THE KELLEY GROUP
▪ A CIVIL ENGINEERING COMPANY ▪

PROJECT: Dallas County Water & Sewer Authority
Phase I Sewer System Improvements (CWSRF No. CS010889-03)
KG Project No. 22-0031

ADDENDUM NO. Three (3)

DATE: February 11, 2026

TO: All Registered Contract Document Holders

This Addendum is issued to all registered plan holders pursuant to the Conditions of the Contract.

This Addendum serves to clarify, revise, and supersede information in the Project Manual, Drawings, and previously issued Addenda. This addendum and its attachments shall become a part of the plans and specifications and shall apply to the bid proposals for the above-named project.

The bidder(s) shall notify all affected subcontractors, material suppliers, and others to incorporate necessary cost and schedule updates, to the bid proposal and the work changes affected by this Addendum.

The Bidder shall acknowledge receipt of this Addendum in the appropriate space on the Bid Form. Bidders must also acknowledge receipt by email to jessica@kelleynetwork.com.

In the event of conflict between plans and specifications and this addendum, the addendum shall take precedence. Any modifications necessary to incorporate the revisions shall be included in the appropriate bid prices. The bid documents are hereby corrected, modified, and/or amended in the following manner:

General:

1. A site visit has been scheduled for this Friday, February 13th, at 10:00 A.M.

    a. The site visit will begin at 309 Craig Industrial Park Lift Station, located outside of Plantation Patterns Furniture Co (942 W Park Road, Selma, AL 36701). The exact location for this site can be found at the following Google Maps link: https://maps.app.goo.gl/8mnx2iorAGe86aWKA

    b. Each of the following sites will be visited immediately thereafter: 260 Craig Industrial Park Lift Station, 43 Craig Industrial Park Lift Station, 320 Craig Industrial Park Lift Station, and Hwy 80 Lift Station.

2. To provide clarification, all wastewater pumps furnished under this Contract shall be provided with a manufacturer's warranty meeting or exceeding the following minimum requirements: a five (5) year warranty covering parts and labor for the complete pump assembly, including motor, bearings, impeller, shaft, mechanical and electrical components, and mechanical seals. The warranty period shall commence upon final acceptance by the OWNER following startup and commissioning and shall not begin at shipment, delivery, or installation. Warranty

coverage shall include removal and reinstallation labor, replacement parts, on-site service, and all associated travel and related expenses, with no additional cost to the OWNER. The warranty shall be issued directly by the pump manufacturer; warranties dependent upon third-party insurance or extended service agreements shall not be acceptable. Any exclusions or limitations shall be clearly stated in the manufacturer's written warranty documentation submitted with the bid. Pumps failing to comply with these requirements shall be considered non-responsive.

a. Remove and replace Section 01 78 36 WARRANTIES AND BONDS with the revised Section 01 78 36 WARRANTIES AND BONDS – ADDENDUM #3 (4 pages total) attached hereto.

b. Remove and replace Page 3 of Section 33 30 00 SANITARY SEWERAGE with the revised Page 3 of Section 33 30 00 SANITARY SEWERAGE – ADDENDUM #3 (1 page total) attached hereto.

c. Remove and replace Pages 3 and 13 of Section 33 32 16 NON-CLOG SUBMERSIBLE CENTRIFUGAL PUMPS AND DRIVES with the revised Pages 3 and 13 of Section 33 32 16 NON-CLOG SUBMERSIBLE CENTRIFUGAL PUMPS AND DRIVES – ADDENDUM #3 (2 pages total) attached hereto.

d. Remove and replace Section 33 32 16.13 ABOVE GROUND PACKAGED UTILITY SEWERAGE PUMPING STATIONS with the revised Section 33 32 16.13 ABOVE GROUND PACKAGED UTILITY SEWERAGE PUMPING STATIONS – ADDENDUM #3 (26 pages total) attached hereto.

e. Remove and replace Section 40 50 00 SUBMERSIBLE LIFT STATION INSTRUMENTATION AND CONTROL SYSTEMS with the revised Section 40 50 00 SUBMERSIBLE LIFT STATION INSTRUMENTATION AND CONTROL SYSTEMS – ADDENDUM #3 attached hereto.

3. To provide clarification, Bid Item #40, Bid Item #41, and Bid Item #42 shall each have a quantity of 1 Lump Sum. Remove and replace Pages 11 and 12 of Section 00 41 43 BID FORM with the revised Pages 11 and 12 of Section 00 41 43 BID FORM – ADDENDUM #3 (2 pages total) attached hereto.

4. The following question was asked during the project's advertisement:

Q: Specification Section 40 50 00 - 1.06.H requires certain spare parts to be provided. Are the listed spare parts required to be furnished for each individual submersible lift station, or is one consolidated spare parts package acceptable for all submersible lift stations under this Contract?

A: Specification Section 40 50 00 - 1.06.H is revised to add Paragraph 1.06.H.1 as follows:

a. Provide one consolidated spare parts package for all Lift Control Panels (LCPs) of identical configuration under this Contract. Where LCP configurations differ, provide

one spare parts package for each unique LCP configuration. Identical configuration shall mean panels with the same control components, ratings, and internal equipment arrangement.

Specifications:

1. Remove and replace Section 00 01 10 TABLE OF CONTENTS with the revised Section 00 01 10 TABLE OF CONTENTS – ADDENDUM #3 (4 pages total) attached hereto.

2. Remove and replace Pages 11 and 12 of Section 00 41 43 BID FORM with the revised Pages 11 and 12 of Section 00 41 43 BID FORM – ADDENDUM #3 (2 pages total) attached hereto.

3. Remove and replace Section 01 78 36 WARRANTIES AND BONDS with the revised Section 01 78 36 WARRANTIES AND BONDS – ADDENDUM #3 (4 pages total) attached hereto.

4. Remove and replace Page 3 of Section 33 30 00 SANITARY SEWERAGE with the revised Page 3 of Section 33 30 00 SANITARY SEWERAGE – ADDENDUM #3 (1 page total) attached hereto.

5. Remove and replace Pages 3 and 13 of Section 33 32 16 NON-CLOG SUBMERSIBLE CENTRIFUGAL PUMPS AND DRIVES with the revised Pages 3 and 13 of Section 33 32 16 NON-CLOG SUBMERSIBLE CENTRIFUGAL PUMPS AND DRIVES – ADDENDUM #3 (2 pages total) attached hereto.

6. Remove and replace Section 33 32 16.13 ABOVE GROUND PACKAGED UTILITY SEWERAGE PUMPING STATIONS with the revised Section 33 32 16.13 ABOVE GROUND PACKAGED UTILITY SEWERAGE PUMPING STATIONS – ADDENDUM #3 (26 pages total) attached hereto.

7. Remove and replace Section 40 50 00 SUBMERSIBLE LIFT STATION INSTRUMENTATION AND CONTROL SYSTEMS with the revised Section 40 50 00 SUBMERSIBLE LIFT STATION INSTRUMENTATION AND CONTROL SYSTEMS – ADDENDUM #3 (23 pages) attached hereto.

8. Remove and replace APPENDIX B ELECTRICAL SPECIFICATIONS with the revised APPENDIX B ELECTRICAL SPECIFICATIONS – ADDENDUM #3 (93 pages total) attached hereto, consisting of the complete Electrical Specifications.

Drawings:

1. Remove Sheet No. E5 from the contract documents and replace with Sheet No. E5 attached hereto.

2. Remove Sheet No. E13 from the contract documents and replace with Sheet No. E13 attached hereto.

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This Addendum No. 3 shall be attached to the front of your set of Specifications and made a part of the Specifications and Contract Documents. Acknowledgment of receipt of Addendum No. 3 shall be noted on Page 00 41 43-1 of the Bid Form.

THE KELLEY GROUP, LLC.

By: _____
Chase Williams, P.E.

Addendum #3 is _161_ total pages.
This concludes Addendum #3.

SECTION 00 01 10
TABLE OF CONTENTS – ADDENDUM NO. 3

Dallas County Water and Sewer Authority
Sewer System Improvements: Phase I

DIVISION 32 – EXTERIOR IMPROVEMENTS

DIVISION 33 – UTILITIES

DIVISION 40 – PROCESS INTERCONNECTIONS

APPENDICES

BASE BID – IMPROVEMENTS TO LIFT STATIONS 1, 2, 4, 6, & 8 CONTINUED					
Item #	**Description**	**Unit**	**Qty**	**Unit Price**	**Total Price**
37	**43 Craig Industrial Park Lift Station:** Inspection and Cleaning of the Existing Wetwell, to include vacuum removal and hauling to waste facility, cleaning, high pressure blasting of floor and walls, inspection of the existing wetwell after cleaning. Engineer & Owner to witness inspection to determine the need or extent of wetwell rehabilitation.	LS	1		
38	**43 Craig Industrial Park Lift Station:** Coating to include application of monolithic cementitious lining to fill voids, leaks, or cracks, and the application of 100% solids epoxy lining.	SY	280		
39	**43 Craig Industrial Park Lift Station:** Structural Modifications To The Existing Wetwell as Shown or Specified in the Contract Documents, To Include, Sealing of Openings or Stairs Into Wetwell, Reinforcing Existing Wetwell Top Concrete Slab, Access Hatches, Screened Vent Pipes, Bypass Pump Suction, Plugging Existing Pipe Penetrations and Saw Cutting New Pipe Penetrations, Bottom Grouting, Water-Stops, Rubber Boot Seals, and All Required Appurtenances**; FURNISH AND INSTALL.**	LS	1		
40	**43 Craig Industrial Park Lift Station:** Installation Of New Gorman Rupp Explosion Proof Submersible Pump System Including, But Not Limited To, Installation Of New (2) Gorman Rupp SF6B-X Explosion Proof Submersible Pumps Sized For 2000 GPM At 48.5' TDH With 75HP 460/3/60 1750RPM Inverter-Duty Rated Motors, Air Filled, Premium Efficient, Seal Monitor In Seal And Motor Chambers, One Thermostat Per Phase, 6" Discharge Connections, 2 Vane GR Ductile Iron Impellers, Ductile Iron Wear Rings, Silicon Carbide/Silicon Carbide Lower Seals, 50' Cables; (1) Gorman Rupp SF8B-X Explosion Proof Submersible Pump Sized For 2411 GPM At 70' TDH With 75HP 460/3/60 1750RPM Inverter-Duty Rated Motor, Air Filled, Premium Efficient, Seal Monitor In Seal And Motor Chambers, One Thermostat Per Phase, 8" Discharge Connection, 2 Vane GR Ductile Iron Impeller, Ductile Iron Wear Ring, Silicon Carbide/Silicon Carbide Lower Seal, 50' Cables; (2) Baseplate Kits With Base Elbow 6"X6", Non-Sparking Guide Shoes, 50' SS Lifting Cables, Intermediate Guide Rail Brackets, 6"X8" Increasers; (1) Baseplate Kit With Base Elbow 8"X8", Non-Sparking Guide Shoe, 50' SS Lifting Cable, Intermediate Guide Rail Brackets, 8"X10" Increaser; NEMA 4X 304SS Triplex 75HP Control Panel 460/3/60 With Main Breaker For Incoming Power, Dead Front, (3) 75HP RVSS With Input Circuit Breakers, Keypads On Inner Door, MPE SC2000 Station Controller, IS Submersible Level Transducer, IS 2 Float Backup, Interconnecting Wiring From Sensors To Control Panel, Rails, Guide Brackets, Lifting Hoist & Foundations, Etc. To Make Complete Installation; Excludes Discharge Piping and Valves, Incoming Electrical Power Wiring, Unloading and Final Electrical; **FURNISH & INSTALL.**	LS	1		

BASE BID – IMPROVEMENTS TO LIFT STATIONS 1, 2, 4, 6, & 8 CONTINUED					
Item #	**Description**	**Unit**	**Qty**	**Unit Price**	**Total Price**
41	**43 Craig Industrial Park Lift Station:** Construction of new 10-inch, 12-inch, and 14-inch force main piping and appurtenances to connect the new pumps to the new valve vault and from the valve vault to the existing 14-inch force main, including but not limited to new force mains, discharge piping, spool pieces, mechanical joint fittings, reducers, bends, cleanouts, thrust restraints and concrete kickers, and all other fittings and appurtenances required to provide complete, continuous, and functional discharge connections. Work shall include all connections from the pump discharge outlets to the valve vault and from the valve vault to the designated tie-in location along the existing 14-inch force main, including construction of sufficient pipe lengths to allow proper installation, restraint, testing, and operation; **FURNISH AND INSTALL**.	LS	1		
42	**43 Craig Industrial Park Lift Station**: New Valve Vault Including, but Not Limited to, Concrete Valve Vault Sized as Required to Accommodate Check Valves, Gate Valves, Fittings, Connections to Proposed Force Mains, 3" PVC Drain Line to Wetwell, Duckbill Check Valve, Pressure Transmitters, Spool Pieces, Aluminum Double Leaf Hatch, Pipe Supports, Etc. to Make Complete and Operational; **FURNISH & INSTALL.**	LS	1		
43	**43 Craig Industrial Park Lift Station:** Electrical work detailed in Electrical Contract Documents including, but not limited to, instrumentation and controls, electrical equipment, electrical conduit and wiring, unloading, and final electrical hookup (items excluded from the pump station supply scope) and connection to existing service feed. Coordinate with APCO and cover all costs from the service main disconnection to the lift station; **FURNISH AND INSTALL.**	LS	1		

SECTION 01 78 36
WARRANTIES AND BONDS – ADDENDUM NO. 3

PART 1 – GENERAL

1.01 SUMMARY

A. This section specifies general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including the manufacturer's standard warranties on products and special warranties.

B. Related Sections

1. SECTION 01 77 00 – Closeout Procedures

1.02 SUBMITTALS

A. Submit written warranties to the OWNER prior to the date fixed by the ENGINEER for Substantial Completion. If the Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the work, or a designated portion of the work, submit written warranties upon request of the OWNER.

B. Forms for special warranties are included at the end of this Section. Prepare a written document utilizing the appropriate form, ready for execution by the CONTRACTOR or the CONTRACTOR and Subcontractor, supplier, or manufacturer. Submit a draft to the OWNER for approval prior to final execution.

C. Refer to individual Sections for specific content requirements and particular requirements for the submittal of special warranties.

D. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents and sized to receive 8½- inch by 11-inch paper.

E. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the Section in which specified and the name of the product or work item.

F. Provide heavy paper dividers with celluloid-covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of the installer, supplier, and manufacturer.

G. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS," the project title or name, and the name, address, and telephone number of the CONTRACTOR.

H. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

1.03 WARRANTY EQUIPMENT

A. Related Damages and Losses: When correcting warranted work that has failed, remove and replace other work that has been damaged as a result of such failure, or that must be removed and replaced to provide access for correction of warranted work.

B. Reinstatement of Warranty: When work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

C. Replacement Cost: Upon determination that work covered by a warranty has failed, replace or rebuild the work to an acceptable condition complying with requirements of Contract Documents. The CONTRACTOR is responsible for the cost of replacing or rebuilding defective work regardless of whether the OWNER has benefited from the use of the work through a portion of its anticipated useful service life.

D. OWNER's Recourse: Written warranties made to the OWNER are in addition to implied warranties and shall not limit the duties, obligations, rights, and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the OWNER can enforce such other duties, obligations, rights, or remedies.

E. Rejection of Warranties: The OWNER reserves the right to reject warranties and to limit selections to products with warranties not in conflict with the requirements of the contract Documents.

F. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the CONTRACTOR of the warranty on the work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the CONTRACTOR.

1.04 MANUFACTURER'S CERTIFICATIONS

A. Where required, the CONTRACTOR shall supply evidence, satisfactory to the ENGINEER, that the CONTRACTOR can obtain manufacturers' certifications as to the CONTRACTOR's installation of equipment.

1.05 DEFINITIONS

A. Standard Product Warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the OWNER.

B. Special Warranties are written warranties required by or incorporated in the Contract

Documents, either to extend time limits provided by standard warranties or to provide greater rights for the OWNER.

1.06 MINIMUM PUMP WARRANTY REQUIREMENTS

A. General

1. All wastewater pumps furnished under this Contract shall be provided with a manufacturer's warranty meeting or exceeding the minimum requirements specified herein. These requirements establish a mandatory, performance-based warranty floor applicable to all manufacturers without exception.

B. Warranty Duration and Coverage

1. Provide a five (5) year manufacturer's warranty covering parts and labor for the complete pump assembly, including but not limited to the motor, bearings, impeller, shaft, and all mechanical and electrical components.

2. Provide a five (5) year manufacturer's warranty covering mechanical seals, including parts and labor for seal repair or replacement.

C. Warranty Commencement and Effective Date

1. The warranty period shall commence upon final acceptance by the OWNER or the OWNER's authorized agent following startup and commissioning.

2. The warranty shall not commence upon shipment, delivery, storage, installation, energization, or any event other than formal Owner acceptance.

3. No manufacturer terms or conditions shall modify, shorten, or otherwise alter the warranty commencement date established herein.

D. Included Warranty Services

1. Warranty coverage shall include, at a minimum, all costs associated with:

a. Removal and reinstallation labor

b. Replacement parts and components

c. On-site service labor

d. Travel, mileage, per diem, and related service expenses

e. No additional charges to the OWNER shall be permitted for warranty service.

E. Warranty Provider

1. The warranty shall be provided directly by the pump manufacturer. Warranties dependent upon third-party insurance policies, extended service contracts, or instruments not issued by the manufacturer shall not be acceptable.

F. Exclusions and Limitations

1. Any exclusions, limitations, conditions, or operational requirements shall be clearly and explicitly stated in the manufacturer's written warranty documentation submitted with the bid and pump submittals.

2. Exclusions inconsistent with normal municipal wastewater service conditions shall not be permitted.

G. Basis of Acceptance

1. Pumps failing to comply with the requirements of this Section shall be considered non-responsive and shall not be approved for installation.

H. Operation and Maintenance

1. Warranty claims shall not require proof of improper operation unless such operation materially deviates from the manufacturer's published operating limits and recommended maintenance practices.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

E. If during construction of the project, the site or project conditions reveal conflicts or harm to existing utilities either by vicinity or by destruction during construction, the contractor must repair or relocate the existing utility at the contractor or developer's expense. Failure to do this in a timely manner will result in suspension of the project or rejection of final acceptance of the project until the item is corrected. If a major break occurs and the contractor does not correct immediately a repair will be made and billed to the Contractor.

F. Equipment furnished under this Section shall comply with the warranty requirements specified in Section 01 78 36 – Warranties & Bonds.

1.05 PROJECT CONDITIONS

A. Site Information: Perform site survey, research public utility records, and verify existing utility locations. Verify that sanitary sewerage system piping may be installed in compliance with original design and referenced standards.

B. The Contractor shall maintain all drainage ways, gutters, etc. at all times. The Contractor shall remove any eroded or washed material that enters pipes, ditches, or streams.

C. The Contract shall provide erosion control as required to protect from damage surrounding areas. Erosion control measures shall meet all requirements of Section 01 57 13 - Temporary Erosion Control

1.06 SEQUENCING AND SCHEDULING

A. Coordinate connection to public sewer with utility company.

B. Coordinate with interior building sanitary drainage piping.

C. Coordinate with other utility work.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

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

1. Cleanouts:

a. Ancon, Inc

solid, with materials, motor cooling, sealing system, and manufacturer support equal to or better than the specified models.

B. Basis of Design / Manufacturer & Models:

1. Gorman-Rupp SF Series

2. Vaughan Submersible Series

3. Flygt N-Technology Series

4. Wilo-EMU FA Series

5. Or Equivalent ENGINEER approved equal submersible wastewater pumps

C. Pump Requirements:

1. Minimum 3-inch solids passage in critical flow areas.

2. Cast iron or ductile iron solids-handling impeller (or equivalent corrosion-resistant material).

3. Submersible motor with thermal protection, moisture detection and dual sealed chambers.

4. Slide rail or guide rail system compatible with lift station access.

5. Factory performance curve at duty point certified by manufacturer.

6. Equipment furnished under this Section shall comply with the warranty requirements specified in SECTION 01 78 36 – Warranties & Bonds.

7. The services of a factory trained, qualified representative shall be provided to inspect the completed installation, direct and assist the contractor in making all adjustments necessary to place the system in trouble-free operation and instruct the operating personnel in the proper care and operation of the equipment. The equipment manufacturer must also have a factory trained authorized service center located within 250 miles of the project site. The service center must be capable of conducting pump and control panel repairs, be fully equipped with service trucks for field assistance and be staffed with factory authorized service technicians on call 24hrs/day. Equipment offered by suppliers lacking this type service center/service capability will be rejected.

2.02 PUMP PERFORMANCE

A. The pumps shall be suitable for pumping raw sewage in normal domestic and commercial settings and shall be designed and fully guaranteed for this use.

1. The pump shall be visually inspected to confirm that it is built in accordance with the specification as to HP, voltage, phase, and hertz.

2. The motor seal and housing chambers shall be meggered for infinity to test for moisture content or insulation defects.

3. Pump shall be allowed to run dry to check for proper rotation.

4. Discharge piping shall be attached, the pump submerged in water, and amp readings shall be taken in each leg to check for an imbalanced stator winding. If there is a significant difference in readings, the stator windings shall be checked with a bridge to determine if an unbalance resistance exists. If so, the stator shall be replaced.

5. The pump shall be removed from the water, meggered again, dried and the motor housing filled with appropriate material.

C. During Final Acceptance Testing, the manufacturer's service representative shall review recommended operation and maintenance procedures with the OWNER'S personnel. Prior to Final Acceptance testing the pump manufacturer shall submit a written report that the pump(s) are satisfactorily installed in accordance with the manufacturer's recommendations.

3.05 OPERATING MANUALS

A. The pumps shall be supplied with four (4) copies of an Operating Manual with detailed pump assembly drawings, warranty, and component lists.

3.06 PUMP WARRANTY

A. Equipment furnished under this Section shall comply with the warranty requirements specified in Section 01 78 36 – Warranties & Bonds.

B. The pump manufacturer shall have a minimum of 1,000 units of similar type pumps, installed and operating for no less than five (5) years in the United States.

END OF SECTION

SECTION 33 32 16.13
ABOVE GROUND PACKAGED UTILITY SEWERAGE PUMPING STATIONS – ADDENDUM NO. 3

PART 1 - GENERAL

1.01 SUMMARY

A. Work under this section includes, but is not limited to, furnishing and installing a factory built duplex pump station as indicated on the project drawings, herein specified, as necessary for proper and complete performance.

1.02 REFERENCES

A. Publications listed below form part of this specification to extent referenced in the text by basic designation only. Consult latest edition of publication unless otherwise noted.

