAL STATUS)
MS	MOTOR STARTER
MTD	MOUNTED
MTS	MANUAL TRANSFER SWITCH
N	NEUTRAL
NFDS	NON–FUSED DISCONNECT SWITCH
NTS	NOT TO SCALE
OC	ON CENTER
OH	OVERHEAD
OL	OVERLOAD
OPGP	OFFICE PRINCIPAL GROUND POINT
PB	PUSH BUTTON
PDSC	POWER DISTRIBUTION SERVICES CABINET
PEC	PHOTO ELECTRIC CELL
PF	POWER FACTOR
PFR	POWER FAIL RELAY
PL	PILOT LIGHT
PMR	PHASE MONITOR RELAY
PNL	PANEL
PTT	PUSH–TO–TEST
PVC	SCHEDULE 40 POLYVINYL CONDUIT
RECPT	RECEPTACLE
RM	ROOM
RVAT	REDUCED VOLTAGE AUTO–TRANSFORMER STARTER
S	SECOND
SA	SURGE ARRESTER
SDBC	SOFT DRAWN BARE COPPER
SE	SERVICE ENTRANCE

SHT	SHEET
SN	SOLID NEUTRAL
SS	STAINLESS STEEL
STA	STATION
SW	SWITCH
TC	TIME CLOCK
TEL	TELEPHONE
TD	TIME DELAY
TDD	TIME DELAY ON DE–ENERGIZATION
TDE	TIME DELAY ON ENERGIZATION
TYP	TYPICAL
TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSOR
UG	UNDER GROUND
UH	UNIT HEATER
UP	UNDERGROUND PRIMARY
US	UNDERGROUND SECONDARY
VA	VOLT–AMP
VFD	VARIABLE FREQUENCY DRIVE
VM	VOLT–METER
W	WATT OR WIRE
WH	WEATHER HEAD
WM	WATT METER
WP	WEATHERPROOF
W/	WITH
XMFR	TRANSFORMER

CONTROL SCHEMATIC LEGEND

	WIRING WITHIN PANEL
	WIRING TO FIELD DEVICE
	PUSHBUTTON SWITCH, NORMALLY OPEN
	PUSHBUTTON SWITCH, NORMALLY CLOSED
	SELECTOR SWITCH, NUMBER OF POSITIONS AND CONTACTS AS SHOWN
	RELAY CONTACT, NORMALLY OPEN
	RELAY CONTACT, NORMALLY CLOSED
	TIME DELAY CONTACT, CLOSE ON ENERGIZATION
	TIME DELAY CONTACT, OPEN ON ENERGIZATION
	TIME DELAY CONTACT, OPEN ON DE–ENERGIZATION
	TIME DELAY CONTACT, CLOSE ON DE–ENERGIZATION
	LEVEL SWITCH
	PRESSURE SWITCH
	LIMIT SWITCH CONTACT, NORMALLY OPEN
	LIMIT SWITCH CONTACT, NORMALLY CLOSED
	LIMIT SWITCH CONTACT, HELD OPEN
	LIMIT SWITCH CONTACT, HELD CLOSED
	RELAY COIL, "TR" INDICATES "TIMING RELAY"
	PILOT LIGHT; "A" INDICATES "AMBER LENS," "G" INDICATES "GREEN LENS" "R" INDICATES "RED LENS"
	SOLENOID
	ELAPSED TIME METER
	TERMINAL BLOCK
	ELECTRICAL CONNECTION
	FUSE, AMPERE RATING AS SHOWN OR REQUIRED "BFI" INDICATES "BLOWN FUSE INDICATOR" TYPE
	GROUND CONNECTION TO ENCLOSURE GROUND BAR

GENERAL NOTES:

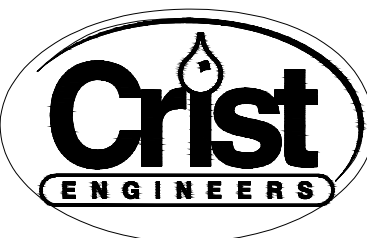
1. SOME SYMBOLS OR ABBREVIATIONS MAY APPEAR ON THIS SHEET AND NOT BE UTILIZED ON THE PROJECT.

REV. NO.	DATE	DRWN	CHKD	REMARKS	



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CITY OF HOT SPRINGS
OUACHITA WATER TREATMENT PLANT
WASTE RESIDUALS LAGOONS