B. American National Std. Institute (ANSI) / American Water Works Assoc. (AWWA)

1.	ANSI B16.1	Cast iron pipe flanges and flanged fittings.
2.	ANSI/AWWA C115/A21.51	Cast/ductile iron pipe with threaded flanges.
3.	ANSI 253.1	Safety Color Code for Marking Physical Hazards.
4.	ANSI B40.1	Gages, Pressure and Vacuum.
5.	AWWA C508	Single Swing Check Valves.

C. American Society for Testing and Materials (ASTM)

1.	ASTM A48	Gray Iron Castings.
2.	ASTM A126	Valves, Flanges, and Pipe Fittings.
3.	ASTM A307	Carbon Steel Bolts and Studs.
4.	ASTM A36	Structural Steel.

D. Institute of Electrical and Electronics Engineers (IEEE)

1.	IEEE Std 100	Standard Dictionary of Electrical Terms.
2.	IEEE Std 112	Test Procedure for Polyphase Induction Motors.
3.	IEEE Std 242	Protection of Industrial and Control Power Systems.

E. National Electric Code (NEC) / National Electrical Manufacturers' Assoc. (NEMA)

1.	NEC	National Electrical Code.
2.	NEMA Std MG1	Motors and Generators.

F. Miscellaneous References

1. Ten-State Standards Recommended Standards for Sewage Works.
2. Hydraulic Institute Std for Centrifugal, Rotary and Reciprocating Pumps.
3. ISO 9001 International Organization for Standardization.

4. ISO 14001 International Organization for Standardization.

1.03 SYSTEM DESCRIPTION

A. Design requirements consist of factory built pump station design, including materials of construction, pump features, valves and piping, and motor controls shall be in accordance with requirements listed under PART 2 - PRODUCTS of this section.

1. Contractor shall furnish and install one factory built above ground, automatic pump station. The station shall be complete with all equipment specified herein, factory assembled in a fiberglass reinforced polyester resin enclosure.

2. In addition to the station enclosure, principle items of equipment shall include two horizontal, self priming, centrifugal sewage pumps, V-belt drives, motors, internal piping, valves, motor control panel, automatic liquid level control system, and internal wiring. Station manufacture shall also be the manufacturer of the pumps, valves and control panel.

B. Performance Criteria

1. Pumps must be designed to handle raw, unscreened, domestic sanitary sewage. Pumps shall have 3" to 6" suction connection, and 3" to 6" discharge connection. Each pump shall be selected to perform under following operating conditions:

309 Craig:

a. Capacity (GPM)	540
b. Total Dynamic Head(FT)	54
c. Total Dynamic Suction Lift(FT)	19.8
d. Maximum Static Suction Lift(FT)	17
e. Total Discharge Static Head(FT)	23.5
f. Horsepower	20
g. Site Power	230/60/3

260 Craig:

a. Capacity (GPM)	200
b. Total Dynamic Head(FT)	34
c. Total Dynamic Suction Lift(FT)	17.33
d. Maximum Static Suction Lift(FT)	16
e. Total Discharge Static Head(FT)	17.0
f. Horsepower	7.5
g. Site Power	460/3/60

320 Craig:

a.	Capacity (GPM)	300
b.	Total Dynamic Head(FT)	40
c.	Total Dynamic Suction Lift(FT)	20.12
d.	Maximum Static Suction Lift(FT)	18.12
e.	Total Discharge Static Head(FT)	35
f.	Horsepower	10
g.	Site Power	460/3/60

1.02 SUBMITTALS

A. Product Data

1. Prior to fabrication, pump station manufacturer shall submit 1 copy of submittal data for review and approval.

2. Submittal shall include shop drawings, electrical ladder logic drawings, and support data as follows: Catalog cuts sheets reflecting characteristics for major items of equipment, materials of construction, major dimensions, motor and v-belt drive data, pump characteristic curves showing the design duty point capacity (GPM), head (FT), net positive suction head required (NPSHr), and hydraulic brake horsepower (BHP). Electrical components used in the motor branch and liquid level control shall be fully described.

B. Shop Drawings

1. Shop drawings shall provide layout of mechanical equipment and anchor bolt locations for station. Pipe penetrations and station access clearances shall be dimensioned relative to the station centerline. The electrical ladder logic drawings shall illustrate motor branch and liquid level control circuits to extent necessary to validate function and integration of circuits to form a complete working system.

C. Operations and Maintenance Manuals

1. Operation shall be in accordance with written instructions provided by the pump station manufacturer. Comprehensive instructions supplied at time of shipment shall enable personnel to properly operate and maintain all equipment supplied. Content and instructions shall assume operating personnel are familiar with pumps, motors, piping and valves, but lack experience on exact equipment supplied.

2. Documentation shall be specific to the pump station supplied and collated in functional sections. Each section shall combine to form a complete system manual covering all aspects of equipment supplied by the station manufacturer. Support data for any equipment supplied by others, even if mounted or included in overall station design, shall be provided by those supplying the equipment. Instructions shall include the following as a minimum:

a) Functional description of each major component, complete with operating instructions.

b) Instructions for operating pumps and pump controls in all modes of operation.

c) Calibration and adjustment of equipment for initial start-up, replacement of level control components, or as required for routine maintenance.

d) Support data for commercially available components not produced by the station manufacturer, but supplied in accordance with the specifications, shall be supported by literature from the prime manufacturer and incorporated as appendices.

e) Electrical schematic diagram of the pump station circuits shall be in accordance with NFPA 70. Schematics shall illustrate, to the extent of authorized repair, pump motor branch, control and alarm system circuits including interconnections. Wire numbers and legend symbols shall be shown. Schematic diagrams for individual components, not normally repairable by the station operator, need not be included. Details for such parts shall not be substituted for an overall system schematic. Partial schematics, block diagrams, and simplified schematics shall not be provided in lieu of an overall system diagram.

f) Mechanical layout drawing of the pump station and components, prepared in accordance with good commercial practice, shall provide installation dimensions and location of all pumps, motors, valves and piping.

g) Operation and maintenance instructions which rely on vendor cut-sheets and literature which include general configurations, or require operating personnel to selectively read portions of the manual shall not be acceptable. Operation and maintenance instructions must be specific to equipment supplied in accordance with these specifications.

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications

1. The pumps must be ISO 9001:2015 revision certified, with scope of registration including design control and service after sales activities.

2. The pumps and pump station manufacturer must be registered to the ISO 14001 Environmental Management System standard and as such is committed to minimizing the impact of its activities on the environment and promoting environmental sustainability by the use of best management practices, technological advances, promoting environmental awareness and continual improvement.

3. Upon request from the engineer, the pump station manufacturer shall prove financial stability and ability to produce the station within the specified delivery schedules. Evidence of facilities, equipment and expertise shall demonstrate the manufacturer's commitment to long term customer service and product support.

4. Manufacturer must show proof of original product design and testing. Products violating intellectual property regulations shall not be allowed, as they may violate international law and expose the user or engineer to unintended liabilities. "Reverse-engineered" products fabricated to substantially duplicate the design of original product shall not be allowed, as they may contain substantial differences in tolerances and material applications addressed in the original design, which may contribute to product failure.

5. The term "pump manufacturer" or "pump station manufacturer" shall be defined as the entity which designs, machines, assembles, hydraulically tests and warranties the final product. Any entity that does not meet this definition will not be considered a "pump manufacturer" or "pump station manufacturer" and is not an acceptable supplier. For quality control reasons and future pump and parts availability, all major castings of the pump shall be sourced and machined in North America.

B. Pump Performance Certifications

1. Solids Handling Capability

a) All internal passages, impeller vanes, and recirculation ports shall pass a minimum 3" spherical solid. Smaller internal passages that create a maintenance nuisance or interfere with priming and pump performance shall not be permitted. Upon request from the engineer, manufacturer's certified drawings showing size and location of the recirculation port(s) shall be submitted for approval.

2. Reprime Performance

a) Consideration shall be given to the sanitary sewage service anticipated, in which debris is expected to lodge between the suction check valve and its seat, resulting in the loss of the pump suction leg, and siphoning of liquid from the pump casing to the approximate center line of the impeller. Such occurrence shall be considered normal, and the pump must be capable of automatic, unattended operation with an air release line installed.

b) During unattended operation, the pump shall retain adequate liquid in the casing to insure automatic repriming while operating at its rated speed in a completely open system. The need for a suction check valve or external priming device shall not be required.

c) Pump must reprime 22 vertical feet at the specified speed and impeller diameter. Reprime lift is defined as the static height of the pump suction above the liquid, while operating with only one-half of the liquid remaining in the pump casing. The pump must reprime and deliver full capacity within five minutes after the pump is energized in the reprime condition. Reprime performance must be confirmed with the following test set-up:

1) A check valve to be installed down stream from the pump discharge flange. The check valve size shall be equal (or greater than) the pump discharge diameter.

2) A length of air release pipe shall be installed between pump and the discharge check valve. This line shall be open to atmosphere at all times duplicating the air displacement rate anticipated at a typical pump station fitted with an air release valve.

3) The pump suction check valve shall be removed. No restrictions in the pump or suction piping will prevent the siphon drop of the suction leg. Suction pipe configuration for reprime test shall incorporate a 2 feet minimum horizontal run, a 90 degree elbow and vertical run at the specified lift. Pipe size shall be equal to the pump suction diameter.

4) Impeller clearances shall be set as recommended in the pump service manual.

5) Repeatability of performance shall be demonstrated by testing five consecutive reprime cycles. Full pump capacity (flow) shall be achieved within five minutes during each cycle.

6) Liquid to be used for reprime test shall be water.

3. Upon request from the engineer, certified reprime performance test results, prepared by the manufacturer, and certified by a registered professional engineer, shall be prepared and forwarded to the customer.

C. Factory System Test

1. All internal components including the pumps, motors, valves, piping and controls will be tested as a complete working system at the manufacturer's facility. Tests shall be conducted in accordance with Hydraulic Institute Standards at the specified head, capacity, rated speed and horsepower. Factory operational test shall simulate actual performance anticipated for the complete station.

D. Manufacturer's Start-up Services

1. The manufacturer's technical representative shall inspect the completed installation, correct or supervise the correction of any defect or malfunction, and instruct operating personnel in the proper operation and maintenance of the equipment as described in Part 3 of this section.

1.04 MANUFACTURER'S WARRANTY

A. Equipment furnished under this Section shall comply with the warranty requirements specified in Section 01 78 36 – Warranties & Bonds.

PART 2 – PRODUCT

2.01 PRODUCTS

A. The pumps at Lift Station #1, Lift Station #2, and Lift Station #6 are based on centrifugal, solids-handling, self-priming, suction-lift wastewater pump stations, and the Contract Documents have been prepared using this configuration as the Basis of Design. The Basis of Design manufacturer and model is Gorman-Rupp AM Prepackaged Series. CONTRACTOR may elect to provide a submersible pump configuration, packaged or field-assembled, in lieu of the suction-lift configuration. Submersible pump requirements are specified in Section 33 32 16.11. All performance requirements, capacities, and heads must be met regardless of pump configuration selected and for all lift stations listed above in Section 1.03.B. CONTRACTOR may provide package stations by Gorman-Rupp, USEMCO, or ENGINEER approved equal. Furthermore, CONTRACTOR may elect to provide submersible pumps by Gorman-Rupp, Vaughan, Flygt, Wilo, or ENGINEER approved equal in performance and design, meeting all requirements below. Pumps shall be capable of passing a minimum 3-inch spherical solid, with materials, motor cooling, sealing system, and manufacturer support equal to or better than the specified models.

B. Acceptable Manufacturers & Models:

1. Gorman-Rupp AM Prepackaged Series

2. USEMCO PumpMate Package Series

3. Or Equivalent ENGINEER approved equal self-priming wastewater pumps

C. CONTRACTOR shall be solely responsible for all costs associated with design modifications, structural revisions, wet well or valve vault modifications, electrical changes, site adjustments, hydraulic recalculations, and any other changes required to accommodate the alternate configuration. No additional compensation shall be provided for engineering, redesign, coordination, or construction impacts resulting from selection of an alternate pump configuration.

2.02 MANUFACTURER

A. The pump station system integrator must be ISO 9001:2015 revision certified, with scope of registration including design control and service after sales activities.

B. The specifications and project drawings depict equipment and materials manufactured by The Gorman-Rupp Company which are deemed most suitable for the service anticipated. It is not intended, however, to eliminate other products of equal quality and performance. The contractor shall prepare his bid based on the specified equipment for purposes of determining low bid. Award of a contract shall constitute an obligation to furnish the specified equipment and materials.

C. After execution of the contract, the contractor may offer substitutions to the specified equipment for consideration. The equipment proposed for substitution must be superior in construction and performance to that specified in the contract, and the higher quality must be demonstrated by a list of current users of the proposed equipment in similar installations.

D. In event the contractor obtains engineer's approval for equipment substitution, the contractor shall, at his own expense, make all resulting changes to the enclosures, buildings, piping or electrical systems as required to accommodate the proposed equipment. Revised detail drawings illustrating the substituted equipment shall be submitted to the engineer prior to acceptance.

E. It will be assumed that if the cost to the contractor is less for the proposed substitution, then the contract price shall be reduced by an amount equal to the savings.

2.03 STATION ENCLOSURE

A. The station enclosure shall contain and protect all pumps, interior piping, valves and associated controls. Enclosure shall incorporate the following design and service features:

1. Access panels must be supplied on all sides. Location and size shall permit access for routine maintenance functions such as pump and motor inspection, drive belt adjustment, and pump clean-out. Non-hinged panels shall be secured with stainless steel tamper-proof hardware.

2. A continuous hinge and latch shall be installed on at least two access panels. The hinged panels shall allow easy access to the electrical controls for frequent adjustments and inspections. A two-point mechanical latch assembly shall secure the panel at top and bottom. Latch handle locks shall be match keyed, requiring only one key to open all access panels.

3. A vent in one access panel shall allow free air flow for enclosure ventilation.

4. The complete station enclosure, less base, must be completely removable after disengaging reusable hardware. After disassembly, no portion of the enclosure (except electrical service entrance) shall project above the base surface to interfere with maintenance or endanger personnel.

5. Disassembly and removal of the enclosure shall require no more than two people working without assistance of lifting equipment.

B. Station enclosure shall be manufactured of molded reinforced orthophthalic polyester resins with a minimum of 30% fiberglass, and a maximum of 70% resin. Resin fillers or extenders shall not be used.

1. Chopped glass fibers of 1 1/4 inch average length shall be sprayed and rolled. Major design consideration shall be given to structural stability, corrosion resistance, and watertight integrity. The polyester laminates shall provide a balance of mechanical, chemical, and electrical properties to ensure long life. They must be impervious to micro-organisms, mildew, mold, fungus, corrosive liquids, and gases which are expected to be present in the environment surrounding the wet well.

2. All interior surfaces of the housing shall be coated with a polyester resin-rich finish providing maintenance-free service, abrasion resistance, and protection from sewage, greases, oils, gasoline, and other common chemicals.

3. Outside surfaces of the enclosure shall be coated with gel-coat pigmented resin to ensure long maintenance-free life and UV protection. Color used shall de-emphasize the presence of dirt, grease, etc.

C. The station base shall be constructed of pre-cast, reinforced concrete. To ensure long-term durability and chemical resistance, the exterior of the concrete base shall feature a high-performance, fiberglass-reinforced finish, provided either via encapsulation within a permanent fiberglass mold or through the application of a factory-applied, high-performance fiberglass-reinforced polymer (FRP) coating. The final finish shall be green in color and specifically engineered to resist impact, abrasion, and broad-spectrum chemical exposure common in wastewater environments. Base shall incorporate drainage provisions, and an opening sized to permit installation of piping and service connections to the wet well. After installation, the opening shall serve as a grout dam to be utilized by the contractor. The base shall incorporate anchor bolt recesses for securing the complete station to a concrete pad (supplied by the contractor) in accordance with the project plans.

D. A blower mounted in the station roof shall be sized to exchange station air volume at least once every two minutes. Blower motor shall energize automatically at approximately 70 degrees F, and turn off at 55 degrees F. The blower motor control circuit shall incorporate a thermal-magnetic circuit breaker providing overcurrent and overload protection. Exhaust and inlet locations shall prevent the entrance of rain, snow, or debris.

E. Station Heater

1. Pump station shall be provided with a 1300/1500 watt, 115 volt electric heater with cord and grounding plug. Ungrounded heaters shall not be acceptable.

2.04 PUMP DESIGN

A. Pumps shall be horizontal, self-priming centrifugal type, designed specifically for handling raw, unscreened, domestic sanitary sewage. Pump solids handling capability and performance criteria shall be in accordance with requirements listed under PART 1 - GENERAL of this section.

B. The pump manufacturer must be ISO 9001:2000 revision certified, with scope of registration including design control and service after sales activities.

C. Materials and Construction Features

1. Pump casing: Casing shall be cast iron Class 30 with integral volute scroll. Casing shall incorporate following features:

a) Mounting feet sized to prevent tipping or binding when pump is completely disassembled for maintenance.

b) Fill port coverplate, 3 1/2" diameter, shall be opened after loosening a hand nut/clamp bar assembly. In consideration for safety, hand nut threads must

provide slow release of pressure, and the clamp bar shall be retained by detente lugs. A Teflon gasket shall prevent adhesion of the fill port cover to the casing.

c) Casing drain plug shall be at least 1 1/4" NPT to ensure complete and rapid draining.

d) Liquid volume and recirculation port design shall be consistent with performance criteria listed under PART 1 - GENERAL of this section.

2. Coverplate: Coverplate shall be cast iron Class 30. Design must incorporate following maintenance features:

a) Retained by hand nuts for complete access to pump interior. Coverplate removal must provide ample clearance for removal of stoppages, and allow service to the impeller, seal, wearplate or check valve without removing suction or discharge piping.

b) A replaceable wearplate secured to the coverplate by weld studs and nuts shall be AISI 1015 HRS. The pump shall be fitted with a replaceable self-cleaning wear plate. Replacement of the wear plate, impeller, seal, and suction check valve shall be accomplished through the removable cover plate. The wear plate shall be the "Eradicator" model as manufactured by Gorman-Rupp, or a pre-approved equal of a similar self-cleaning type that includes notches and grooves in combination with a rotating tooth designed to clear the eye of the impeller of debris.

c) In consideration for safety, a pressure relief valve shall be supplied in the coverplate. Relief valve shall open at 75-200 PSI.

d) Two O-rings of Buna-N material shall seal coverplate to pump casing.

e) Pusher bolt capability to assist in removal of coverplate. Pusher bolt threaded holes shall be sized to accept same retaining capscrews as used in rotating assembly.

f) Easy-grip handle shall be mounted to face of coverplate.

3. Rotating Assembly: A rotating assembly, which includes impeller, shaft, mechanical shaft seal, lip seals, bearings, sealplate and bearing housing, must be removable as a single unit without disturbing the pump casing or piping. Design shall incorporate following features:

a) Sealplate and bearing housing shall be cast iron Class 30. Separate oil filled cavities, vented to atmosphere, shall be provided for shaft seal and bearings. Cavities must be cooled by the liquid pumped. Three lip seals will prevent leakage of oil.

b) The bearing cavity shall have an oil level sight gauge and fill plug check valve. The clear sight gauge shall provide easy monitoring of the bearing cavity oil level and condition of oil without removal of the fill plug check valve. The check valve shall vent the cavity but prevent introduction of moist air to the bearings.

c) The seal cavity shall have an oil level sight gauge and fill/vent plug. The clear sight gauge shall provide easy monitoring of the seal cavity oil level and condition of oil without removal of the fill/vent plug.

d) Double lip seal shall provide an atmospheric path providing positive protection of bearings, with capability for external drainage monitoring.

e) Impeller shall be ductile iron, two-vane, semi-open, non-clog, with integral pump out vanes on the back shroud. Impeller shall thread onto the pump shaft and be secured with a lockscrew and conical washer.

f) Shaft shall be AISI 4140 alloy steel unless otherwise specified by the engineer, in which case AISI 17-4 pH stainless steel shall be supplied.

g) Bearings shall be anti-friction ball type of proper size and design to withstand all radial and thrust loads expected during normal operation. Bearings shall be oil lubricated from a dedicated reservoir. Pump designs which use the same oil to lubricate the bearings and shaft seal shall not be acceptable.

h) Shaft seal shall be oil lubricated mechanical type. The stationary and rotating seal faces shall be tungsten titanium carbide alloy or silicon carbide. Each mating surface shall be lapped to within three light bands flatness (35 millionths of an inch), as measured by an optical flat under monochromatic light. The stationary seal seat shall be double floating by virtue of a dual O-ring design; an external O-ring secures the stationary seat to the sealplate, and an internal O-ring holds the faces in alignment during periods of mechanical or hydraulic shock (loads which cause shaft deflection, vibration, and axial/radial movement). Elastomers shall be viton. Cage and spring to be stainless steel. Seal shall be oil lubricated from a dedicated reservoir. The same oil shall not lubricate both shaft seal and shaft bearings. Seal shall be warranted in accordance with requirements listed under PART 1 - GENERAL of this section.

i) Pusher bolt capability to assist in removal of rotating assembly. Pusher bolt threaded holes shall be sized to accept same capscrews as used for retaining rotating assembly.

4. Adjustment of the impeller face clearance (distance between impeller and wearplate) shall be accomplished by external means.

a) Clearances shall be maintained by a four point external shimless coverplate adjustment system, utilizing a four collar and four adjusting screw design allowing for incremental adjustment of clearances by hand as required. Each of the four points shall be lockable to prevent inadvertent clearance increases or decreases due to equipment vibration or accidental operator contact. The four point system also allows for equal clearance gaps at all points between the impeller and wear plate. Requirement of realignment of belts, couplings, etc., shall not be acceptable. Coverplate shall be capable of being removed without disturbing clearance settings. Clearance adjustment systems that utilize less than four points will not be considered.

b) There shall be provisions for additional clearance adjustment in the event that adjustment tolerances have been depleted from the coverplate side of the pump. The removal of stainless steel shims from the rotating assembly side of the pump shall allow for further adjustment as described above

c) Clearance adjustment which requires movement of the shaft only, thereby adversely affecting seal working length or impeller back clearance, shall not be acceptable.

5. Suction check valve shall be molded Neoprene with integral steel and nylon reinforcement. A blow-out center shall protect pump casing from hydraulic shock or excessive pressure. Removal or installation of the check valve must be accomplished through the coverplate opening, without disturbing the suction piping. Sole function of check valve shall be to save energy by eliminating need to reprime after each pumping cycle. Pumps requiring a suction check valve to assist reprime will not be acceptable.

6. Spool flanges shall be one-piece cast iron, class 30 fitted to suction and/or discharge ports. Each spool shall have one 1-1/4" NPT and one 1/4" NPT tapped hole with pipe plugs for mounting gauges or other equipment.

D. Serviceability

1. The pump manufacturer shall demonstrate to the engineer's satisfaction that consideration has been given to reducing maintenance costs.

2. No special tools shall be required for replacement of any components within the pump.

E. Spare Parts Kit:

1. The following minimum spare parts shall be furnished with the pump station:

a) One pump mechanical seal
b) Required cover plate O-Ring(s)
c) One rotating assembly O-Ring(s)
d) One set of impeller clearance adjustment spacers

2.05 VALVES AND PIPING

A. Check Valve: Each pump shall be equipped with a full flow type check valve capable of passing a 3" spherical solid. Valve shall be constructed with flanged ends and fitted with an external lever and torsional spring. Valve seat shall be constructed of stainless steel, secured to the body to ensure concentricity, sealed by an O-ring, and shall be replaceable. The valve body shall be cast iron incorporating a clean-out port large enough to allow removal and/or replacement of the valve clapper without removing valve or piping from the line. Valve clapper shall have a molded neoprene seating surface incorporating low pressure sealing rings. Valve hinge pin and internal hinge arm shall be stainless steel supported on each end

in brass bushings. Shaft nut shall have double O-rings which shall be easily replaceable without requiring access to interior of valve body. All internal hardware shall be stainless steel. Valve shall be rated at 175 PSI water working pressure, 350 PSI hydrostatic test pressure. Valves other than full flow type or valves mounted in such a manner that prevents the passage of a 3" spherical solid shall not be acceptable.

B. Plug Valve: Each station shall be equipped with an isolation valve arrangement that allows either or both pumps to be isolated from the common force main. This may be accomplished via a single 3-way tapered plug valve or individual non-lubricated plug valves. All valves shall feature high-quality cast-iron bodies and corrosion-resistant seats (such as welded nickel). For 3-way tapered designs, the actuator shall provide lift, turn, and reseat action. For individual valves, each pump discharge line must be independently isolatable. One operating handle/lever shall be provided for each valve type as required.

C. Automatic air release valves:

1. An automatic air release valve shall be furnished for each pump designed to permit the escape of air to the atmosphere during initial priming or unattended repriming cycles. Upon completion of the priming cycle or repriming cycle, the valve shall close to prevent recirculation. Valves shall provide visual indication of valve closure, and shall operate solely on discharge pressure. Valves which require connection to the suction line shall not be acceptable.

2. All valve parts exposed to sewage shall be constructed of cast iron, stainless steel, or similar corrosion resistant materials. Diaphragms, if used, shall be of fabric-reinforced neoprene or similar inert material.

3. A cleanout port, three inches in diameter, shall be provided for ease of inspection, cleanout, and service.

4. Valves shall be field adjustable for varying discharge heads.

5. Connection of the air release valves to the station piping shall include stainless steel fittings.

D. Gauge Kit

1. A gauge kit shall be supplied for each pump. Suction pressure must be monitored by a glycerin-filled compound gauge, and discharge pressure by a glycerin-filled pressure gauge. Gauges to be at least 4 inches in diameter, graduated in feet water column. Rated accuracy shall be 1% of full scale reading. Compound gauge shall be graduated -34 to +34 feet water column minimum. Pressure gauge to be graduated 0 to 70 feet water column minimum.

2. Gauges to be factory mounted on a resilient panel with frame assembly secured to pumps or piping. Gauge installations shall be complete with all hoses and stainless steel fittings, including a shutoff valve for each gauge line at the point of connection to suction and discharge pipes.

E. Piping

1. Flanged header pipe shall be centrifugally cast, ductile iron, complying with ANSI/AWWA A21.51/C115 and class 53 thickness.

2. Flanges shall be cast iron class 125 and Comply with ANSI B16.1.

3. Pipe and flanges shall be threaded and suitable thread sealant applied before assembling flange to pipe.

4. Bolt holes shall be in angular alignment within 1/2 degree between flanges. Flanges shall be faced with a gasket finish having concentric grooves a minimum of 0.01 inch deep by approximately 0.03 inch wide, with a minimum of three grooves on any given surface spaced a maximum of 1/4 inch apart.

F. Supports and Thrust Blocks: Contractor must ensure all pipes connected to the pump station are supported to prevent piping loads from being transmitted to pumps or station piping. Pump station discharge force main piping shall be anchored with thrust blocks where shown on the contract drawings.

2.06 DRIVE UNIT

A. Motors (Note: Maximum motor frame size is 326T open drip-proof.)

1. Pump motors shall be the HP indicated in 1.03.B.1, horizontal ODP or TEFC, 1,800 RPM, NEMA design B with cast iron frame with copper windings, induction type, with class F insulation and 1.15 Service Factor for normal starting torque and low starting current characteristics, suitable for continuous service. The motors shall not overload at the design condition or at any head in the operating range as specified. Motors shall be suitable for operation using the utility power available specified in part 1 of this section.

2. Motors shall be tested in accordance with provisions of ANSI/IEEE Std. 112, Method B.

B. Drive Transmission

1. Power to pumps transmitted V-belt drive assemblies. The sheave/belt combination shall provide the speed ratio needed to achieve the specified pump operating conditions.

2. Each drive assembly shall utilize at least two V-belts providing a minimum combined safety factor of 1.5. Single belt drives or systems with a safety factor of less than 1.5 are not acceptable. Computation of safety factors shall be based on performance data published by the drive manufacturer.

3. Precise alignment tolerances of the drive assemblies shall be achieved by means of a belt/sheave laser alignment system resulting in the reduction of vibration, accelerated wear, and premature failure.

4. The pump manufacturer shall submit power transmission calculations which document the following:

    a) Ratio of pump/motor speed.
    b) Pitch diameter of driver and driven sheaves.
    c) Number of belts required per drive.
    d) Theoretical horsepower transmitted per belt, based on vendor's data.
    e) Center distance between pump and motor shafts.
    f) Arc-length correction factor applied to theoretical horsepower transmitted.
    g) Service factor applied to established design horsepower.
    h) Safety factor ratio of power transmitted/brake horsepower required.

5. Pump drives to be enclosed on all sides by a guard constructed of fabricated steel or combination of materials including expanded, perforated, or solid sheet metal. No opening to a rotating member shall exceed 1/2 inch.

    a) Guards must be completely removal without interference from any unit component, and shall be securely fastened and braced to the unit base.

    b) Metal to be free from burrs and sharp edges. Structural joints shall be continuously welded. Rivet spacing on panels shall not exceed five inches. Tack welds shall not exceed four inch spacing.

    c) The guard shall be finished with one coat of gray W.R. non-lift primer and one coat of orange acrylic alkyd W.R. enamel in accordance with section 3, Color Definitions of ANSI 253.1; Safety Color Code for Marking Physical Hazards.

2.07 FINISH

A. Pumps, piping and exposed steel framework shall be cleaned prior to coating using an approved solvent wipe or phosphatizing cleaner. The part must thoroughly dry before paint application. Open joints shall be caulked with an approved polyurethane sealant. Exposed surfaces to be coated with two coats of a semi gloss white 2-component epoxy/polyamide to a dry film thickness of a minimum of 10 mils (5 mils minimum per coat). Coating shall be a high solids, 2 component epoxy/polyamide semi-gloss white coating for optimum illumination enhancement. The coating shall be corrosion, moisture, oil, and solvent resistant when completely dry. The factory finish shall allow for over-coating and touch-up for 6 months after coating. Thereafter, it will generally require sanding to accept a topcoat or touch-up coating. See Product Data Sheet for additional information.

2.08 ELECTRICAL CONTROL COMPONENTS

A. The pump station control panel will be tested as an integral unit by the pump station manufacturer. The control panel shall also be tested with the pump station as a complete working system at the pump station manufacturer's facility.

B. Panel Enclosure

1. Electrical control equipment shall be mounted within a common NEMA 1 stainless steel enclosures. Doors shall be hinged and sealed with a neoprene gasket and equipped with captive closing hardware. Control components shall be mounted on removable steel back panels secured to enclosure with collar studs.

2. All control devices and instruments shall be secured to the sub-plate with machine screws and lockwashers. Mounting holes shall be drilled and tapped; self-tapping screws shall not be used to mount and component. All control devices shall be clearly labeled to indicate function.

C. Branch Components

1. All motor branch and power circuit components shall be of highest industrial quality. The short circuit current rating of all power circuit devices shall be a tested combination or evaluated per the National Electrical Code Article 409. the lowest rated power circuit component shall be the overall control panel short circuit rating and shall not be less than the fault current available. The minimum control panel rating shall not be less than 25 kA, rms symmetrical for Lift Station #1 (309 Craig) and shall not be less than 10 kA symmetrical for Lift Station #2 (260 Craig) and Lift Station #6 (320 Craig). Control assemblies operating at 120 volts nominal or less may be provided with transformers which limit the fault current and may be rated less than the minimum required short circuit rating.

2. Circuit Breakers and Operating Mechanisms

   a) Either provide main breaker within each control panel, or provide a panel designed with bussing/etc. that is properly-rated to be protected by the upstream feeder fuses/breaker specified (see electrical plans and coordinate with submittals from electrical subcontractor).

   b) A properly sized heavy duty circuit breaker shall be furnished for each pump motor. The circuit breakers must be sealed by the manufacturer after calibration to prevent tampering.

   c) An operating mechanism installed on each motor circuit breaker shall penetrate the control panel door. A padlockable operator handle shall be secured on the exterior surface. Interlocks must prevent opening the door until circuit breakers are in "OFF" position. An additional mechanism(s) shall be provided on the circuit breaker permitting the breaker to be operated and/or locked with the control panel door in the open position.

3. Motor Starters

   a) An open frame, across-the-line, NEMA rated magnetic starter with under-voltage release, and overload protection on all three phases, shall be furnished for each pump motor. Starters of NEMA size 1 and above shall allow addition of at least two auxiliary contacts. Starters rated "O", "OO", or fractional size are not acceptable. Power contacts to be double-break type made of cadmium oxide silver.

Coils to be epoxy molded for protection from moisture and corrosive atmospheres. Contacts and coils shall be easily replaceable without removing the starter from its mounted position. Each starter shall have a metal mounting plate for durability.

4. Overload Relays

   a) Overload relays shall be solid-state block type, having visual trip indication with trip-free operation. Electrically resetting the overload will cause one (1) normally open and one (1) normally closed isolated alarm/control contact to reset, thus re-establishing a control circuit. Trip setting shall be governed by solid-state circuitry and adjustable current setting. Trip classes shall be 10, 15 and 20. Additional features to include phase loss protection, selectable jam/stall protection and selectable ground fault protection.

   b) A reset pushbutton, mounted through the control panel door, shall permit resetting the overload relays without opening the door.

5. Phase Monitor

   a) The control panel shall be equipped to monitor the incoming power and shut down the pump motors when required to protect the motor(s) from damage caused by phase reversal, phase loss, voltage unbalance, high voltage, and low voltage. An adjustable time delay shall be provided to minimize nuisance trips. The motor(s) shall automatically restart, following an adjustable time delay, when power conditions return to normal.

6. Transient Voltage Surge Suppressor

   a) The control panel shall be equipped with a modular surge arrestor to minimize damage to the pump motors and control from transient voltage surges. The suppressor shall utilize thermally protected by heavy duty zinc-oxide varistors encapsulated in a non-conductive housing. Mechanical indicators shall be provided on each phase to indicate protection has been lost. The suppressor shall have a short circuit current rating of 200,000 Amps and a Maximum Discharge current rating [I_{max}] of 40,000 Amperes. Nominal discharge current [I_n] is 20,000 Amperes. Surge arrester according to UL 1449 3rd Edition,Type 2 component assembly.

7. Voltage Alert Indication

   a) The control panel shall include a voltage alert indicator to reduce the risk of electrical arc flash by pre-verifying the electrical isolation from outside of the control panel. Hardwired to the main incoming point of termination, the indicator shall be powered by the same voltage that it indicates utilizing redundant circuitry, thereby flashing whenever voltage is present. An eight detector display shall visually alert the presence of dangerous AC or DC potentials occurring between any combination of the monitored input lines.

D. Control Circuit

1. A normal duty thermal-magnetic circuit breaker shall protect all control circuits by interrupting control power.

2. Pump mode selector switches shall permit manual start or stop of each pump individually, or permit automatic operation under control of the liquid level control system. Manual operation shall override all shutdown systems, except the motor overload relays. Selector switches to be oil-tight design with contacts rated NEMA A300 minimum.

3. Pump alternation shall be integral to the liquid level controller. Provisions for automatic alternation or manual selection shall also be integral to the liquid level controller.

4. Six digit elapsed time meter shall be displayed on the Integrinex™ Standard operator interface to indicate total running time of each pump in "hours" and "tenths of hours". Pump runtime shall be adjustable and password protected.

5. A high pump temperature protection circuit shall override the level control and shut down the pump motor(s) when required to protect the pump from excessive temperature. A thermostat shall be mounted on each pump casing and connected to the Integrinex™ Standard. If casing temperature rises to a level sufficient to cause damage, the thermostat causes the Integrinex™ Standard to interrupt power to the motor. The Integrinex™ Standard will display an alarm banner indicating the motor stopped due to high pump temperature. The motor shall remain locked out until the pump has cooled and circuit has been manually reset. Automatic reset of this circuit is not acceptable.

6. A duplex ground fault receptacle providing 115 VAC, 60 Hz, single phase current, will be mounted on the side of the control enclosure. Receptacle circuit shall be protected by a 15 ampere thermal-magnetic circuit breaker.

7. Auxiliary Power Transformer

    a) The lift station shall be equipped with a 3 KVA (minimum) step-down transformer to supply 115 volt, AC, single phase for the control and auxiliary equipment. See electrical plans for additional requirements for 115V branch circuit breakers. The primary and secondary side of the transformer to be protected by a thermal magnetic circuit breaker, sized to meet the power requirements of the transformer. An operating mechanism shall penetrate the control panel door and a padlockable operator handle shall be secured on the exterior surface. Interlocks must prevent opening the door until circuit breakers are in "OFF" position. An additional mechanism(s) shall be provided on the circuit breaker permitting the breaker to be operated and/or locked with the control panel door in the open position.

8. Wiring

a) The pump station, as furnished by the manufacturer, shall be completely wired, except for power feed lines to the branch circuit breakers and final connections to remote alarm devices.

b) All wiring, workmanship, and schematic wiring diagrams shall comply with applicable standards and specifications of the National Electric Code (NEC).

c) All user serviceable wiring shall be type MTW or THW, 600 volts, color coded as follows:

1) Line and Load Circuits, AC or DC power.....Black
2) AC Control Circuit Less Than Line Voltage.....Red
3) DC Control Circuit..... Blue
4) Interlock Control Circuit, from External Source.....Yellow
5) Equipment Grounding Conductor.....Green
6) Current Carrying Ground..... White
7) Hot With Circuit Breaker Open.....Orange

d) Control circuit wiring inside the panel, with exception of internal wiring of individual components, shall be 16 gauge minimum, type MTW or THW, 600 volts. Power wiring to be 14 gauge minimum. Motor branch wiring shall be 10 gauge minimum.

e) Motor branch and other power conductors shall not be loaded above the temperature rating of the connected termination. Wires must be clearly numbered at each end in conformance with applicable standards. All wire connectors in the control panel shall be ring tongue type with nylon insulated shanks. All wires on the sub-plate shall be bundled and tied. All wires extending from components mounted on door shall terminate at a terminal block mounted on the back panel. All wiring outside the panel shall be routed through conduit.

f) Control wires connected to door mounted components must be tied and bundled in accordance with good commercial practice. Bundles shall be made flexible at the hinged side of the enclosure. Adequate length and flex shall allow the door to swing full open without undue stress or abrasion. Bundles shall be held on each side of hinge by mechanical fastening devices.

9. Conduit

a) Factory installed conduit shall conform to following requirements:

1) All conduit and fittings to be UL listed.
2) Liquid tight flexible metal conduit to be constructed of smooth, flexible galvanized steel core with smooth abrasion resistant, liquid tight polyvinyl chloride cover.
3) Conduit to be supported in accordance with articles 346, 347, and 350 of the National Electric Code.
4) Conduit shall be sized according to the National Electric Code.

10. Grounding

a) Station manufacturer shall ground all electrical equipment inside the pump station to the control panel back plate. All paint must be removed from the grounding mounting surface before making final connection.

b) The contractor shall provide an earth driven ground connection to the pump station at the main grounding lug in accordance with the National Electric Code (NEC).

11. Equipment Marking

a) Permanent corrosion resistant name plate(s) shall be attached to the control and include following informaffffftion:

1) Equipment serial number
2) Control panel short circuit rating
3) Supply voltage, phase and frequency
4) Current rating of the minimum main conductor
5) Electrical wiring diagram number
6) Motor horsepower and full load current
7) Motor overload heater element
8) Motor circuit breaker trip current rating
9) Name and location of equipment manufacturer

b) Control components shall be permanently marked using the same identification keys shown on the electrical diagram. Labels shall be mounted adjacent to device being identified.

c) Switches, indicators, and instruments mounted through the control panel door shall be labeled to indicate function, position, etc. Labels shall be mounted adjacent to, or above the device.

2.09 LIQUID LEVEL CONTROL

A. The level control system shall start and stop the pump motors in response to changes in wet well level, as set forth herein.

B. The level control system shall be capable of operating as either a submersible transducer type system or ultrasonic transmitter type system.

C. The level control system shall utilize alternation to select first one pump, then the second pump, then the third pump (if required), to run as lead pump for a pumping cycle. Alternation shall occur at the end of a pumping cycle, or in the event of excessive run time.

D. The level control system shall continuously monitor the wet well level, permitting the operator to read wet well level at any time. Upon operator selection of automatic operation, the electronic pressure switch shall start the motor for one pump when the liquid level in the wet well rises to the "lead pump start level". When the liquid is lowered to the "lead pump stop level", the electronic pressure switch shall stop this pump. These actions shall

constitute one pumping cycle. Should the wet well level continue to rise, the electronic pressure switch shall start the second and/or third pump (if required) when the liquid reaches the "lag pump start level", or "standby pump start level" so that all pumps are operating. These levels shall be adjustable as described below.

1. The level control system shall include integral components to perform all pressure sensing, signal conditioning, EMI and RFI suppression, DC power supply and 120 volt outputs. Comparators shall be solid state, and shall be integrated with other components to perform as described below.

2. The level control system shall be capable of operating on a supply voltage of 12-24Vdc in an ambient temperature range of -10 degrees C (14 degrees F) through 55 degrees C (131 degrees F). Ingress Protection of IP56 for indoor use with closed cell neoprene blend gasket material. Evaluated by Underwriters Laboratories for Pollution Degree 2 device for U.L. and cU.L. Control range shall be 0 to 33.3 feet of water with an overall repeat accuracy of (plus/minus) 0.1 feet of water. Memory shall be non-volatile. A Battery backed real time clock shall be standard.

3. Eleven optically isolated, user defined digital inputs for pump and alarm status. Rated at 10mA at 24Vdc. Eight digital output relays (mechanical contacts), configurable for pump start/stop or alarms. Three relays rated at 12 Amp @ 28Vdc and 120Vac, five relays rated at 3 Amp @ 30Vdc and 120Vac. The level control system shall consist of the following integral components: pressure sensor, display, electronic comparators, digital inputs and digital output relays.

    a) The internal pressure sensor shall be a strain gauge transducer and shall receive an input pressure from the air bubbler system. The transducer shall convert the input to a proportional electrical signal for distribution to the display and electronic comparators. The transducer output shall be filtered to prevent control response to level pulsations or surges. The transducer range shall be 0-14.5 PSI, temperature compensated from -40 degrees C (-40 degrees F) through 85 degrees C (185 degrees F), with a repeat accuracy of (plus/minus) 2.5% full scale about a fixed temperature. Transducer overpressure rating shall be 3 times full scale.

    b) The level control system shall incorporate a digital back lighted LCD panel display which, upon operator selection, shall indicate liquid level in the wet well, and pump status indication for up to 3 pumps. The display shall include a 128 x 64 bit resolution LCD to read out directly in feet of water, accurate to within one-tenth foot (0.1 foot), with a full scale indication of not less than 12 feet. The display shall be easily convertible to indicate English or metric units.

    c) Level adjustments shall be electronic comparator set-points to control the levels at which the lead, lag and standby pumps start and stop. Each of the level settings shall be easily adjustable with the use of membrane type switches, and accessible to the operator without opening any cover panel on the electronic pressure switch. Controls shall be provided to permit the operator to read the selected levels on the display. Such adjustments shall not require hard wiring, the use of electronic test equipment, artificial level simulation or introduction of pressure to level control system.

d) Each digital input can be programmed as pump run, pump HOA, pump high temp, pump moisture/thermal, starter failure (FVNR, RVSS, VFD), and phase failure. Inputs are used for status and alarm indication.

e) Each output relay in the level control system shall be hard contact mechanical style. Each relay input shall be optically isolated from its output and shall incorporate zero crossover switching to provide high immunity to electrical noise. Each output relay shall have an inductive load rating equivalent to one NEMA size 3 contactor. A pilot relay shall be incorporated for loads greater than a size 3 contactor.

4. The level control system shall be equipped with alarm banners with time and date history for displaying alarm input notification. Alarm history will retain a 16 of the most recent alarm events.

5. The level control system shall be equipped with pump start/stop and alarm input delay(s) that have an adjustable delay set points.

6. An Antiseptic function with a built in timer shall be incorporated in the level control system to prevent the well from becoming septic.

7. The level control system shall be capable of jumping to next available pump if current pump is out of service due to pump failure or manual selection. Circuit design in which application of power to the lag pump motor starter is contingent upon completion of the lead pump circuit shall not be acceptable.

8. The level control system shall be equipped with a simulator system capable of performing system cycle testing functions.

9. The level control system shall be capable of calculating and displaying pump elapse run time. The elapse run time is resettable and adjustable.

10. The level control system shall have internal capability of providing automatic simplex, duplex, and triplex alternation, manual selection of pump sequence operation, and alternation in the event of 1-24 hours of excessive run time.

11. The level control system shall be equipped with a security access code to prevent accidental set-up changes and provide liquid level set-point lock-out. The supervisor access code is adjustable.

12. The level control system shall be equipped with one (1) 0-33 ft. W.C. input, one (1) scalable analog input of either 0-5Vdc, or 4-20mA, and one (1) scalable analog output of either 0-5Vdc, 0-10Vdc or 4-20mA. Output is powered by 10-24Vdc supply. Load resistance for 4-20mA output shall be 100-1000 ohms.