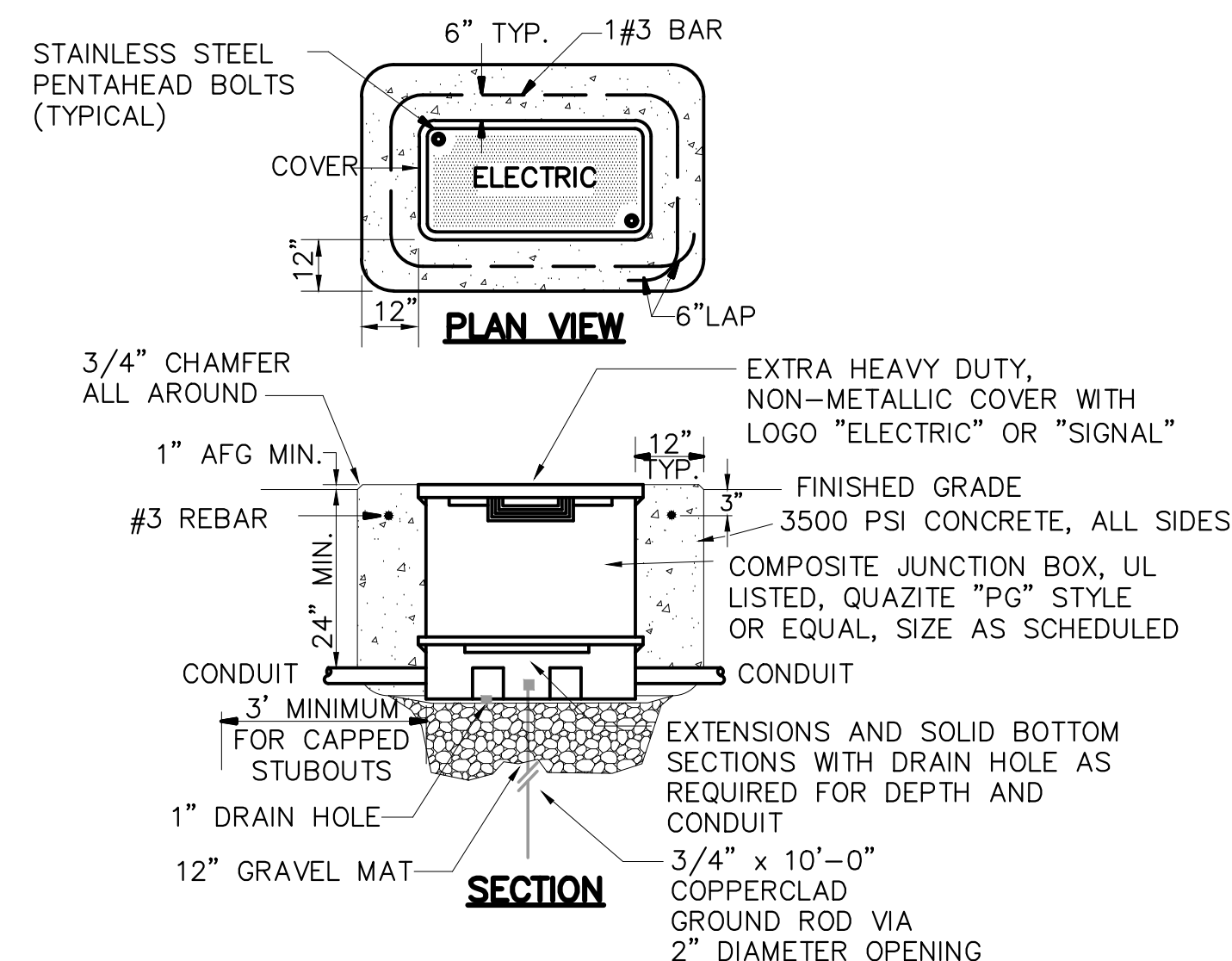
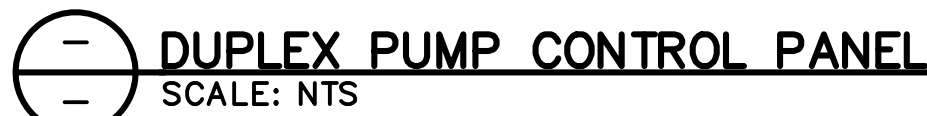
FOR PERMITTING
ELECTRICAL
LEGEND AND ABBREVIATIONS

JOB NO.	CRI-043
SHEET NO.	E1



- NOTES:**

- PIPE AND CONDUIT RACKING SYSTEM
— SCALE: NTS



- NOTES:

1. HANDHOLE AND EXTRA HEAVY-DUTY COVER SHALL BE DESIGNED FOR A TEST LOAD OF 33,750 LBS AND A DESIGN LOAD OF 22,500 LBS.
2. PROVIDE HANDHOLE WITH 2-2" C STUBOUTS IN EACH FACE, CAPPED WATERTIGHT.
3. HANDHOLE INTERIOR DIMENSIONS SHALL BE 30"L x 30"W x 28"D.
4. PROVIDE MINIMUM 3' SLACK CABLE LOOP FOR EACH CABLE.
5. COLOR CODE, TAG AND IDENTIFY ALL CABLES IN HANDHOLE.
6. EXACT LOCATION OF EACH HANDHOLE SHALL BE APPROVED BY THE OWNER AND ENGINEER.



REV. NO.	DATE	DRWN	CHKD	REMARKS



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FOR PERMITTING
ELECTRICAL
DETAILS

SHEET NO.

E3

A circular professional engineer seal for the State of Arkansas. The outer ring contains the text "STATE OF ARKANSAS" at the top and "BRUCE W. BROWN" at the bottom. Inside the ring, the words "REGISTERED PROFESSIONAL ENGINEER" are arranged in a circular pattern around the center. The center of the seal features the number "No. 10206" and the expiration date "JAN 28, 2015". A blue ink signature, "Bruce W. Brown", is written across the seal, overlapping the "REGISTERED PROFESSIONAL ENGINEER" text and the central information.

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DRAFTED:	CD
CHECKED:	BB
DATE:	JAN, 2025



CITY OF HOT SPRINGS
OUACHITA WATER TREATMENT PLANT
WASTE RESIDUALS LAGOONS
 FOR PERMITTING
 ELECTRICAL
 ONE-LINE DIAGRAM

JOB NO.
CRI-043

SHEET NO.
E.