13. The level control system shall include a DC power supply to convert 120Vac control power to 12 or 24Vdc power. The power supply shall be 500 mA (6W) minimum and be UL listed Class II power limited power supply.

14. The level control system shall be equipped with an electronic comparator and mechanical output relay to alert maintenance personnel to a high liquid level in the wet well. An alarm banner, visible on the front of the controller, shall indicate that a high wet well level exists. The alarm signal shall be maintained until the wet well level has been lowered and the circuit has been manually reset. High water alarm shall be furnished with a dry contact wired to terminal blocks.

15. The level control system shall be equipped with an electronic comparator and mechanical output relay to alert maintenance personnel to a low liquid level in the wet well. An alarm banner, visible on the front of the controller, shall indicate that a low wet well level exists. The alarm signal shall be maintained until the cause for the low wet well level has been corrected and the circuit has been manually reset. A low liquid level condition shall disable all pump motors. When the wet well rises above the low level point, all pump motors shall be automatically enabled. Low water alarm shall be furnished with a dry contact wired to terminal blocks.

E. An alarm silence pushbutton and relay shall be provided to permit maintenance personnel to de-energize the audible alarm device while corrective actions are under way. After silencing the alarm device, manual reset of the alarm condition shall clear the alarm silence relay automatically. The pushbutton shall be integral to the level control system or operator interface.

F. Submersible Transducer System

1. The level control system shall utilize a submersible transducer. It shall be a strain gauge transducer with a pressure sensor housed in a 316 SST or Titanium case designed to extend into the wet well. The pressure transducer shall provide a proportional signal for distribution to the display and electronic comparators of the electronic pressure switch, and remainder of the level control system. Sensor range shall be 0-12 ft. W.C. minimum with an over-pressure rating 3 times full scale. The transducer shall have output capability of 1.5-7.5VDC or 4-20mA. The transducer's polyurethane jacketed shielded cable shall be of suitable length for proper installation into the wet well without splicing.

2. An intrinsically safe repeater shall be supplied in the control enclosure. Repeater must be recognized and listed as intrinsically safe by a nationally recognized testing laboratory. Station manufacturer shall make all connections from repeater to feeder lines and motor controls. Installing contractor shall make connections from repeater to transducer.

H. A two float backup option shall be provided. This option will allow the system to run both pumps in the event of a primary controller failure. In the event that the lead level float is tipped, the controls will call the lead pump to run and after a time delay, call the lag pump to run. Both pumps will run until the off float is reached. This will continue until the failure of the primary controller is addressed. This backup float option shall utilize hardwired relays and a separate pump alternator (rather than the primary controller) to control the pumps in the event of failure of the primary controller or level transducer. Provide intrinsically-safe relaying/barriers/separating for all wetwell float switch connections. Float switches shall be

self-weighted Anchor Scientific "Roto-Float" type(s) as required by application, supported by ¼" type 304 stainless steel cable support with PVC-coated 15-pound anchor, installed per manufacturer's recommendations.

I. Should the water level rise to the "high water alarm" level, the high level alarm float switch shall energize a 115-volt AC circuit for the external alarm light indicated below. An indicator, visible from front of control panel, shall indicate high level condition exists. The alarm signal shall maintain until wet well level is lowered and alarm circuit manually reset.

G. Alarm Light (External)

1. Station manufacturer will supply one 115 VAC alarm light fixture with vapor-tight shatter resistant red globe, conduit box, and mounting base. The design must prevent rain water from collecting in the gasketed area of the fixture, between the base and globe. The alarm light will be shipped loose for installation by the contractor.

H. CONTRACTOR may propose alternate level control devices, including alternate models or configurations of the specified level transducer and float controls, provided such alternates perform inherently the same functions and serve the same operational purpose as those specified herein. Any proposed alternates shall maintain full functionality as described in this Section and shall be submitted in writing to the ENGINEER for review and approval prior to procurement, fabrication, or installation. Alternates not disclosed and approved in advance shall be considered non-conforming, and the CONTRACTOR shall be solely responsible for all costs, modifications, delays, or corrective work required to achieve full compliance with the Contract Documents.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Contractor shall off-load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Station manufacturer shall provide written instruction for proper handling. Immediately after off-loading, contractor shall inspect complete pump station and appurtenances for shipping damage or missing parts. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all station serial numbers and parts lists with shipping documentation. Notify the manufacturer's representative of any unacceptable conditions noted with shipper.

3.02 INSTALLATION

A. Install, level, align, and lubricate pump station as indicated on project drawings. Installation must be in accordance with written instructions supplied by the manufacturer at time of delivery.

B. Suction pipe connections are vacuum tight. Fasteners at all pipe connections must be tight. Install pipe with supports and thrust blocks to prevent strain and vibration on pump station piping. Install and secure all service lines (level control, air release valve or pump drain lines) as required in wet well.

C. Check motor and control data plates for compatibility to site voltage. Install and test the station ground prior to connecting line voltage to station control panel.

D. Prior to applying electrical power to any motors or control equipment, check all wiring for tight connection. Verify that protective devices (fuses and circuit breakers) conform to project design documents. Manually operate circuit breakers and switches to ensure operation without binding. Open all circuit breakers and disconnects before connecting utility power. Verify line voltage, phase sequence and ground before actual start-up.

E. After all anchor bolts, piping and control connections are installed, completely fill the grout dam in the pump station base with non-shrink grout.

3.03 FIELD QUALITY CONTROL

A. Operational Test

1. Prior to acceptance by owner, an operational test of all pumps, drives, and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

2. After construction debris and foreign material has been removed form the wet well, contractor shall supply clear water volume adequate to operate station through several pumping cycles. Observe and record operation of pumps, suction and discharge gage readings, ampere draw, pump controls, and liquid level controls. Check calibration of all instrumentation equipment, test manual control devices, and automatic control systems. Be alert to any undue noise, vibration or other operational problems.

B. Manufacturer's Start-up Services

1. Coordinate station start-up with manufacturer's technical representative. The representative or factory service technician will inspect the completed installation. He will calibrate and adjust instrumentation, correct or supervise correction of defects or malfunctions, and instruct operating personnel in proper operation and maintenance procedures.

3.04 CLEANING

A. Prior to acceptance, inspect interior and exterior of pump station for dirt, splashed material or damaged paint. Clean or repair accordingly. Remove from the job site all tools, surplus materials, scrap and debris.

3.05 PROTECTION

A. The pump station should be placed into service immediately. If operation is delayed, drain water from pumps and piping. Open motor circuit breakers and protect station controls and interior equipment from cold and moisture. Station is to be stored and maintained per manufacturer's written instructions.

END OF SECTION

SECTION 40 50 00
SUBMERSIBLE LIFT STATION INSTRUMENTATION AND CONTROL SYSTEMS – ADDENDUM NO. 3

PART 1 – GENERAL

1.01 SUMMARY

A. Section includes general information, products, and execution for instrumentation and control systems for submersible lift stations.

B. Related Sections:

1. SECTION 01 31 00 - Project Management and Coordination

2. SECTION 01 44 33 - Manufacturer's Services

3. SECTION 01 78 23 - Operation and Maintenance Data

4. SECTION 01 91 00 – Commissioning

5. SECTION 26 05 00 - Basic Electrical Materials and Methods

6. SECTION 26 05 53 – Electrical Identification

7. SECTION 26 29 00 - Manufactured Control Panels

8. SECTION 26 29 16 – Reduced Voltage Soft Starters, 600vac

1.02 REFERENCES

A. Section American National Standards Institute (ANSI):

1. C39.1 - Requirements for Electrical Analog Indicating Instruments

2. C84.1 - Electric Power Systems and Equipment — Voltage Ratings (60 Hertz)

B. CSA Group (CSA):

1. C22.2 NO. 107.1 - Power conversion equipment

C. Institute of Electrical and Electronics Engineers (IEEE)

1. C37.90.1 - Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus

2. C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1,000 V and less) AC Power Circuits
3. C62.45 - Recommended Practice on Surge Testing for Equipment connected to Low-Voltage (1,000 V and less) AC Power Circuits

4. 802.3 - Standard for Ethernet

D. National Electrical Manufacturers Association (NEMA):

1. ICS 2 - Controllers, Contactors and Overload Relays Rated 600 V

2. PE1 - Uninterruptible Power Systems (UPS) — Specification and Performance Verification

E. National Fire Protection Association (NFPA):

1. 70 - National Electrical Code (NEC)

F. NSF International/American National Standards Institute (NSF/ANSI):

1. 61 - Drinking Water System Components — Health Effects

G. Occupational Safety and Health Administration (OSHA):

1. 29 CFR 1910 - Occupational Safety and Health Standards

H. Underwriters Laboratories (UL):

1. 1449 - Standard for Surge Protective Devices

2. 1778 - Standard for Uninterruptible Power Supply Equipment

1.03 DEFINITIONS

A. Unwitnessed Factory Test (UFT)

B. Witnessed Factory Test (WFT)

C. Operational Readiness Test (ORT)

D. Functional Demonstration Test (FDT)

E. Site Acceptance Test (SAT)

F. Site Demonstration Test (SDT)

1.04 COORDINATION

A. The I&C Systems Subcontractor shall be a Subcontractor to the Electrical Contractor.

B. Work Includes: Engineering, design, providing, installing, calibrating, adjusting, testing, documenting, starting up, and OWNER training for a complete I&C system.

C. Detailed Design: The I&C design, as indicated in the Contract Documents, includes functional, performance, and component requirements. Complete the detailed I&C design.

D. I&C Work Scope:

1. At a minimum, provide pump station control panel and instruments as required by application and/or shown on the Drawings, etc.

2. For equipment and ancillaries required for the I&C system:

    a. Furnish and install the equipment specified in the Contract Documents required for the I&C.

    b. Completing detail design.

    c. Required Submittals.

    d. Instructions, details, recommendations, and coordination for the certificate of proper installation.

    e. Verify readiness for operation.

    f. Verify the correctness of final interface.

    g. Adjusting and calibrating.

    h. Starting up and commissioning.

    i. Testing and coordination of testing.

    j. Training.

3. Verify the following Work is provided: Correct size, type, materials, connections, and interface of field equipment and devices.

4. For equipment not provided under I&C systems but directly connected to equipment required by I&C systems:

    a. Obtain the Manufacturer's information on installation, interface, function, and adjustment.

    b. Coordinate to allow required interface and operation with I&C.

c. For operation and control, verify that installations, interfacing signal terminations, and adjustments have been completed in accordance with the Manufacturer's recommendations.

d. Test to demonstrate required interface and operation with I&C.

e. Examples of items that may be in this category shall not be limited to:

1) Line 5

2) Electrical equipment indicated in Division 26.

3) Valve operators.

4) RVSS motor controllers.

5) Transformers.

6) Pumps and motors.

1.05 SEQUENCING AND SCHEDULING

A. I&C Progress Schedule:

1. Coordinate activities and interactions between the ENGINEER and the OWNER for coordination meetings, testing, programming, Submittal reviews, test witnessing, and training. Clarify required Work sequences and major milestone prerequisites.

2. Format: As specified in SECTION 01 31 00 - Project Management and Coordination.

3. Include:

a. Design activities.

b. Submittals.

c. Purchasing, fabricating, and assembly activities.

d. Shipment and delivery.

e. Installation.

f. Testing.

g. Startup.

h. Training.

i. Coordination meetings.

j. Substantial Completion date.

k. Acceptance.

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

1. Submittal to the ENGINEER:

a. Prerequisite: ENGINEER acceptance of the I&C progress schedule.

b. Provide PLC equipment as shown on the Drawings or listed in the specifications.

2. Hardware purchasing, fabrication, and assembly: Associated Shop Drawing Submittals completed.

3. Tests: Associated test plan Submittal completed.

4. Training: Associated training plan Submittal, reviewed, and accepted by the ENGINEER.

5. FDT: Shop Drawing Submittals completed.

6. FDT completed.

7. Shipment to site: Completion of Shop Drawing Submittals, preliminary O&M manuals, and for I&C elements involved in the FDT.

8. ORT: The allowance for interruptions to the CONTRACTOR's Work due to applications software testing shall be 10 days total.

9. PAT:

a. Prerequisite: ORT completed, and facility started up.

b. Allowance for interruptions to the CONTRACTOR's Work due to applications software testing shall be 10 days total.

C. I&C Substantial Completion Date: In accordance with the General Conditions and the Supplementary Conditions, unless otherwise noted below for I&C. Additional prerequisites for Substantial Completion include:

1. I&C Submittals accepted or approved, as specified.

2. PAT successfully completed.
3. OWNER training plan on schedule.

4. Spares, expendables, and test equipment delivered to the OWNER.

5. Service and maintenance agreements submitted for the Work required in this Section.

D. I&C Acceptance: In accordance with the General Conditions, unless otherwise specified below for I&C.

1. When the ENGINEER issues a written notice of acceptance, the following prerequisites shall have been met:

a. I&C certificate of Substantial Completion.

b. Punchlist items completed.

c. Final revisions to O&M manuals accepted.

d. After the I&C has been completely installed and made operational, the entire system shall be subject to an operational test run before being accepted. To complete the requirement, the I&C and PLC/RTU communications shall operate properly, without significant system malfunction, as deemed by the ENGINEER, for a continuous uninterrupted time period of 20 days. If the PLC/RTU system fails to meet the requirement, make the necessary repairs or adjustments required to correct the problem. The acceptance test shall completely restart from the beginning for a complete retest.

e. Maintenance service agreements for I&C have been accepted by the OWNER.

1.06 SUBMITTALS

A. Refer to Specification Section 26 29 00 ("Manufactured Control Panels") for additional requirements.

B. ENGINEER's Review: The ENGINEER will act upon the CONTRACTOR's Submittal and transmit a response to the CONTRACTOR no later than 10 days after receipt. Resubmittals will be subject to the same review time.

C. Administrative Submittals:

1. Statements of qualification:

a. I&C Contractor.

b. I&C Contractor's site representative.

c. Resume for each I&C Contractor's on-site startup and testing team member.

2. I&C progress schedule:

    a. Submit within 30 days after the Pre-Construction Meeting.

    b. Upon acceptance by the ENGINEER, it shall form the basis and schedule for Submittal reviews, test witnessing, and partial payments relating to I&C Work.

3. OWNER training plan: As specified in SECTION 01 44 33 – Manufacturer's Services.

D. Shop Drawings:

2. Itemized Bill of Materials

    a. Data included:

        1) Tag number.

        2) Description.

        3) Manufacturer, complete model number, and options not defined by the model number.

        4) Quantity supplied.

3. Catalog cuts for equipment, components, devices, and materials:

    a. Catalog information.

    b. Descriptive literature.

    c. External power and signal connections.

    d. Scaled drawings showing exterior dimensions and locations of electrical interfaces, mechanical interfaces, and mounting arrangements.

    e. Specific features and configuration data:

        1) Location or service.

        2) Manufacturer and complete model number.

        3) Setpoints and scale range.

        4) Engineering specifications.

        5) Equipment weights.

6) Power and grounding requirements.

7) Materials of construction.

f. Name, address, and telephone number of the Manufacturer's local office, representative, distributor, or service facility.

4. Construction drawings:

a. Show to scale enclosure, internal equipment layout, and external device nameplates and layout.

b. Show dimensions and locations of panel-mounted devices, doors, louvers, and subpanels (internal and external).

c. Panel legend: List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.

d. Construction details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, louvers, mounting brackets and tabs, door hinges and latches, and welding.

e. Cable access areas and cable routing.

f. Anchor bolt size and location.

g. Installation and mounting detail drawings.

h. P&IDs.

i. Hydraulic and electrical schematics.

j. Equipment weights.

5. Wiring diagrams:

a. Ladder diagrams in a format similar to those shown on the drawings.

b. Diagrams shall be coordinated and show field interfaces.

c. Interconnection from power sources and panelboards.

d. Electrical connections between equipment, consoles, panels, terminal junction boxes, and field-mounted components.

e. Component and panel terminal board identification numbers, and external wire and cable numbers.
f. Circuit names, identify terminals, cable ID tags, actual cable lengths, and conduit tags.

g. Grounding diagram, philosophy, implementation, terminations, type, and connections.

h. Show each circuit individually.

i. Identify each item with attributes listed:

1) Wires, conductors, cables: Type, number, size and color.

2) Terminals: Location, terminal strip number, and terminal block number.

3) Discrete components:

i. Tag number, terminal numbers, and location.

ii. Switching action, open or close on rising or falling variable, setpoint value and units, and variable description.

4) I/O point list for I/O points, include:

i. Point names and descriptions.

ii. Point addresses, tag numbers, functions, ranges, and engineering units.

i. Wire and cable assignments.

ii. I/O card layout, module, and block number.

iii. Field wiring termination assignments.

5) Relay coils:

i. Tag number and its function.

ii. On the right side of the run where the coil is located, list the contact location by ladder number and sheet number.

6) Relay contacts: Coil tag number, function, and coil location.

6. Pump Control Panel cabinet power consumption and heat dissipation, tabulate and summarize:

a. Required voltages, currents, and phases.

b. Maximum heat dissipations Btu per hour.

c. Include calculations.

7. Communications with Pump Control Panel devices, PLC equipment: Describe configuration, operation, limitations, and diagnostics for LANs, data highway, serial links, and other communication paths.

8. Applications software documentation:

a. Complete configuration documentation for microprocessor based configurable devices.

b. For each device, include a program configuration listing showing:

1) Functional blocks or modules used.

2) Configuration, calibration, and tuning parameters.

3) Descriptive annotations.

E. Shop Drawings for changes impacting software configuration:

1. Schedule:

a. Submit first changes as part of Shop Drawings.

b. Submit updated changes at 30-day intervals.

2. Changes to I/O list reflecting actual equipment and instrumentation.

3. Changes required to software configuration resulting from installation of alternative, upgraded, and modified equipment.

F. Quality Control Submittals:

1. Testing Related Submittals:

a. Unwitnessed factory test: No Submittals required.

b. FDT, operational readiness, and PAT:

1) Preliminary test procedures: Outlines of proposed tests, forms, and checklists.

2) Final test procedures: Proposed test procedures, forms, and checklists.

3) Test documentation: A copy of the signed off test procedures when tests are completed. completed component calibration sheets with O&M manuals.

2. O&M manuals:

a. As specified in SECTION 01 78 23 – Operations and Maintenance Date, unless otherwise specified in this Section.

b. Include Shop Drawing submittal information.

c. Manufacturer's O&M manuals: Certificate of proper installation, instructions for installation, operation, maintenance, troubleshooting, and calibration. Include internal schematics and wiring diagrams.

d. Software documentation: Updated version of software.

e. Hardcopy and electronic version of installed programs in controllers.

f. Calibration, startup, and commissioning reports.

g. Complete lists of equipment furnished, including Manufacturer model numbers, correct settings, alarm points, and operating ranges.

h. Detailed instructions for periodic maintenance schedules, equipment inspection, and adjustment.

i. Drawings shall be provided in electronic media on standard IBM computer compatible hi-speed USB flash drives and in quality hardcopy media. AutoCAD Drawings shall be in accordance with Design Drafting Standards.

j. List of spares and expendables required and recommended.

G. Contract Closeout Submittals: Prior to the Substantial Completion date, submit service agreements signed by the OWNER and the maintenance provider for Work required in this Section.

H. Extra Materials:

1. Provide one consolidated spare parts package for all Lift Control Panels (LCPs) of identical configuration under this Contract. Where LCP configurations differ, provide one spare parts package for each unique LCP configuration. Identical configuration shall mean panels with the same control components, ratings, and internal equipment arrangement.

2. Furnish, box, tag, and clearly mark on exterior, identify each item with the Manufacturer's name, description, and part number for shipment and long-term storage, and deliver prior to 75%« of the Substantial Completion date the following extra materials for the Pump Control Panels and associated components:

a. Fuses: A minimum of 10 of each type and size.

b. One 24 VDC power supplies.

c. Indicating light bulbs and LEDs: A minimum of 10 of each type and size.

d. Relay: 3 of each type.

e. Corrosion-inhibiting vapor capsules: The Manufacturer's recommended 2-year supply.

f. Spray pump filter adhesive: One pint.

g. One spare PLC chassis, I/O cards, communications ports, power supply and CPU.

I. Warranty Documentation:

1. Sample warranty.

2. Warranty.

J. Supplements listed in this Section.

1.07 QUALITY ASSURANCE

A. The CONTRACTOR shall provide OWNER contact information to Equipment Manufacturers as "owner of record" for warranties, recalls, updates (including software and firmware), notices, etc.

B. UL Compliance: Materials manufactured within the scope of UL shall conform to UL Standards and have an applied UL listing mark.

C. Qualifications:

1. I&C Contractor qualifications:

a. A minimum of 10 years of documented experience in the Work of this Section.

b. Approved by the Manufacturer.

2. I&C Contractor's site representative qualifications: A minimum of 10 years of documented experience in the Work of this Section.

D. Coordination Meetings:

1. General: As specified in SECTION 01 31 00 – Project Management and Coordination.

a. Location: At the site or the ENGINEER's office, as approved by the ENGINEER.

b. Attended by: ENGINEER, CONTRACTOR, Subcontractor, Manufacturer, and OWNER, as requested by the ENGINEER.

c. Meeting frequency: When requested by the ENGINEER. Estimated monthly in the first half of the Project and weekly in the second half of the Project.

E. Training:

1. General:

a. Provide an integrated training program for the OWNER's personnel.

b. Perform training to meet the specific needs of the OWNER's personnel.

c. Include training sessions, classroom, and field, for managers, ENGINEERs, operators, and maintenance personnel.

d. Accommodate the OWNER's personnel schedule.

e. The OWNER reserves the right to make and reuse videos of the training sessions.

2. O&M training:

a. Coordinate specific requirements specified in the I&C subsystems.

b. Include a review of O&M manuals and a survey of spares, expendables, and test equipment.

c. Use equipment similar to that provided or currently owned by the OWNER.

d. Provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics, instrumentation, or digital systems.

3. Operation training:

a. Training session duration: One instructor day.

b. Number of training sessions: One.

c. Location: Project site.

d. Content:

1) Loop/circuit functions: Understanding of loop/circuit functions, including interlocks for each loop/circuit.

2) Operation: For example, adjusting variable setpoints, manual/remote control, protective relay trips and resets, annunciator acknowledgment and resetting.

3) Interfaces with field equipment, governor equipment, electrical equipment, existing equipment, etc.

4. Maintenance training:

a. Training session duration: One instructor day.

b. Number of training sessions: One.

c. Location: Project site.

d. Content: Provide training for each type of component and function provided.

1) Functions: Understanding details of each loop/circuit and how they function.

2) Component calibration.

3) Adjustments: For example, controller tuning constants, current switch trip points, and similar items.

4) Troubleshooting and diagnosis for components.

5) Replacing lamps, fuses, reset breakers, reset protective relays.

6) Component removal and replacement.

7) Periodic maintenance.

F. Instrument Tag Numbers: The tag number notation corresponds to the Drawings and is used in the loop specifications. Example: PI-02-01.

Notation	Explanation
PI	ISA designator for Pressure Indicator
02	Loop number
01	First unit number

1.08 DELIVERY, STORAGE, AND HANDLING

A. Provide field and warehouse storage facilities for equipment.

B. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers, and related equipment as recommended by the Capsule Manufacturer.

C. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

D. Cover panels and other elements exposed to dusty construction environments.

1.09 SITE CONDITIONS

A. Materials and equipment shall be designed and manufactured for continuous operation, site conditions as specified in SECTION 26 05 00 – Common Work Results for Electrical.

1.10 WARRANTY

A. Equipment furnished under this Section shall comply with the warranty requirements specified in SECTION 01 78 36 – Warranties & Bonds.

PART 2 – PRODUCTS

2.01 REFER TO SPECIFICATION SECTION 26 29 00 ("MANUFACTURED CONTROL PANELS") FOR ADDITIONAL REQUIREMENTS.

2.02 PUMP CONTROL PANEL

A. General:

1. The I&C Systems Subcontractor shall furnish factory-assembled, wired, and tested Pump Control Panels for the following pump stations:

   a. LS4 @ 43 Craig Industrial Park

   b. LS8 @ Hwy 80

2. Each panel shall be constructed in accordance with the general requirements of this specification and the project-specific requirements detailed below.

3. Each panel shall provide control for all of the 3-phase submersible pumps at the site as indicated on the Electrical Drawings.

4. The scope of supply shall be in accordance with the project documents.

5. Each Pump Control Panel shall be fabricated to meet all requirements shown on the Electrical Drawings.

6. Refer to Specification Section 26 29 00 ("Manufactured Control Panels") for additional control panel requirements.

7. The control system shall be designed to operate the required number of pumps specified on the drawing at the power characteristics shown on the plans.

8. The control function shall provide for the operation of the pumps under normal conditions, and shall alternate the pumps on each pump down cycle to equalize the run time. In the event the incoming flow exceeds the pumping capacity of the lead pump, subsequent pumps shall automatically start to handle the increased flow. As the flow decreases, the pumps shall cut off at the elevations as shown on the plans.

9. The control shall function as described below. The equipment listed below is a guide and does not relieve the supplier from supplying a system that will function as required.

B. MECHANICAL

1. The enclosure shall be a NEMA 4X Stainless steel enclosure. The enclosure shall be a wall mount type with a minimum depth of 10" sized to adequately house all the components. Enclosures larger than 60" high x 36" wide shall be provided with 12" high leg stands. The enclosure door gaskets shall be rubber composition with a retainer or seamless foamed in place to assure a positive weatherproof seal. The gasket material shall not retain memory. The door shall open a minimum of 180 degrees.

2. A polished aluminum dead front inner door shall be mounted on a continuous aircraft type hinge and shall contain cutouts for mounted equipment and provide protection of personnel from live internal wiring. Cutouts for breaker handles shall be provided to allow operation of breakers without entering the compartment. All control switches, indicator pilot lights, elapsed time meters, and other operational devices shall be mounted on the external surface of the dead front. The dead front shall open a minimum of 150 degrees to allow access to equipment for maintenance. A 3/4" break shall be formed around the perimeter of the dead front to provide rigidity.

3. The back plate shall be manufactured of 12 gauge sheet steel and be finished with a primer coat and two [2] coats of baked on white enamel. All hardware mounted to the subpanel shall be accomplished with machine thread tapped holes. Sheet metal screws are not acceptable. All devices shall be permanently identified using engraved name plates. Use of DYMO type labels is not acceptable.

C. ELECTRICAL

1. The panel power distribution shall include all necessary components and be completely wired with tinned, stranded copper conductors rated at 90 degrees c. All conductor terminations shall be as recommended by the device manufacturer.

2. All circuit breakers shall be heavy duty thermal magnetic or motor circuit protectors similar and equal to SQUARE D type FAL. Each motor breaker shall be adequately sized to meet the pump motor operating characteristics and shall have a minimum of 22,000 amps at 480 VAC. The control circuit shall individually be controlled by a heavy-duty breaker.

a. Circuit breakers shall be indicating type, providing "on-off-trip" positions of the operating handle. When the breaker is tripped automatically, the handle shall assume a middle position indicating "trip".

b. Thermal magnetic motor breakers shall be quick-make and quick-break on manual and automatic operation and have inverse time characteristics secured through the use of bimetallic tripping elements supplemented by a magnetic trip.

c. Breakers shall be designed so that an overload on one pole automatically trips and opens all legs. Field installed handle ties shall not be acceptable.

3. Motor starters shall be Reduced Voltage Soft Starters (RVSS) with a NEMA-rated, three-contactor, starting-duty Full Voltage Non-Reversing (FVNR) bypass.

4. Control transformers shall be provided to provide the 120 VAC and/or 24 VAC for control circuits when required. Transformers shall be fused on the primary and secondary circuits. The secondary windings shall be grounded.

5. A lightning-transient protector with tell-tale warning lights on each phase to indicate loss of protection on the individual phases shall be provided. The device shall be solid state with a response time of less then 5 nanoseconds with withstanding surge capacity of 6500 amperes. Unit shall be instant recovery, long life and have no holdover currents.

6. The Phase Monitor shall be a 12 pin, plug in style unit. The Phase Monitor shall monitor Under Voltage, Phase Reversal, Loss of Power and Phase Imbalance. The motor starter circuits shall be de-energized upon sensing of any of the faults and shall automatically restore service upon return to normal power. The Phase Monitor shall be available to monitor Over Voltage as an option. The output relay shall be DPDT rated at 10A at 240 VAC. The Phase Monitor shall be model 001-230-1212, or model 001-480-1212 as manufactured by Motor Protection Electronics, Apopka, Florida, (407) 299-3825.

7. The control panel shall be suitable for 277/480V-3Phase-4Wire input service voltage.

D. ALARM SYSTEM

1. The alarm light shall be a weatherproof, shatterproof, red light fixture with a 40 watt bulb to indicate alarm conditions. The alarm light shall be turned on by the high level alarm and flash until the condition has been corrected. An open contact shall be provided for remote monitoring.

2. The alarm horn shall be mounted on the exterior of the cabinet. The alarm horn shall provide a signal of not less than 90db at 10 feet. The alarm horn shall not degrade the listing of the enclosure. An alarm horn off and silence switch shall deactivate the alarm horn; however, the alarm light will flash until the alarm condition ceases to exist. At that time the alarm reset function will reset for normal operation.

E. LEVEL CONTROL SYSTEM (SC1000 Controller)

1. A controller shall be provided to control up to three pumps. The controller shall be capable of alternating the pumps, and must provide lag pump delays and high and low level alarms.

2. The controller shall be standard "off the shelf" equipment with published literature and fully tested hardware and operating program. The controller must be field configurable from the front of the unit, and require no special tools or software to set-up or operate.

3. The controller shall be a microprocessor-based device and not require a battery to maintain the operating program. All set-up values shall be stored in non-volatile memory. The controller shall be UL listed as Industrial Control Equipment, UL 508.
4. A numerical 3 digit, 7 segment LED level display shall be provided on the front of the unit showing levels in feet and tenths of feet.

5. The controller shall not require an external power supply or any external I/O modules to be a fully functioning unit. An analog input (4-20mA) with zero and span adjustments, shall be provided. Relays with 10 amps rated contacts shall be provided as standard for control functions.

6. All electrical connections, for power or I/O, shall be by quick disconnect phoenix style connectors.

7. The controller shall have 12 discrete inputs.

8. Troubleshooting features shall include a fault indicator on the front of the unit and retrievable fault codes that aid in diagnosing most common problems. Status of the discrete inputs shall also be viewable from the front of the unit. A level simulation feature shall be available from the front of the unit. The controller shall automatically return to monitoring wet well level after sixty seconds, if left in simulation mode.

9. Menu selectable First-On/First-Off or First-On/Last-Off alternation sequences shall be available.

10. Pump disable discrete inputs shall cause the alternator to skip over disabled pumps. The controller shall remember which pump was in the lead position during a power outage.

11. An RS232 serial port with the Modbus protocol shall be provided for SCADA. Modbus RTU or ASCII modes shall be menu selectable. RTS and CTS hardware connections along with all necessary programming shall be in place to fully interface with commonly used radio or telephone modems. Programming shall be in place to collect and transmit the station status, and to allow for the remote control of the pumps.

12. The pump On/Off levels, high level alarm, and low level alarm setup values shall be viewable and changeable from a remote location. Pump elapsed time meters shall be viewable and resettable from a remote location, and shall be stored in non-volatile memory during a power outage.

13. The controller shall contain a discrete input for connection to an external time clock to force pump alternation. The controller shall have a parameter setting to allow the analog input level to be a 4-20ma signal from a transducer, or an input from a conductance level probe with ten sensor points or both using probe as a backup. The controller shall have a parameter to select the level probe type by the distance between the electrodes, impedance settings and shall have a level offset parameter to enable the transducer or conductance level probe to be placed off the bottom of the wet well, while maintaining an accurate representation of the wet well depth. The controller shall be able to perform floatback-up with two to six floats.

14. The controller shall be model SC1000 as manufactured by MPE Electronics, Apopka, Florida.

F. SUBMERSIBLE TRANSDUCER

1. A submersible transducer manufactured from 316 stainless steel, containing a piezo resistive sensor with output signals proportional to applied pressure shall be supplied. The electronics shall be padded in a silicon compound for protection and have 316 stainless or plastic composite device protecting the sensing face of the transducer. The transducer shall operate from a power supply voltage of 10-30 VDC and supply a 4-20ma signal proportional to water level into the controller. The control signal shall be transmitted via a vented, molded polyurethane jacketed cable. The cable shall be gripped by a neoprene grommet and potted in place. The transducer shall be protected by a desiccant and surge arrestor. Surge protection shall be provided for the transducer. The suppressor shall be a dual pair [four wire] module implementing three stage hybrid technology to address over voltage transients and fault currents. The surge suppressor shall be supplied with a female connector and be part number PC642 as manufactured by EDCO.

2. An Intrinsically safe barrier shall be supplied for the transducer as manufactured by Cooper Crouse Hinds or equal. The barrier shall have an LED indicating power with replaceable fuses and dual ground. The barrier socket shall be of plug in design utilizing back plane technology. The barrier shall be UL listed as associated apparatus providing intrinsic circuits for use in Class I, Group A,B,C,D, Class II, Group E,F,G, Class III when used with drawing number SBO3 US1.BACKUP FLOAT CONTROLS.

G. Backup Float Controls:

1. A two float backup option shall be provided. This option will allow the system to run both pumps in the event of a primary controller failure. In the event that the lead level float is tipped, the controls will call the lead pump to run and after a time delay, call the lag pump to run. Both pumps will run until the off float is reached. This will continue until the failure of the primary controller is addressed. This backup float option shall utilize hardwired relays and a separate pump alternator (rather than the primary controller) to control the pumps in the event of failure of the primary controller or level transducer. Provide intrinsically-safe relaying/barriers/separating for all wetwell float switch connections. Float switches shall be self-weighted Anchor Scientific "Roto-Float" type(s) as required by application, supported by ¼" type 304 stainless steel cable support with PVC-coated 15-pound anchor, installed per manufacturer's recommendations.

H. ANCILLARY EQUIPMENT

1. The following devices shall be furnished on the inner door of the control enclosure for each pump motor:

   a. For Each Pump:

      1) Overtemperature Light (Amber)
      2) Leakage Alarm Light (Amber)
      3) Pump Starter/Overload Alarm Light (Amber)
      4) Alarm Reset Pushbutton
      5) Hand/Off/Auto Selector Switch
      6) Running Light (Green)
      7) Pump Called To Run Light (Blue)
      8) Off Light (Red)
      9) Elapsed Time Meter

   b. Other:

      1) High-Level Alarm Light (Amber)
      2) Backup Float System Active Alarm Light (Amber)
      3) Backup Lag2 Level Alarm Light (Amber) – ONLY FOR TRIPLEX STATIONS
      4) Backup Lag Level Alarm Light (Amber)
      5) Backup Lead Level Alarm Light (Amber)
      6) Backup Low Level Alarm Light (Amber)
      7) General Alarm Silence Pushbutton

2. The alternator shall be a plug in, solid state unit with lead-lag-auto selector and test switches except when provided in a dedicated control device. LEDs shall indicate the next position to run as lead pump.

3. A thermal heater and thermostat shall be installed to maintain the internal temperature of the enclosure above the dew point.

4. Control wiring shall be copper, tinned, UL1015, 18ga. Minimum.

5. One pump monitoring relay be supplied for each pump to monitor the pump for over-temp and leakage. The unit shall have an 11pin, round base to mate with a standard 11 pin socket. The unit shall also be flanged in order to allow deadfront door mounting with use of 11 pin reverse socket, Omron part number P3GA-11.

   a. The unit is to be able to be powered by 24VAC, 24VDC, or 120VAC, and to contain LED indication for power on, over-temp, and leakage conditions. The unit shall contain an over-temp reset bush-button to reset the unit after the fault has cleared, as well as a selector switch that allows the selection of manual or auto reset.

b. The sensor input circuitry is to contain both hardware and software filters for noise immunity, as well as sensor input short circuit protection. The Mini-Cas 120 unit shall be model 14-407129, as supplied by Flygt Corporation.

6. Load Center

a. The lift station shall be equipped with a 120/240V-1Phase load center with main primary and secondary breakers and branch circuit breakers as indicated on electrical plans (mounted within control panel) to feed all control and auxiliary equipment at site as required and as indicated on electrical plans. The load center shall be fed from a step down transformer mounted within the pump station enclosure as indicated on electrical plans. An operating mechanism shall penetrate the control panel deadfront door and a padlockable operator handle shall be secured on the exterior surface for each breaker. Interlocks must prevent opening the door until main circuit breaker is in "OFF" position. An additional mechanism(s) shall be provided on the circuit breaker permitting the breaker to be operated and/or locked with the control panel door in the open position. All breakers shall be numbered and labeled (with associated circuit function).

7. SCADA I/O

a. Provide dry contacts and 4-20mA signal outputs for SCADA signals as indicated on point lists on electrical plans.

I. MANUFACTURER

1. A final as built drawing encapsulated in mylar shall be attached to the inside of the front door. Schematics shall be done in ladder logic with wire numbers and line numbers. Real time cross referencing of relay contact to line numbers shall be given as well as written description of component function on each circuit of the drawings. From/ to wire and termination reports shall be shown on the as built drawings. Drawings shall be available in HTML format. Terminal strip layouts shall be provided for ease of connecting external devices.

2. All component parts in the control panel shall be permanently identified with engraved legend plates as designated on the drawings. A list of all legends shall be available in Excel format and attached with the schematics on the panel door.

3. All equipment shall be tested to the operational requirements. Each control function shall be activated to check for proper indication.

4. Equipment furnished under this Section shall comply with the warranty requirements specified in Section 01 78 36 – Warranties and Bonds.

5. The manufacturer shall be a UL508 shop and provide evidence on the end product.

PART 3 – EXECUTION

3.01 GENERAL

A. Refer to Specification Section 26 29 00 ("Manufactured Control Panels") for additional requirements.

B. Provide materials, equipment, and software, whether indicated or not, necessary for complete system integration and performance.

C. Use products of one Manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and Manufacturer's services.

3.02 PREPARATION

A. Equipment provided by the I&C contractor and installed by others requires the I&C Contractor to observe and advise on installation to extent required to certify with ORT that equipment has been properly installed.

B. For equipment not provided by the I&C Contractor, but that directly interfaces with the I&C, verify the following conditions:

1. Proper installation, calibration, and adjustment.

2. Correct control action.

3. Switch settings and dead bands.

4. Opening and closing speeds and travel stops.

5. Input and output signals.

3.03 INSTALLATION

A. Material and Equipment Installation:

1. Follow the Manufacturer's installation instructions. Provide signed draft copy of the Manufacturer's certification of proper installation prior proceeding with further testing.

B. Provide, install, and be responsible for a complete fully operational control system.

C. The intent of the Contract Documents is to show general locations and the minimum amount of devices and interconnection required to make the I&C functional. The detailed design, layout, and installation of the required control wiring, interconnections, and devices to make the complete system fully functional is the CONTRACTOR'S responsibility.

D. Install and perform in accordance with the Manufacturer's recommendations including, but

not limited to, communications equipment, terminations, testing, startup, and other necessary appurtenances.

1. The fully operational system shall include:

    a. Communications between PLCs and office servers.

    b. Field I/O connections and terminations in accordance with the Contract Documents.

    c. Field I/O connections include, but are not limited to, primary elements, transmitters, control panels, etc.

2. PLC programming logic shall be provided by and installed by the ENGINEER.

3. Demonstrate to the ENGINEER network communications between the PLCs and office servers.

3.04 PROTECTION

A. Protect enclosures and other equipment containing electrical, I&C devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules.

B. Periodically replace capsules in accordance with the Capsule Manufacturer's recommendations. Replace capsules just prior to Final Payment and Acceptance.

3.05 CLEANING

A. Clean debris, dirt, dust, etc. from equipment.

END OF SECTION

APPENDIX B
ELECTRICAL SPECIFICATIONS
ADDENDUM #3

JRA PROJECT NO. 225180
Sewer System Improvements - Phase I
Dallas County Water & Sewer Upgrades
CLIENT JOB NO. CS010889-03
BASED ON CLIENT TEMPLATE: "Kelley Group5.docx"
PRINTED ON: December 22, 2025

ELECTRICAL SPECIFICATION INDEX:

12/22/2025

SECTION 26 05 00
Basic Electrical Materials And Methods

PART 1 - GENERAL

1.01 DESCRIPTION

A. General Conditions:

1. The accompanying General Conditions (front-end specifications) shall apply to and form a part of this section.

B. General Requirements:

1. Carefully examine General Conditions, other specification sections, and other drawings (in addition to Electrical) in order to be fully acquainted with their effect on electrical work.
2. Do all work in compliance with all applicable codes, laws, and ordinances, the National Electrical Safety Code, the National Electrical Code (hereinafter referred to as "Code"), applicable energy codes, and the regulations of the local utility companies. Obtain and pay for any and all required permits, inspections, certificates of inspections and approval, and the like.
3. Cooperate with other trades and contractors at job. Perform work in such manner and at such times as not to delay work of other trades. Complete all work as soon as the structure and installations of equipment will permit. Patch, in a satisfactory manner and by the proper craft, any work damaged by electrical workmen.
4. The Owner shall be provided access to all software to include copies of software for all systems provided under this division of the specifications. Software shall be password protected where applicable.
5. Only qualified electrical sub-contractors will be allowed to submit proposals for this project. In order to be considered qualified, contractor shall have completed a minimum of five (5) projects of similar type/scope and equal or greater magnitude and complexity within the last ten (10) years. Sub-contractors without qualifications will be rejected. If desired, potential electrical sub-contractors may submit qualification evidence for review and pre-bid approval a minimum of ten (10) days prior to bid. Previous projects used to meet this experience requirement must have included similar (or greater) scopes of work for each of the following areas:

    a. Power Systems.
    b. Control Systems.
    c. Instrumentation Systems.

C. Electrical Contractor Experience Requirements:

1. Electrical contracting firm shall be licensed as an electrical contractor in the state where work will be performed.
2. Only qualified electrical sub-contractors will be allowed to submit proposals for this project. In order to be considered qualified, electrical contractor shall have

successfully completed, under his/her present firm name, not less than five (5) projects of similar size and scope within the last ten (10) years. For example, electrical contractors proposing on water/wastewater projects shall have completed the specified quantities/types of water/wastewater projects. Similarly, the Electrical Project Manager and Electrical Foreman to be assigned to this project must meet the following minimum requirements:

a. Minimum of 5 years of experience (in their current/respective role) with projects of similar size and scope.
b. The Electrical Project Manager and Electrical Foreman should be assigned to the project for its duration. Any changes made shall be done with two weeks minimum notice and include the following:

1) Reason for change in personnel.
2) Proposed Replacement with resume and work history on similar type projects meeting the requirements listed above.
3) Must meet Owner approval before being assigned to the project.

3. Previous projects used to meet the experience requirement above must have included similar (or greater) scopes of work for each of the following areas:

a. Power Systems.
b. Control Systems.
c. Instrumentation Systems.

4. Sub-contractors without qualifications will be rejected. If desired, potential electrical sub-contractors may submit qualification evidence for review and pre-bid approval a minimum of ten (10) days prior to bid.

1.02 GENERAL SCOPE OF ELECTRICAL WORK (REFER TO DRAWINGS FOR OTHER SPECIFIC SCOPE ITEMS)

A. Furnish all labor and materials to complete electrical work as shown on drawings and/or herein specified.

B. Remove all existing electrical equipment and wiring made obsolete by this project and remove or relocate all electrical services located on or crossing through the project property, either above or below grade, which would obstruct the construction of the project or conflict in any manner with the completed project or any code pertaining thereto. Dispose of salvageable materials as directed by the Engineer. Contractor shall schedule meeting to review scope of electrical demolition and to confirm scope and phasing of proposed demolition with the owner in the presence of the prime consultant prior to start of any electrical demolition.

C. Furnish and install complete power, telephone and other electrical services as shown on drawings and/or specified herein.

D. Pay all electrical utility company service charges (if any) in connection therewith, including permanent meter deposit. Meter deposits will be refunded to Contractor at

time of Owner's acceptance.

E. Furnish and install complete power distribution system as shown on drawings and/or specified herein.

F. Furnish and install complete reduced voltage soft starters and associated devices for motors as shown on drawings and/or specified herein.

G. Furnish and install disconnect switches for motors as shown on drawings and/or specified herein.

H. Furnish and install complete electrical grounding systems as shown on drawings and/or specified herein.

I. Install and connect electrical equipment mentioned in Division 26/27/28 Specifications or noted in drawings, whether furnished by electrical contractor or by others.

1. Where shown or specified, equipment furnished by others shall be installed and connected under this Contract.
2. Where shown or specified, Contractor shall receive, unpack, check and assume custody of equipment furnished by Others. Contractor shall assume responsibility for care and safekeeping of this equipment, when delivered into his custody. He shall protect it from moisture, dust and damage during construction and until Owner acceptance of project.

J. Furnish and install complete electrical lighting systems as shown on drawings and/or specified herein.

K. Furnish and install all electrical items shown on drawings and/or herein specified, unless shown or specified otherwise.

L. Furnish and install complete controls, instrumentation & auxiliary systems as shown on drawings and/or specified herein.

M. Furnish and install a complete Surge Protection System as shown on drawings and/or specified herein.

N. Procure and pay for permits and certificates as required by local and state ordinances and fire underwriter's certificate of inspection.

O. Balance loads as equally as practicable on services, distribution feeders, circuits and buses. Provide typewritten directory for each panel.

P. Unless specifically indicated or required otherwise, terminate all circuitry/cabling provided within this contract at associated equipment/devices/etc. in accordance with all applicable codes, standards and supplier requirements, whether associated equipment/device/etc. is furnished within this contract or by others.

Q. Complete field testing, adjustment & startup of all systems listed above as shown on

drawings and/or specified herein.

PART 2 - PRODUCTS

2.01 APPROVED MATERIALS AND DEVICES

A. Where not otherwise specified, provide only new, standard, first-grade materials/systems throughout, conforming to standards established by Underwriter's Laboratories, Inc., and so marked or labeled, together with manufacturer's brand or trademark. All equipment/systems subject to approval of Engineer before installation. All like items and associated equipment/systems shall be of one manufacturer.

B. To ensure proper coordination, it is intended that all electrical equipment and materials specified in Division 26/27/28 of these specifications and shown on the electrical drawings be furnished and installed by the electrical sub-contractor, for proper coordination. It will not be permissible for any of these items to be furnished directly by the general contractor.

C. To ensure commonality of spare parts, it is required that the electrical contractor provide the same brand for all circuit breakers, starters, power equipment, etc. provided under the following divisions of these specifications:

1. SECTION 26 05 73: POWER DISTRIBUTION SYSTEM ELECTRICAL STUDIES
2. SECTION 26 28 16: SAFETY SWITCHES AND FUSES

2.02 SUBMITTALS

A. All submittals to the design team shall be accompanied by a letter summarizing all proposed deviations from specified products or pre-approved substitutions. The absence of such a letter shall be understood to indicate that the contractor intends to meet all contract requirements, regardless of cut-sheets/data-sheets provided within the submittal.

B. Submit to Engineer ten (10) days prior to bid date three (3) copies of any items and/or manufacturers which are proposed as substitutes for those specified.

C. Submit to Engineer promptly after award of Contract and prior to purchasing, the number of copies required by the contract. All drawings of a specific item or system shall be made in one submittal, and within thirty (30) days after award of Contract. Shop drawings of all power equipment shall contain exact details of device placement, phasing and numbering, in form of elevations, for each major piece of equipment. Shop drawings shall be submitted on the following:

1. SECTION 26 05 73: POWER DISTRIBUTION SYSTEM ELECTRICAL STUDIES
2. SECTION 26 28 16: SAFETY SWITCHES AND FUSES
3. SECTION 26 29 00: MANUFACTURED CONTROL PANELS
4. SECTION 26 29 16: REDUCED VOLTAGE SOFT STARTERS, 600VAC

5. SECTION 26 43 00: SURGE PROTECTIVE DEVICES
6. SECTION 26 50 00: LIGHTING MATERIALS AND METHODS
7. ALL POWER DISTRIBUTION EQUIPMENT (i.e. SWITCHBOARDS, PANELBOARDS, DRY TYPE TRANSFORMER, ETC.)
8. ALL ELECTRICAL AND TELECOMMUNICATION EQUIPMENT LAYOUTS - Submittals shall include ¼" = 1'-0" CAD drawings (hand drawn sketches will not be accepted) of each electrical room, IT room, electrical equipment stand, generator area, or any other similar area with electrical equipment. Drawings shall indicate all panelboards, transformers, switchboards, generators, equipment racks, control panels, HVAC equipment, etc. that are located in each electrical/IT area. Layouts shall show that each piece of electrical equipment has the clearances, working space and dedicated equipment space required by applicable codes. No conduits to equipment within these areas shall be installed until submittals have been provided and returned without exception by the design team.
9. ALL CONTROL ITEMS & SYSTEMS

D. The contractor shall fully review, comment upon and correct all shop drawings as required to assure compliance with contract documents prior to submittal to Engineer. The failure of the contractor to properly review and correct shop drawings prior to submittal will result in rejection of shop drawings by the engineer. Review by the Engineer will be for general conformance with contract documents. The contractor shall be fully responsible for correctness of all submitted dimensions, details, quantities and locations.

E. None of the above items shall be installed until shop drawings or catalog data have been reviewed by Engineer without rejection or required resubmittal. Any listed item not submitted, even if specified, shall be considered not acceptable and shall be removed if directed.

F. Any required resubmittal will be reviewed by the Engineer for conformance with previously issued comments only. The contractor shall be responsible for verifying that all items not specifically requiring resubmittal have not been altered from the previously reviewed submittal.

G. Material proposed for substitution shall be of the same quality, perform the same functions, conform to such physical dimensions and appearance as are required by the Engineer. All material proposed for substitution is subject to the approval of the Engineer and his authority for approval is final. No material proposed for substitution will be considered unless all submittal data complies with the drawings and specifications of Section 16 as to time of submission, number of copies of submittal, and detail requirements.

H. Samples of material shall be furnished where required by drawings or Division 26/27/28 Specification, or as requested by the Engineer on items proposed as substitutes.

I. Submit to Engineer a certificate of final inspection from local inspection department.

PART 3 - EXECUTION

3.01 SITE VISIT

A. The Contractor shall visit the site to determine existing dimensions and conditions affecting electrical work. Failure to do so in no way relieves Contractor of his responsibility under Contract.

3.02 CLEARANCE WITH UTILITIES

A. It shall be the responsibility of this Contractor, prior to bid, to reaffirm with the utility companies involved, that the locations, arrangement (and with power company voltage, phase, and metering required) and connections to utility service are in accordance with their regulations and requirements. If their requirements are at variance with these drawings and specifications, the Contract price shall include any additional cost necessary to meet those requirements without extra cost to Owner after a contract is entered into.

B. On many projects the utility company may levy charges due to locations, size or type service involved. The Contractor shall be responsible for these charges (including permanent meter deposit), unless such charges are not available prior to bid and Contractor so documents as described below. The meter deposit will be refunded to the contractor at time of Owner's acceptance.

C. Should above cost not be available, prior to bid, Contractor must submit a letter signed by a responsible utility company person so stating with his bid and in turn must be submitted by Prime Contractor with his bid to Owner. The cost will then be deleted from the Contract and become responsibility of the Owner.

D. The contractor shall be fully responsible for scheduling and coordinating all required utility company work with associated utility companies prior to start of work. Contractor shall be responsible for notifying the owner of any required utility company costs/fees, forms, contracts, etc. as required to keep the project on schedule as early as possible, and for providing necessary forms from utility company to owner for signing where necessary.

E. Arrange with utility companies for such services as shown or herein specified and installation of meter where shown. Furnish with shop drawings a signed document from utility companies describing the location and type of services to be furnished and any requirements they may have. This document shall be signed for each utility company by a person responsible for granting such service.

3.03 WORKMANSHIP

A. All work shall be in accordance with the latest editions of NFPA 70 (National Electrical Code), NFPA 101 (Life Safety Code), National Electric Safety Code, International Building Code, applicable NECA standards and the rules and regulations of State and Local Authorities Having Jurisdiction.

B. All work shall be executed in a workmanlike manner and shall present a neat and mechanical appearance upon completion.

C. All equipment, devices, etc. shall be installed in accordance with manufacturer's recommendations.

D. All items shall be installed straight and plumb in a workmanlike manner and care shall be exercised so that like items are mounted the same position, heights and general location.

E. Keep site clean of accumulation of cartons, trash and debris.

3.04 SAFETY

A. The contractor is solely responsible for all job safety. Engineer assumes no responsibility for job safety. Maximum consideration shall be given to job safety and only such methods as will reasonably ensure the safety of all persons shall be employed. The codes and regulations of OSHA shall be given strict compliance as well as such other codes, laws, and regulations as may be applicable.

3.05 CONTRACT DOCUMENTS

A. Contract documents indicate diagrammatically, extent, general character and approximate location of work. Where work is indicated but minor details omitted, furnish and install it complete so as to perform its intended functions. For details and mechanical equipment, follow drawings provided by other disciplines (Architectural, Mechanical, Structural, Civil, etc.) and fit electrical work thereto.

B. Contract documents consist only of the hardcopy documents issued by the Prime Engineer. Electronic documents issued directly by the electrical engineer to the contractor and/or its sub-contractors/vendors are issued for convenience only (electronic documents are not formal contract documents).

C. If the contractor and/or one of its suppliers require a one-time transfer of electronic files of the current electrical construction documents to prepare shop drawings (or for another similar purpose), it shall:

1. Sign a waiver prepared by the electrical engineer prior to the transmittal of these files.
2. Agree to pay the electrical engineer a fee of $50.00 per drawing, up to a maximum of $400 per transfer, payable upon receipt of the files.
3. To the fullest extent permitted by law, indemnify, hold harmless, and defend JRA from all claims, damages, losses and expenses, including attorneys' fees arising out of or resulting from the use of the CAD files.

D. Take finish dimensions at job in preference to scaled dimensions.

E. Except as above noted, make no changes in or deviations from work as shown or specified except on written order of Engineer.

3.06 UNDERGROUND UTILITY/EQUIPMENT COORDINATION

A. Prior to commencement of work, verify exact locations of all existing or proposed underground utilities and/or underground equipment and verify that proposed electrical installation does not conflict with these items. Notify Engineer immediately if any conflict is found.

3.07 EQUIPMENT STORAGE

A. Store all electrical equipment in dry, covered locations as directed by equipment manufacturers. Contractor shall be responsible for replacing or repairing improperly-stored equipment as directed by Engineer.

3.08 EXCAVATION, CUTTING AND PATCHING

A. Perform all cutting and excavating as necessary for installation of electrical systems, unless specifically covered under another section. After Engineer's observation, complete all excavation, filling and backfilling as directed under specifications for preparation of site and earthwork. Foundations for equipment shall be as specified under concrete section. Concrete pads shall be minimum of 6" thick; unless greater thickness required by equipment manufacturer. Obtain specific approval of Engineer before cutting into any structural members.

B. For all such work employ competent workmen, and finish up in neat and workmanlike manner, equal to quality and appearance to adjacent work.

3.09 PENETRATIONS

A. All penetrations in water tight barriers shall be made so that barrier rating is not compromised. Furnish roof flashing for all equipment installed under Division 26/27/28 that penetrates through the roof. Appropriate flashing is specified under roofing and sheet metal section. Supply these flashings for installation under roofing and sheet metal section.

B. All fire/smoke barrier penetrations shall be made in accordance with a U.L. listed assembly to maintain the fire/smoke rating of the associated membrane.

C. Where penetrations are required through structural elements, verify penetration locations and sizes with structural engineer. In no case shall the structural integrity be compromised without written approval from structural engineer.

3.10 INSTALLATION OF EQUIPMENT - GENERAL

A. Care shall be exercised in exact routing and location of all items so as not to obstruct access to equipment, personnel walkways, or expose it to potential mechanical damage.

B. Items shall be securely anchored and/or fastened. Provide proper support for all equipment, devices, conduits, boxes, panels, etc. as required by code and for a workmanlike installation. Provide guy wiring for wood poles where required to prevent leaning. All construction shall meet the seismic design requirements of the building code. Items (especially transformers, light fixtures, equipment racks, freestanding gear,

etc.) installed in seismic zones C, D, E or F shall be supported and braced per applicable codes and standards.

C. All wall, pole or frame-mounted electrical equipment shall be mounted to metal unistrut (or similar) frames of same material as electrical equipment. For example, pole-mounted stainless steel disconnect switches shall be mounted to stainless steel unistrut frames.

D. All electrical equipment, furnished by Contractor or by others shall be covered and protected during construction.

E. All control cabinets, panels, motor control centers and other electrical cabinets and enclosures shall have all trash removed and be vacuumed clean. All foreign paint, etc., shall be removed from exterior and all scratches in finish touched up with same color and material as original. Any rusted areas shall be sanded, primed and repainted.

F. All relays, starters, push-button and other control devices shall be cleaned and if necessary, lubricated with CRC 2-26 to assure free operation.

3.11 MOTORS, STARTERS AND CONTROLS

A. Unless otherwise specified or shown, all motors will be furnished and installed under other sections of this specification.

B. Electrical Contractor shall install all starters and all electrical power wiring and connections to motors and starters.

C. Unless otherwise specified or shown, all control items for motors shall be furnished, installed and wired in conduit by the electrician.

3.12 CIRCUITS AND BRANCH CIRCUITS

A. Outlets shall be connected to branch circuits as indicated on drawings by circuit numbers. No more outlets than are indicated shall be connected to a circuit.

B. Branch circuit homeruns shall be installed as shown on drawings. Multiple homerun conduits shall not be combined by contractor into larger, single homerun conduits unless specific permission is granted by the Engineer.

3.13 LUG/TERMINAL RATINGS

A. All lug/terminal ratings, sizes, locations, types, etc. shall be coordinated with the associated conductor sizes, types, routings, etc. by the contractor.

B. All lugs/terminals/etc. shall be rated for 75 degree C terminations (minimum, unless specified otherwise).

3.14 EQUIPMENT FAULT CURRENT RATINGS

A. All equipment and breakers shall meet the minimum RMS symmetrical interrupting capacity ratings shown on plans for the associated distribution equipment. All interrupting ratings shall be full ratings. Where new devices or breakers are added to existing distribution equipment, the new devices/breakers shall have interrupting ratings matching or exceeding that of the existing distribution equipment.

3.15 OUTLET LOCATION

A. Symbols shown on drawings and mounting heights indicated on drawings and in specifications are approximate only. The exact locations and mounting height must be determined on the job and it shall be the Contractor's responsibility to coordinate with other trades to ensure correct installation.

3.16 IDENTIFICATION

A. Each panel shall have each circuit identified. Panels without branch circuit nameplates shall have typewritten directories.

B. Each individually mounted switch, circuit breaker, starter and/or any other control or protective device shall identify equipment fed and fuse size, if any, by engraved plastic nameplate, white with black letters, screw attached.

C. See Specification Section 26 05 53 for additional requirements.

3.17 GROUNDING

A. All equipment shall be grounded and bonded in accordance with all state/local regulations, The National Electrical Code and as specified herein.

3.18 PAINTING

A. Refer to Painting/Finishing specifications for requirements regarding field painting of exposed conduit. Any scratches, dents or rust spots in conduit electrical enclosures, panels, motor control or any other electrical items shall have the dents removed, and they, along with any rust spots or scratches, sanded and touched up with the same exact color paint as original finish.

3.19 ACCEPTANCE TESTING

A. Upon completion of work, the entire electrical system installed within this project shall be tested and shall be shown to be in perfect working condition, in accordance with the intent of the specifications and drawings. It shall be the responsibility of the Electrical Contractor to have all systems ready for operation and to have an electrician available to operate same in accordance with and under the supervision of the observation representative(s) of the Engineer. The Electrician shall be available to assist in removal of panel fronts, etc., to permit inspection as required.

B. The electrical sub-contractor shall include in bid price start-up assistance and training from a certified representative of the manufacturer for the following systems:

1. SECTION 26 29 16: REDUCED VOLTAGE SOFT STARTERS, 600VAC

3.20 OPERATION AND MAINTENANCE DATA

A. One set of marked "AS BUILT" drawings, three (3) sets of all equipment catalog and maintenance data and three (3) sets of all final shop drawings, on all equipment requiring same shall be turned over to owner. These items shall be bound in hard back book. Contractor shall explain and demonstrate all systems to Owner's representative.

3.21 GUARANTY-WARRANTY

A. Furnish a written Guarantee-Warranty, countersigned and guaranteed by General Contractor, stating:

1. That all work executed under this section will be free from defects of workmanship and materials for a period of one (1) year from date of final acceptance of this work.
2. Above parties further agree that they will, at their own expense, repair and replace all such defective work, and all other work damaged thereby, which becomes defective during the term of the Guaranty-Warranty.

END OF SECTION 26 05 00

SECTION 26 05 19
Power Conductors And Cables 51v-600v

PART 1 - GENERAL

1.01 DESCRIPTION

A. Power Wires and Cables

B. Low Voltage Wires and Cables

PART 2 - PRODUCTS

2.01 POWER WIRES AND CABLES - 600 VOLT

A. General: Conductors shall have current carrying capacities as per N.E.C. and with 600 volt insulation, #12 minimum except for controls and fixture wire. Conductors shall be copper.

B. General Application (see below for exceptions):

1. At or Below Grade (including within slab-on-grade):

a. #8 or larger conductors:

1) XHHW or RHH/RHW/USE stranded (in conduit).

b. #10 or smaller conductors for circuits terminating at motors:

1) THHN/THWN or XHHW stranded (in conduit).

c. #10 or smaller conductors (excluding circuits terminating at motors):

1) THHN/THWN or XHHW solid (in conduit).

2. Above Grade:

a. #8 or larger conductors:

1) THHN/THWN, XHHW or RHH/RHW/USE stranded (in conduit).

b. #10 or smaller conductors for circuits terminating at motors:

1) THHN/THWN, XHHW or RHH/RHW/USE stranded (in conduit).

c. #10 or smaller conductors (excluding circuits terminating at motors):

1) THHN/THWN, XHHW or RHH/RHW/USE solid (in conduit).

3. Power Wire and cable shall be as manufactured by Southwire, Rome, Encore Wire, American Insulated Wire, Okonite, Phelps-Dodge, Amercable, Aetna or approved equal.

C. VFD Cabling

1. Wiring/Cabling installed between each VFD (Variable Frequency Drive) and the associated motor shall be multi-conductor shielded VFD power cable with the following characteristics:

    a. Multi-conductor cable with three (3) power conductors and three (3) ground conductors
    b. Soft annealed flexible stranded copper conductors.
    c. 1kV cross-linked polyolefin insulation (to resist the potential reflected voltages experienced in 600VAC VFD applications).
    d. Metallic shielded providing 100% shield coverage
    e. Oil, abrasion, chemical & sunlight resistant thermosetting compound outer jacket.
    f. Flexible TC-ER rated, UL listed for use in cable trays.
    g. Equal to AmerCable #37-108VFD cable.

D. Class 1 Control Cabling (120VAC Control Circuits, Etc.)

1. Unless specified otherwise, Class 1 control cabling shall:

    a. Be rated for exposed cable tray installation.
    b. Be plenum rated (Class 1 Control cabling and Instrumentation cabling installed in conduit or exposed in cable tray in non-plenum areas is not required to be plenum-rated).
    c. Be UL-rated for the proposed application.
    d. Be multi-conductor with overall outer sheath as required by the application. The insulation of each conductor within the overall multi-conductor cable shall be uniquely color-coded. Ground conductors (when provided) within the multi-conductor cable shall have green insulation. Conductors with green insulation shall not be used for conductors other than ground.
    e. Utilize copper conductors.
    f. Have wire gauge as required to limit voltage drop to acceptable limits determined by the system supplier and to meet all applicable code requirements.
    g. Where installed underground, within slab-on-grade or in exterior locations, be rated for wet locations.
    h. Where required for specific systems, meet the specific requirements (conductor quantity, wire gauge, insulation type, shielding, etc.) of the system supplier.
    i. Be rated for 600V.
    j. Be industrial grade.
    k. Have stranded conductors.
    l. Have sunlight/oil-resistant PVC/Nylon insulation and jacket with ripcord.

2. Control cabling shall be as manufactured by Belden, AlphaWire or General Cable.

E. Fixture Wiring

1. Conductor Types:

   a. Type TFFN or XFF.

2. Minimum Sizes:

   a. For fixtures up to 300 watts: #16.
   b. For fixtures over 300 watts up to 1500 watts: #14.
   c. For fixtures over 1500 watts: as required.
   d. Conductors to concrete pour fixtures: #12.

3. Fixture wire shall extend only from fixture to first junction, and not over 6 feet, except for concrete pour units.

2.02 WIRE CONNECTIONS:

A. All connector types:

1. Shall be properly rated for the proposed application by UL and per the manufacturer.

B. At Motor Connections (within motor terminal boxes):

1. On Unshielded Wire:

   a. Single conductor per phase: shall be made with insulated set screw connectors or 3M 5300 Series 1kV Motor Lead Connections kits with mechanical lugs as required.
   b. Multiple conductors per phase: shall be made with insulated mechanical lugs, rated for the associated motor cable types, by Polaris or Ilsco.

2. On Shielded Power Wire:

   a. The braided shields and internal grounding conductors of shielded power (not instrumentation) cables shall be grounded at BOTH ends (at VFD/starter and at motor) with a termination kit provided by the cable supplier. This termination kit shall include a connection ring that makes contact around the full circumference of the braided shield, and connects all internal grounds to a common external ground point.

3. Cabling within motor terminal boxes shall be trained such as to prevent any splice/termination/connection kits from contacting inside edge(s) of the motor terminal boxes (to prevent chaffing of the insulation/splice/wiring which could lead to faults). Contractor shall carefully coordinate all required motor terminal box sizes to ensure proper capacity for all required conductors/splices.

C. Other Dry locations:

1. On Wire larger than #10: shall be made with solderless, non-insulated compression-type connectors meeting requirements of Federal Specification WS-610e for Type II, Class 2 and shall be covered with Scotch #33 electrical tape so that insulation is equal to 150% of conductor insulation.
2. On Wire #10 and smaller: shall be made with one of the following:

    a. Ideal Wing Nuts or equal by 3M .
    b. Ideal Push-In Wire Connectors (for #12 and smaller only).

D. Other Wet/Damp locations:

1. On Wire larger than #10: shall be made with underground/direct-burial, waterproof rated EPDM or TPE-insulated connectors by Ilsco, Burndy or T&B.
2. On Wire #10 and smaller: shall be made with one of the following:

    a. Ideal Weatherproof or Underground Wire Connectors pre-filled with 100% silicone sealant as required by the application.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. All wires and cables shall be installed in conduit unless specifically noted otherwise.

B. All joints and splices on wire shall be made with solderless connectors, and covered so that insulation is equal to conductor insulation.

C. No splices shall be pulled into conduit.

D. No conductor shall be pulled until conduit is cleaned of all foreign matter.

E. Wire and cable shall be neatly formed, bundled and tied in all panelboards, wireways, disconnect switches, pullboxes, junction boxes, cabinets and other similar electrical enclosures.

F. All wires and cables installed in underground or other wet locations shall be rated by the manufacturer for wet locations.

G. Network cabling shall be continuous from endpoint to endpoint and shall not be spliced unless specifically noted otherwise.

H. All conductors/cabling (including spare conductors) shall be properly terminated unless specifically directed otherwise. See above for general termination hardware requirements.

3.02 POWER WIRE AND CABLE INSTALLATION:

A. No power conductor shall be smaller than #12 except where so designated on the drawings or hereinafter specified.

B. Multi-wire lighting branches shall be used as indicated.

C. Where more than three current-carrying conductors are installed in a single raceway or cable, conductors shall be derated as indicated in NEC Table 310.15(B)(3)(a).

D. Raceways/cables shall generally not be installed exposed to sunlight on roofs unless specifically required. Where raceways or cables are installed exposed to sunlight on roofs, conductors shall be derated with ampacities adjusted per NEC Table 310.15(B)(3)(c).

E. In installing parallel power conductors, it is mandatory that all conductors making up the feeder be exactly the same length, the same size, the same type of conductor with the same insulation. Each group of conductors making up a phase or neutral must be bonded at both ends in an approved manner.

F. In installing overhead main power services, a minimum of 5'-0" of cable per run shall be extended beyond the weatherhead(s) for connection to service drop. Confirm exact requirements with local utility company.

3.03 WIRE CONNECTIONS

A. See Part 2 above for material types.

B. Aluminum Wire Connections:

1. Where aluminum wiring is allowed, connections shall utilize compression fittings, no exceptions (Anderson Versa Crimp or equal).

C. Any stranded wire connection to wiring devices shall be made with crimp type terminals.

D. All electrical connections and terminals shall be tightened according to manufacturer's published torque-tightening values with calibrated torque wrenches as required to clearly indicate final torque value to the contractor. Where manufacturer's torque values are not provided, those specified in UL 486A & 486B shall be used.

E. All connections and connector types shall be installed in strict compliance with all requirements of the connector manufacturer.

F. Under no condition shall the specified conductors be connected to terminals rated less than 75°C. Where conductors sized #1 or smaller are shown to be terminated at equipment and the terminals of that equipment are rated for less than 75°C, contractor shall install junction box near equipment to capture the specified conductors, splice with compression connections (rated for a least 75°C) and extend conductors with ampacity rating as required by NEC (based on terminal temperature rating) to equipment terminals. The length of the conductors to be terminated shall be as directed by the AHJ but not less than 48 inches.

3.04 SHIELDED CABLE INSTALLATION

A. Shielded VFD (power) cables:

1. The braided shields and internal grounding conductors of shielded VFD (power) cables shall be grounded at BOTH ends (at VFD and at motor) with a termination kit provided by the cable supplier. This termination kit shall include a connection ring that makes contact around the full circumference of the braided shield, and connects all internal grounds to a common external ground point.
2. Contractor shall coordinate the necessary size of conduit with the outer diameter of the proposed cable type to verify that the raceway loading does not exceed NEC requirements prior to rough-in of the conduit system.

B. Shielded instrumentation (low voltage) cables:

1. The outer foil of shielded instrumentation cables shall be grounded at the PLC/control panel end only (not at the field device end) with a termination kit as directed by the PLC/control panel supplier.

3.05 LOW VOLTAGE (LESS THAN 50V) CONTROL AND NETWORK CABLE INSTALLATION:

A. All wires and cables shall be installed in conduit unless specifically noted otherwise. Low voltage control and/or network cabling located within concealed, accessible ceiling spaces (such as above lay-in ceilings) may be run without conduit if the following requirements are met:

1. Cabling shall be plenum-rated, multi-conductor.
2. Cabling shall be supported by cable tray or with J-hook supports on intervals not to exceed 5'-0" on center. Cabling shall be supported solely from the cable tray or j-hooks supported from the building structure, without using piping, ductwork, conduit or other items as supports.
3. Cabling shall be properly bundled with plenum-rated Velcro straps on intervals not to exceed 30" on center.
4. Properly-sized conduit(s) shall be provided wherever cabling enters an inaccessible or exposed area (such as above gyp board ceilings or through walls). End bushings shall be provided on both ends of all raceway terminations. All fire/smoke barrier penetrations shall be made in accordance with a U.L. listed assembly.

3.06 CIRCUITS AND BRANCH CIRCUITS

A. Outlets shall be connected to branch circuits as indicated on drawings by circuit number adjacent to outlet symbols, and no more outlets than are indicated shall be connected to a circuit.

3.07 LABELING AND COLOR CODING OF WIRE AND CABLE

A. Refer to Specification Section 26 05 53 for all labeling requirements.

B. A color coding system as listed below shall be followed throughout the network of branch power circuits as follows:

PHASE	120/208/240/ COLOR	120/240 HIGH LEG DELTA COLOR	277/480 VOLT COLOR
A	BLACK	BLACK	BROWN
B	RED	ORANGE (FOR HI-LEG)	ORANGE
C	BLUE	BLUE	YELLOW
NEUTRAL	WHITE	WHITE	GRAY
GROUND	GREEN	GREEN	GREEN

C. Where dedicated neutrals are installed for multi-wire branch circuits, the neutral conductors shall be color coded as follows:

PHASE	120/208/240/ COLOR	120/240 HIGH LEG DELTA COLOR	277/480 VOLT COLOR
NEUTRAL A	WHITE W/ BLACK TRACER	WHITE W/ BLACK TRACER	GRAY W/ BROWN TRACER
NEUTRAL B	WHITE W/ RED TRACER	WHITE W/ ORANGE TRACER (FOR HI-LEG NEUTRAL)	GRAY W/ ORANGE TRACER
NEUTRAL C	WHITE W/ BLUE TRACER	WHITE W/ BLUE TRACER	GRAY W/ YELLOW TRACER

D. Control Conductors: Shall be color coded by use of colored "tracers". No control circuit shall contain two identical conductors. For example, a set of five (5) control conductors for a pushbutton station represents one (1) control circuit which would require five (5) uniquely-colored control conductors.

3.08 TESTING

A. The insulation resistance of all feeder conductors (feeding electrical distribution equipment such as switchboards, panelboards, transfer switches, transformers, etc.) shall be tested at the load side of the feeder breaker with a 1000-volt DC Megger Tester prior to energization or final termination. Any feeder conductor with an insulation resistance less than the recommended minimums in the latest version of NETA Acceptance Testing Specification ("ATS") standard shall be replaced by the contractor at the contractor's expense. All final test results shall be clearly documented (with date, time, feeder, results, test equipment, etc.), and the final test results shall be submitted to the design team for review.

END OF SECTION 26 05 19

SECTION 26 05 26
Grounding

PART 1 - GENERAL

1.01 GENERAL

A. THE WORK UNDER THIS SECTION INCLUDES BUT IS NOT LIMITED TO GROUNDING OF THE FOLLOWING:

1. Service Equipment.
2. Transformers.
3. Non-current carrying conductive surfaces of equipment.
4. Metal Buildings.
5. Structures.
6. Other Equipment.

1.02 GENERAL REQUIREMENTS

A. All equipment, building steel, and main service shall be effectively and permanently grounded with a conductor cross section as required by the National Electrical Code and of capacity sufficient to ensure continued effectiveness of the ground connections for fault current. Ground conductors shall be as short and straight as possible, protected from mechanical injury and, if practicable, without splice or joint.

B. All grounding connections shall be installed in accordance with the National Electrical Code and all local codes and requirements. Such codes shall be considered minimum requirements and the installation of the grounding system shall ensure freedom from dangerous shock voltage exposure and provide a low impedance ground fault path to permit proper operation of overcurrent and ground fault protective devices.

PART 2 - PRODUCTS

2.01 CONDUCTORS

A. All grounding conductors shall be insulated with green colored, 600 volt insulation unless noted otherwise.

B. Motors having power supplied by single conductor wire in conduit shall be grounded through the conduit system. Flexible conduit shall be "jumpered" by an appropriate bonding conductor.

C. Supplemental grounding system conductors shall be bare, softdrawn, stranded, single conductor copper wire, and generally sized as follows (unless shown otherwise on plans):

1. Switchgear, motor control centers, and power transformer #4/0 minimum or as shown on plans.
2. Power panels, #2/0.

3. Control panels and consoles, #4.
4. Process Motors, #1/0.
5. Building Columns, #4/0.
6. Light Poles, #2.
7. Telephone Backboard & Cabinet ground busses, #2.

2.02 GROUNDING ELECTRODES

A. Grounding electrodes shall be copper-clad steel rods 3/4 inch in diameter and ten feet long. Where longer electrodes are necessary to reduce the ground resistance, Contractor shall provide sectional rods, connectors, drive heads, etc.

2.03 CONNECTIONS

A. All conductor-to-conductor, conductor-to-ground rod, conductor-to-structure, conductor-to-fence connections of #6 and larger sized conductors and underground ground connections shall be permanent exothermic welded connections (Cadweld or equal) unless otherwise noted on applicable drawings.

B. Connections to equipment shall be by bolted compression type lugs (except for motors). When the conductor is #6 and larger, the lug shall be joined to the conductor by an exothermic weld (Cadweld or equal).

C. Motors to be grounded by the grounding conductors run with the power conductors shall have a split-post grounding stud installed in the connection box.

D. Each cast pull box or junction box shall have a ground lug, connected to largest ground conductor to enter box.

E. Ground connections at conduit terminations shall be made by approved grounding bushings (see Raceways Specification Section for additional requirements).

2.04 MANUFACTURERS

A. Conduit clamps and connectors shall be manufactured by Raco, OZ., or Ercon.

B. Lugs shall be as manufactured by Square "D", Burndy, or T and B.

C. Exothermic weld connections shall be as manufactured by Cadweld, or approved equal.

D. Ground rods shall be as manufactured by Joslyn or McGraw Edison.

E. Split post grounding shall be as manufactured by Burndy or T and B.

PART 3 - EXECUTION

3.01 MAIN SERVICE GROUND

A. The main service grounding electrode system shall consist of the following items bonded

together by the grounding electrode conductor:

1. The main underground cold water pipe (metal).
2. The metal frame of the building.
3. Driven ground rods. Ground rods shall be embedded at the lowest point in the building and below the permanent moisture level. Ground rods shall be spaced a minimum of ten (10) feet apart and connected in parallel until resistance to ground does not exceed five (5) ohms.

B. The grounding electrode system shall be connected to the grounded conductor (neutral) on the supply side of the service disconnecting means by a grounding electrode conductor not smaller than that shown in Table 250.66 of the N.E.C. The main service equipment grounding conductor shall be connected to the grounding conductor on the supply side of the service disconnecting means in accordance with Table 250.122 of the N.E.C. for the ampere rating of the service entrance equipment. Where in a service entrance switchboard, the equipment grounding conductor shall not be less than 25% of the main bus rating. These connections shall be made inside the service entrance equipment enclosure.

3.02 TRANSFORMER GROUNDS

A. Dry type insulation transformers with a grounded conductor in the secondary shall be grounded in accordance with N.E.C. Section 250-30.

3.03 EXPOSED NON-CURRENT-CARRYING METAL PARTS

A. General: Ground connections to equipment or devices shall be made as close to the current carrying parts as possible, that is, to the main frame rather than supporting structures, bases or shields. Grounding connections shall be made only to dry surfaces that are clean and dry. Steel surfaces shall be ground or filed to remove all scales, rust, grease, and dirt. Copper and galvanized steel shall be cleaned to remove oxide before making welds or connections. Code size ground conductors shall be run in all power conduits and properly terminated at each end.

B. Ground conductors shall be routed as straight as possible. Where possible, ground conductors shall be routed such as to avoid bends exceeding 90 degrees or with a radius of less than 8".

C. Motors: Exposed non-current-carrying metal parts, shall be grounded by a grounding conductor either run with power conductors, and/or separate grounding conductors. Drawings will show method(s) to be used. The ground conductors with all motor conductors shall be connected to the ground buss in the motor connection box. Jumper connections shall be installed between frames and rigid conduit for equipment having flexible conduit connections (sealtight). All AC motor grounds shall provide a low impedance path to ground. Connections from the supplemental grounding system (when specified) shall be made directly to the motor frame. Additionally, utilization equipment connected to the motor (pump, fan, mixer, etc.) shall be bonded to the motor with flexible braid-type bonding strap to ensure equalization of ground

potentials.

D. Raceways & boxes: All raceways, conduits, armored or shielded cable and all exposed non-current carrying metal parts shall be grounded. Such items shall be bonded together and permanently grounded to the equipment ground buss. Metallic conduits shall be connected by grounding or clamps to ground buss. Flexible "jumpers" shall be provided around all raceway expansion joints. Bonding straps for steel conduit shall be copper. Jumper connections shall be provided to effectively ground all sections or rigid conduit connected into plastic pipe. No metallic conduit shall be left ungrounded. In conduit systems interrupted by junction or switch boxes where locknuts and bushings are used to secure the conduit in the box, the sections of conduit and box must be bonded together. If conduit, couplings or fittings have a protective coating or non-conductive material, such as enamel, such coating must be thoroughly removed from threads of both couplings and conduit and the surface of conduit or fitting where the ground clamp is secured.

E. Enclosures: Metal conduits entering free standing motor control centers, switchboards or other free standing equipment shall be grounded by bare conductors and approved clamp. Any conduits entering low voltage (480 volts or below) equipment through sheet metal enclosure and effectively grounded to enclosure by double locknut or hub need not be otherwise bonded.

F. Equipment: In addition to equipment grounding provisions mandated by code requirements, additional equipment grounding provisions (including local ground rods, connections, etc.) shall be provided by the contractor as directed by equipment suppliers.

G. Both ends of ground busses in motor control centers, switchboards, etc., shall be separately connected to the main ground buss to form two separate paths to ground.

H. Fences and Grills: Fences and metal grills around equipment carrying voltage above 500 volts between phases shall be bonded together and to ground. Fences and grill work shall be grounded at every post, column, or support, and on each side of every gate.

3.04 ACCEPTANCE DOCUMENTATION AND TESTING

A. Contractor shall take and store photographs of all underground grounding system connections prior to burial of connections, for review by Engineer.

B. Upon completion of work, the entire ground system shall be shown to be in perfect working condition, in accordance with the intent of the Specifications.

C. Contractor shall measure the resistance between the main ground bonding jumper to true earth ground using the Fall of Potential method as described by ANSI/IEEE Standard 81 ("Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of an Earth System"). If the measured value is greater than five ohms, additional grounding electrodes shall be installed as described in Part 3.1 above. The final ground resistance value shall be submitted in writing, and documented via picture of the meter reading from the Fall of Potential test, to the Engineer prior to the final

observation, and shall be included in final O&M documentation.

END OF SECTION 26 05 26

SECTION 26 05 33
Raceways

PART 1 - GENERAL

1.01 DESCRIPTION

A. THE WORK UNDER THIS SECTION INCLUDES BUT IS NOT LIMITED TO THE FOLLOWING:

1. Conduits
2. Conduit Fittings
3. Couplings & Connectors
4. Bushings
5. Raceway Hardware, Conduit Clamps & Supports
6. Watertight Entrance Seal Devices

PART 2 - PRODUCTS

2.01 CONDUITS

A. PVC-Coated Rigid Aluminum:

1. The PVC coated rigid aluminum conduit must be UL Listed. Hazardous location fittings, prior to plastic coating must be UL listed. All conduit and fittings must be new, unused material. Applicable UL standards may include: UL 6A Standard for Safety, Rigid Aluminum Conduit, UL514B Standard for Safety, Fittings for Conduit and Outlet Boxes.
2. The PVC-coated rigid aluminum conduit system shall conform to CSA C22.2 No. 45.2, ANSI C80.5, and NEMA RN-1.
3. Form 8 Condulets®, 3/4" through 2" diameters, shall have a tongue-in-groove "V-Seal" gasket to effectively seal against the elements. The design shall be equipped with a positive placement feature to ease and assure proper installation. Certified results confirming seal performance at 15 psig (positive) and 25 in. of mercury (vacuum) for 72 hours shall be available.
4. A PVC sleeve extending one pipe diameter or two inches, whichever is less, shall be formed at every female fitting opening except unions. The inside sleeve diameter shall be matched to the outside diameter of the conduit.
5. The PVC coating on the outside of conduit couplings shall have a series of longitudinal ribs 40 mils in thickness to protect the coating from tool damage during installation.
6. Form 8 Condulets® shall be supplied with plastic encapsulated stainless steel cover screws.
7. A urethane coating shall be uniformly and consistently applied to the interior of all conduit and fittings. This internal coating shall be a nominal 2 mil thickness. Conduit or fittings having areas with thin or no coating shall be unacceptable.

8. The PVC exterior and urethane interior coatings applied to the conduit shall afford sufficient flexibility to permit field bending without cracking or flaking at temperatures above 30deg.F (-1deg.C).
9. All male threads on conduit, elbows and nipples shall be protected by application of a urethane coating.
10. All female threads on fittings or conduit couplings shall be protected by application of a urethane coating.
11. Independent certified test results shall be available to confirm coating adhesion per UL to the UL DYJC Performance Verification standard AND UL6 under the following conditions:

    a. 240 hours oven conditioning at 212 degrees F, and 600 hours in a salt fog chamber.
    b. Subjection of PVC coated conduit/condulette systems to UV light, salt spary, most CO2, SO2, and air per UL6 standard requirements.
    c. After exposure, the coatings shall conform to the following:

        1) interior coating bond shall be confirmed using the Standard Method of Adhesion by Tape Test (ASTM D3359).
        2) No trace of the internal coating shall be visible on a white cloth following six wipes over the coating which has been wetted with acetone (ASTM D1308).
        3) The exterior coating bond shall be confirmed using the methods described in Section 3.8, NEMA RN1.
        4) After these tests the physical properties of the exterior coating shall exceed the minimum requirements specified in Table 3.1, NEMA RN1.

12. Water tight flex connectors used in areas where PVC coated metal conduit is utilized shall be PVC coated also.
13. Shall be as manufactured by Cal Bond, Perma-Coate, Plastibond, or Ocal.

B. Rigid Galvanized Steel and I.M.C.:

1. Shall be galvanized outside and inside by hot dipping.
2. Shall be as manufactured by Republic, Wheatland, Pittsburg Standard, Youngstown, Allied or equal.

C. Rigid Aluminum:

1. Shall be manufactured of 6063 Alloy, T-1 temper.
2. Shall be manufactured by Republic (Nucor), Wheatland, Allied (Atkore), Penn or equal.

D. Schedule 40 and 80 PVC:

1. Shall be composed of polyvinyl chloride and shall be U.L. rated type 40 or 80 for use with 90 degree rated conductors. Conduit shall conform to NEMA Standards and applicable sections of N.E.C.

2. The conduit manufacturer shall have had a minimum of 5 years experience in the manufacture of the products. Non-metallic raceways shall be as manufactured by Carlon, Triangle, Can-Tex, Allied or equal.

E. HDPE Innerduct

1. Shall be composed high density polyethylene and shall be orange in color, unless noted otherwise.
2. Shall be corrugated unless noted otherwise.
3. Shall be manufactured by Carlon, Ipex or equal.

F. Liquidtight Flexible Metallic Conduit:

1. Shall be galvanized steel-core sealtite, code approved for grounding.
2. Shall have an outer liquidtight, nonmetallic, sunlight-resistant jacket over an inner flexible metal core.
3. Shall be as manufactured by Electric-Flex, Anaconda or equal.

2.02 FITTINGS, COUPLINGS & CONNECTORS

A. Rigid Galvanized Steel and I.M.C. couplings and connectors shall be standard threaded type, galvanized outside and inside by hot dipping. Threadless and clamp type are not acceptable. Couplings/connectors shall be as manufactured by Raco, Efcor, or Appleton or equal.

B. All fittings, conduit bodies, couplings and connectors (**including, but not limited to, condulettes, conduit couplings, connectors, hubs, nipples, unions, expansion fittings, explosion proof seal-offs, threaded hole closures, and seal-tight connectors, etc.**) used in areas where PVC-Coated Rigid Aluminum conduit is used shall also be PVC-coated rigid aluminum.

C. All fittings, conduit bodies, couplings and connectors (**including, but not limited to, condulettes, conduit couplings, connectors, hubs, nipples, unions, expansion fittings, explosion proof seal-offs, threaded hole closures, and seal-tight connectors, etc.**) installed in other wet, exterior or process areas where PVC-coated conduit systems are not required, shall be aluminum or stainless steel type. Standard steel fittings will not be acceptable.

D. All rain tight connectors shall be threaded Myers or approved equal, rated for outdoor application.

E. Rigid Aluminum couplings and connectors shall be standard threaded type, of the same alloy as the associated conduit. Threadless and clamp type are not acceptable. Fittings shall be as manufactured by Thomas & Betts, Crouse-Hinds, Appleton, Pyle-National or equal.

F. All PVC couplings, adapters, end bells, reducers, etc., shall be of same material as conduit.

G. Liquidtight Flexible Metallic Conduit connectors shall be liquidtight with insulating throat or end bushing, designed for application with Liquidtight Flexible Metallic Conduit. Fittings shall be as manufactured by Efcor, Raco, Midwest or equal.

H. All LB unilets sizes 1 ¼" or larger shall have rollers.

I. Miscellaneous conduit fittings shall be as manufactured by Appleton, Crouse-Hinds, Pyle-National, Russell & Stoll or equal.

2.03 BUSHINGS

A. All non-grounding rigid bushings 1-1/4" and larger shall be the insulating type (O-Z/Gedney type "BB" or equal by T&B, Midwest Electric or Penn Union).

B. All non-grounding rigid bushings 1" and smaller shall be threaded malleable iron with integral noncombustible insulator rated for 150°C. Non-grounding rigid conduit bushings shall be O-Z/Gedney type "B" or equal by T&B, Midwest Electric or Penn Union.

C. All grounding rigid bushings shall be threaded malleable iron with integral noncombustible insulator rated for 150°C. All grounding rigid conduit bushings shall be O-Z/Gedney type "BLG" or equal by T&B, Midwest Electric or Penn Union.

2.04 HARDWARE, CONDUIT CLAMPS AND SUPPORTS

A. All hardware such as expansion shields, machine screws, toggle bolts, "U" or "J" bolts, machine bolts, conduit clamps and supports shall be of corrosion resistant materials (stainless steel, aluminum, galvanized or plated steel, or other approved materials).

B. Hardware in contact with aluminum handrails, plates or structural members and all hardware in exterior, wet or corrosive areas shall be type 316 stainless steel or aluminum (with bitumastic paint coating to isolate aluminum from contact with concrete where necessary) unless specifically noted otherwise.

C. Supports in exterior, process, wet or corrosive locations shall be type 316 stainless steel or aluminum (with bitumastic paint coating to isolate aluminum from contact with concrete where necessary) unless specifically noted otherwise.

D. Supports in extremely corrosive environments (such as chlorine or fluoride storage rooms) shall be PVC-Coated aluminum unless specifically noted otherwise.

E. Hardware and conduit clamps shall be as manufactured by Efcor, Steel City, G.A., Tinnerman or equal.

2.05 WATERTIGHT ENTRANCE SEAL DEVICES

A. For new construction, seal devices shall consist of oversized sleeve and malleable iron body with sealing rings, pressure rings, sealing grommets and pressure clamps as required (O-Z/Gedney type FSK/WSK or equal).

B. For cored-hole applications, seal devices shall consist of assembled dual pressure disks with neoprene sealing rings and membrane clamps as required (O-Z/Gedney type CSM or equal).

PART 3 - EXECUTION

3.01 RACEWAY APPLICATION

A. Minimum Diameter: 3/4-inch.

B. Raceway Type: Raceway types shall be as specified below, unless indicated otherwise on drawings:

1. Exposed: Rigid Aluminum unless otherwise noted.
2. Used for Instrumentation Circuits: See Below.
3. Other Exterior (Concrete-Encased or Direct Earth Buried): Schedule 40 PVC. PVC conduit shall convert to metallic conduit prior to exiting concrete-encasement or direct earth burial. See "transition" items below for additional requirements. Conduits shall be left exposed until after Engineer's observation.
4. Raceways used for Instrumentation Circuits:

    a. Typical Dry or Wet Locations: Rigid Aluminum .
    b. Underground or Locations Embedded inside Poured Concrete: PVC-Coated Rigid Aluminum.
    c. Extremely Corrosive Locations (Chlorine Storage Rooms, Fluoride Storage Rooms and other similar areas): PVC-Coated Rigid Aluminum.

5. Terminations at motors, transformers and other equipment which has moving or vibrating parts:

    a. Exterior or Wet Locations (including, but not limited to, Pump Rooms, Wet Wells, Underground Vaults, and other similar locations): Liquidtight Flexible Metallic Conduit (shall generally not exceed 24 inches in length) with watertight fittings.
    b. Dry, Interior Locations: Flexible Metallic Conduit (shall generally not exceed 24 inches in length).

6. Terminations at instruments:

    a. Liquidtight Flexible Metallic Conduit (shall generally not exceed 12 inches in length) with watertight fittings.

7. Transition from underground or concrete-encased to exposed:

    a. Convert PVC to PVC-Coated Rigid Aluminum utilizing PVC-Coated Rigid Aluminum 90 degree bends (and vertical conduits as required by application) prior to exiting concrete/grade (except at outdoor pull boxes and under freestanding electrical equipment, where terminations shall be by PVC end bells installed flush with top of slab). Exposed portions of these coated conduits

shall extend a minimum of 6" above floor level, and shall be installed at uniform heights.

3.02 RACEWAY INSTALLATION

A. General:

1. Follow methods which are appropriate and approved for the location and conditions involved. Where not otherwise shown, specified, or approved in a particular case, run all wiring concealed.
2. Where conduit crosses a structural expansion joint an approved conduit expansion fitting shall be installed.
3. Where any run of rigid aluminum conduit (including bends) exceeds 50' in length, an approved conduit expansion fitting shall be installed (beginning at center of run) at intervals not to exceed 50' on center.
4. A non-conductive polypropylene pull string, properly tied/secured at either end, shall be installed in all empty conduits.
5. Metal conduit field-cuts shall be cut square with a hacksaw and the ends reamed after threading.
6. PVC conduit field-cuts shall be made with hacksaw, and ends shall be deburred.
7. All PVC joints shall be made as follows:

    a. Clean the outside of the conduit to depth of the socket, and the inside of socket with an approved cleaner.
    b. Apply solvent cement as recommended by the conduit manufacturer to the interior of the socket and exterior of conduit, making sure to coat all surfaces to be joined.
    c. Insert conduit into the socket and rotate 1/4 to 1/2 turn and allow to dry.

8. All metallic conduit installed below grade or within concrete shall be coated with two (2) spiral-wrapped layers of 3M Scotchrap 50 PVC tape or two coats of asphaltum paint prior to installation.
9. Install ground wire sized per N.E.C. Table 250.122 in all conduits.
10. Use of running threads is absolutely prohibited. Conduit shall be jointed with approved threaded conduit couplings. Threadless and clamp type not acceptable.
11. Conduits shall be sized in accordance with latest National Electrical Code except when size shown on drawings.
12. Exposed, field-cut threads on all metal conduits shall be painted with zinc primer (for Galvanized Rigid or I.M.C.) or urethane paint (for PVC-Coated Rigid Aluminum) as recommended by conduit manufacturer .
13. Installation of PVC coated conduit systems shall be performed in strict accordance with the manufacturer's installation instructions. Damage to PVC coated conduit coating shall be touched up with patching compound as directed by manufacturer. To assure correct installation, the installer shall be certified by the manufacturer to install coated conduit.

B. Routing/Locating:

1. Exposed conduit runs shall be run level and plumb and shall, on interior of buildings, be run parallel and/or at right angles to building walls and/or partitions.
2. Conduit with an external diameter larger than 1/3 the thickness of a concrete slab shall not be placed in the slab. Conduits in slab shall not be spaced closer than 3 diameters on center.
3. Conduit run in ceiling spaces shall be run as high as possible, all at same level, and shall be supported from building structure. Do not support conduit from any other installation.
4. Conduit run within exterior CMU, concrete or other similar walls shall be run within the CMU cells / concrete structure / etc. Conduits shall not be run on the outside surface of CMU cells / concrete structure / etc. underneath exterior veneers / etc., which could cause a thermal break in the wall insulation or a future water intrusion problem.
5. Install conduit runs to avoid proximity to steam or hot water pipes. In no place shall a conduit be run within 6" of such pipes except where crossing is unavoidable, then conduit shall be kept at least 3" from the covering of the pipe crossed.
6. Before installing raceways for motors, HVAC equipment and other fixed equipment, check location of all equipment connections/terminal boxes with equipment supplier and locate and arrange raceways appropriately.
7. No conduit for instrumentation shall be run closer than 12 inches to parallel power conduits.
8. A minimum of 12" of clearance (or more as required by associated utility companies) shall be provided between the finished lines of exterior, underground conduit runs and exterior, underground utilities (gas, water, sewer, etc.).
9. Where any portion of raceway is installed in a wet environment (such as below grade) and located at a higher elevation than the raceway termination point in a dry environment, install watertight compound inside raceway at termination around cabling to prevent transfer of water through conduit system. Watertight compound shall be rated for the potential water head pressure, based on the assumption that ground water level would be at grade level.

C. Bends:

1. Do not make bends (in any raceway, including flexible conduits) that exceed allowable conductor bending radius of cable to be installed or that significantly restrict conductor flexibility.
2. All bends within concrete-encased ductbanks installed in exterior locations shall be long radius bends (24" minimum bending radius – varies with conduit diameter).
3. All bends in raceways containing multi-conductor power cables (such as shielded VFD cables) shall be long radius bends (24" minimum bending radius – varies with conduit diameter).
4. Where numerous exposed bends or grouped together, all bends shall be parallel, with same center and shall be similar in appearance
5. All PVC elbows, bends, etc., shall be either factory bends or made with an approved heat bender.

D. Support:

1. Anchor conduit securely in place by means of approved conduit clamps, hangers, supports and fastenings. Arrangement and methods of fastening all conduits shall be subject to Engineer's direction and approval. All conduits shall be rigidly supported (wire supports may not be used in any location). Use only approved clamps on exposed conduit.
2. Rigid Aluminum Conduits and PVC-Coated Rigid Aluminum Conduits shall be supported at intervals not to exceed 5' on center.
3. Conduit in riser shafts shall be supported at each floor level by approved clamp hangers.
4. Right angle beam clamps and U bolts shall be specially formed and sized to snugly fit the outside diameters of conduits.
5. Where installed in seismic zones, suspended raceways shall be braced in two (2) directions as required to prevent swaying and excessive movement.
6. Raceways installed on top of flat roofing shall be supported a minimum of 3 ½" above roof with rubber block supports (Cooper B-Line Dura-Blok or equal). Installation shall be in strict accordance with support manufacturer's instructions and recommendations.

E. Terminations:

1. All conduit connections to sheet metal cabinets or enclosures located in exterior or wet locations shall terminate by use of rain tight (Meyers) hubs.
2. In wet, exterior or process areas, conduits shall NOT enter tops of enclosures. All conduits shall enter enclosures from bottom, left or right sides of the enclosure (utilizing rain-tight Meyers hubs as indicated above).
3. Where rigid or I.M.C. conduits enter sheet metal boxes, they shall be secured by approved lock nuts and bushings.
4. Where metal conduits enter outdoor pull boxes, manholes, under freestanding electrical equipment or other locations where direct metal-to-metal contact does not exist between enclosure and conduit, grounding bushings shall be installed. Each grounding bushing shall be connected to the enclosure ground and all other grounding bushings with properly sized grounding conductors.
5. Where PVC enters outdoor pull boxes, manholes or under freestanding electrical equipment, PVC end bells shall be installed.
6. Contractor shall be responsible for coordinating required conduit sizes with equipment hubs/conduit entry provisions (such as at motor tap boxes) prior to installation of conduit systems. Contractor shall field adjust final conduit sizes at terminations where so required (only as allowed by code) from those indicated on plans to coordinate with equipment hubs/conduit entry provisions.
7. Where conduit terminates in free air such that associated cabling/circuitry becomes exposed (such as at cable trays, etc.), conduit shall generally terminate in a horizontal orientation (to prevent dust/debris/etc. from entering conduit system). Where vertical conduit termination is necessary, the termination shall be provided with cord-grip conduit terminations to seal the conduit system.
8. Conduit ends shall be carefully plugged during construction.
9. Permanent, removable caps or plugs shall be installed on each end of all empty raceways with fittings listed to prevent water and other foreign matter from entering the conduit system.

F. Penetrations:

1. All fire/smoke barrier penetrations shall be made in accordance with a U.L. listed assembly. Refer to drawings and other specifications for additional requirements.
2. All penetrations shall be at right angles unless shown otherwise.
3. Structural members (including footings and beams) shall not be notched or penetrated for the installation of electrical raceways unless noted otherwise without specific approval of the structural engineer.
4. Dry-packed non-shrink grout or watertight seal devices shall be used to seal openings around conduits at all penetrations through concrete walls, ceilings or aboveground floors.
5. All raceways entering structures, or where water is otherwise capable of entering equipment/devices through the raceway system, shall be sealed (at the first box or outlet) with foam duct sealant to prevent the entrance of gases or liquids from one area to another or into equipment/devices.

    a. Where the elevation of the raceway penetration (into the structure) is no more than 15' below the other (higher) end of the same raceway, Polywater FST sealant (rated to hold back up to 22' of continuous water head pressure), or pre-approved equal, shall be used.
    b. Where the elevation of the raceway penetration (into the structure) is between 15' and 75' below the other (higher) end of the same raceway, Polywater PHRD Custom Mechanical Seals (rated to hold back up to 36psi or 83' of continuous water head pressure), or pre-approved equal, shall be used.
    c. Where the elevation of the raceway penetration (into the structure) is more than 75' below the other (higher) end of the same raceway, the contractor shall propose a custom solution designed to hold back or to drain the possible water within the associated raceway. Submittals shall be provided to the engineer for review/approval, including a summary of the anticipated elevations/PSIs, details of the proposed installation, cut-sheets of devices/materials, etc.

6. Additionally, where necessary to ensure that water does not enter equipment/devices through the raceway system (where raceways extend to equipment/devices from wet areas), junction boxes with drain assemblies in bottom shall be located at low point of raceway system near equipment/devices (to drain water out of raceway system before it enters equipment/devices). Contractors shall provide drains in raceway systems where so necessary to prevent water entry into equipment/devices. In special applications (such as to instruments, etc.,), where cabling rated for exposed application is provided, contractor may propose short air gaps (approximately 6" or less) between the end of the conduit system and the equipment/device cable entry (to be made with cable gland connectors) to prevent water in conduit system from entering equipment/devices in lieu of drained junction boxes.
7. All raceways passing through concrete roofs or membrane-waterproofed walls or floors shall be provided with watertight seals as follows:

    a. Where ducts are concrete encased on one side: Install watertight entrance seal device on the accessible side of roof/wall/floor as directed by equipment manufacturer.

b. Where ducts are accessible on both sides: Install watertight entrance seal device on each side of roof/wall/floor as directed by equipment manufacturer.

8. All raceways passing through walls of rooms containing/storing noxious chemicals (chlorine, ammonia, etc.) or through hazardous locations shall be sealed with conduit seals (Crouse-Hinds type EYS or equal).
9. All raceways terminating into electrical enclosures/devices/panels/etc. located in hazardous locations shall be sealed with conduit seals (Crouse-Hinds type EYS, EZS or equal) within 18" of the termination.

G. Exterior Electrical Ductbanks:

1. Where exterior electrical concrete-encased ductbanks are indicated on drawings, conduit runs between buildings or structures shall be grouped in concrete-encased ductbanks as follows:

   a. A minimum of 3" of concrete shall encase each side of all ductbanks.
   b. A minimum of 1 ½" of separation shall be provided between each conduit within ductbanks. PVC spacers shall be installed at the necessary intervals prior to placement of concrete to maintain the required spacing and to prevent bending or displacement of the conduits.
   c. Top of concrete shall be a minimum of 30" below grade. A continuous magnetic marking tape shall be buried directly above each ductbank, 12" below grade.
   d. Exact routing of ductbanks shall be field verified and shall be modified as necessary to avoid obstruction or conflicts.
   e. Underground electrical raceways shall be installed to meet the minimum cover requirements listed in NEC Table 300.5. Refer to drawings for more stringent requirements.

END OF SECTION 26 05 33

SECTION 26 05 34
Outlet Boxes, Junction Boxes, Wireways

PART 1 - GENERAL

1.01 DESCRIPTION

A. Outlet and Junction Boxes

B. Pull Boxes

C. Wireways

PART 2 - PRODUCTS

2.01 OUTLET BOXES & JUNCTION BOXES (THROUGH 4-11/16")

A. Sheet Metal: Shall be standard type with knockouts made of hot dipped galvanized steel as manufactured by Steel City, Raco, Appleton, Bowers or equal.

B. Cast: Shall be type FS, FD, JB, GS, or SEH as required for application as manufactured by O-Z/Gedney, Appleton, or equal.

C. Nonmetallic: Shall be type Polycarbonate/ABS construction as required for application with non-metallic quick-release latches as manufactured by Hoffman, O-Z/Gedney, Appleton, or equal.

2.02 JUNCTION AND PULL BOXES (LARGER THAN 4-11/16")

A. Oil-Tight JIC: Shall be Hoffman Type CH box or approved equal.

B. Galvanized Cast Iron or Cast Aluminum: Shall be O-Z/Gedney or approved equal.

C. Stainless Steel: Shall be as manufactured by O-Z/Gedney, Hoffman or approved equal. Boxes shall have continuous hinges, seamless foam-in-place gaskets and screw-down clamps.

D. Nonmetallic: Shall be type Polycarbonate/ABS construction as required for application with non-metallic quick-release latches as manufactured by Hoffman, O-Z/Gedney, Appleton, or equal. Boxes shall have hinged covers and screw-down clamps.

E. Wireways: Shall be standard manufacturer's item as manufactured by Hoffman, Square "D", Burns, B & C or equal. Wireways shall have hinged covers and screw-down clamps.

F. Pre-cast Polymer Concrete Below-Grade Hand Holes & Pull Boxes:

1. Enclosures, boxes and cover are required to be UL Listed and conform to all test provisions of ANSI/SCTE 77 "Specifications For Underground Enclosure

Integrity" for Tier 15 applications (15,000lb design load and 22,500lb test load) unless noted otherwise.
2. All covers shall have a minimum coefficient of friction of 0.05 in accordance with ASTM C1028 and the corresponding Tier level shall be embossed on the top surface.
3. Cover shall be bolt-down include factory-labeling to read "Electric", "Communications" or other as directed.
4. Hardware shall be stainless steel.
5. Shall be Quazite PG/LG Style or approved equal.

G. Above-Grade Padmounted Low Profile Pull Boxes:

1. Construction:

a. 12Ga. stainless steel base with 12Ga aluminum top with brushed finish, and structural bracing as required.
b. Continuous base frame with open bottom and eight (8) ½" x 1" slots for securing box to concrete pad below and a center support member.
c. Two (2) full-size swing-open lids with full-length, stainless steel continuous hinges, lifting handles, key-locking provisions and provisions for latching lids in open position (with stainless steel chain or approved equal).
d. Guides on lid and base frame as required to ensure proper closing of box and to provide increased security.
e. Aluminum or stainless steel barrier between power & instrumentation areas within box if box is used for both power and instrumentation wiring.
f. Other stainless steel hardware as required.

2. Minimum Dimensions:

a. Power: 40 inches square x 18 inches high.
b. Instrumentation: 24 inches square x 18 inches high.

3. Manufacturer:

a. Electrical Enclosure Mfg. (Pell City, AL).
b. Ebox (Pelham, AL).
c. Approved Equal.

PART 3 - EXECUTION

3.01 APPLICATION

A. General

1. All boxes and wireways shall be of sufficient size to provide free space for all enclosed conductors per NEC requirements. Fill calculations shall be performed by contractor per NEC requirements.

B. Outlet Boxes & Junction Boxes (through 4-11/16")

a. Sheet metal boxes shall be used on concealed work in ceiling or walls.

2. Cast boxes shall be used wherever Rigid or I.M.C. conduits are installed. Cast boxes shall be Cast Aluminum wherever installed in same locations as Rigid Aluminum conduit
3. All boxes installed in extremely corrosive areas (such as chlorine and fluoride storage rooms) where non-metallic raceways are used shall be non-metallic.
4. Except when located in exposed concrete block, switch and receptacle boxes shall be 4" square for single gang installation. Appropriate gang boxes shall be used for mounting ganged switches.
5. When installed in exposed concrete block, switch and receptacle boxes shall be square type designed for exposed block installation.
6. Ceiling outlet boxes shall be 4" octagon 1-1/2" deep or larger required due to number of wires.
7. Boxes installed in hazardous locations shall be explosion-proof rated for the associated application, constructed of copper-free cast aluminum.

C. Junction & Pull Boxes (larger than 4-11/16")

1. For all below grade exterior use and elsewhere as shown:

a. In areas subject to future vehicular traffic: shall be galvanized cast iron (rated AASHTO H-20 Loading unless noted otherwise).
b. In areas not subject to vehicular traffic: shall be galvanized cast iron or pre-cast polymer concrete (rated for Tier 15 Loading unless noted otherwise).

2. All boxes installed exposed in exterior or wet areas shall be stainless steel (NEMA 4X).
3. All boxes installed exposed in corrosive areas shall be stainless steel (NEMA 4X).
4. All boxes installed in extremely corrosive areas (such as chlorine and fluoride storage rooms) where non-metallic raceways are used shall be non-metallic.
5. Padmounted Pull Boxes shall be installed as shown on Plans or as required by project conditions. Transclosure-style Padmounted boxes shall be installed wherever required by the quantities and sizes of conductors. Contractor shall submit all Padmounted Pull Box types prior to ordering for engineer's review and comment.
6. Boxes installed in hazardous locations shall be explosion-proof rated for the associated application, constructed of copper-free cast aluminum.
7. All others shall be oil tight JIC box not less than 16 gauge.

3.02 INSTALLATION

A. General

1. All boxes and wireways shall be securely anchored.
2. All boxes shall be properly sealed and protected during construction and shall be cleaned of all foreign matter before conductors are installed.
3. All boxes and wireways shall be readily accessible. Contractor shall be responsible for furnishing and installing access panels per architect's specifications. Locations

shall be as directed by the architect as required to make boxes, wireways, electrical connections, etc. accessible where above gypsum board ceilings or in other similar locations.

4. All metallic boxes and wireways shall be properly grounded.
5. Refer to Specification Section 26 05 53 for identification requirements.

B. Outlet Boxes & Junction Boxes (through 4-11/16")

1. Boxes shall be provided with approved 3/8" fixture studs were required.
2. Recessed boxes for wiring devices, surface fixtures, or connections, shall be set so that the edge of cover comes flush with finished surface.
3. There shall be no more knockouts opened in any sheet metal box than actually used.
4. Any unused opening in cast boxes shall be plugged.
5. Back to back boxes to be staggered at least 3 inches.
6. Under no circumstances shall through-the-wall boxes be used.

C. Junction & Pull Boxes (larger than 4-11/16")

1. Pull boxes shall be installed as indicated on plans and/or as required due to number of bends, distance or pulling conditions.
2. Boxes to be imbedded in concrete shall be properly leveled and anchored in place before the concrete is poured.
3. All pull boxes and/or junction boxes installed exterior below grade, shall have their tops a minimum of 1-1/2 inches above surrounding grade and sloped so that water will not stand on lid. A positive drain shall be installed, to prevent water accumulation inside.
4. Above grade pull boxes shall be installed on concrete anchor bases as shown on Plans.

D. Wireways and/or wall-mounted equipment

1. Mount each wireway to channels of the same metal type as the wireway.
2. Conductors serving a wireway shall be extended without reduction in size, for the entire length of the wireway. Tap-offs to switches and other items served by the wireway shall be made with ILSCO type GTA with GTC cap.

END OF SECTION 26 05 34

SECTION 26 05 53
Electrical Identification

PART 1 - GENERAL

1.01 DESCRIPTION

A. Wire and cable identification.

B. Pullbox & Junction Box Identification

C. Electrical distribution & utilization equipment identification.

D. Instrument and control device identification.

E. Raceway identification.

PART 2 - PRODUCTS

2.01 WIRE AND CABLE IDENTIFICATION

A. Intermediate Locations:

1. Wires and cable labels shall be white, thermal transfer, halogen-free, flame-retardant marker plates (sized to accommodate three lines of text) permanently affixed to the associated cable with UV-resistant plastic wire ties. Labels shall be Panduit #M200X/300X series or equal.

B. Circuit/Cable Termination Locations:

1. Wires and cable labels shall be non-ferrous identifying tags or pressure sensitive labels unless noted otherwise.

2.02 ELECTRICAL DISTRIBUTION & UTILIZATION EQUIPMENT IDENTIFICATION

A. Labels on electrical distribution & utilization equipment shall be black-on-white engraved Bakelite nameplates permanently affixed to the equipment with rivets or silicone adhesive unless noted otherwise.

B. Text used on labels on electrical distribution & utilization equipment shall be sufficiently sized to allow user to quickly/easily read labels while standing a normal/reasonable distance from the equipment. Text sizes shall be adjusted based on types of equipment (large switchgear would require larger labels than small toggle-type disconnect switches). If there is any question about what is reasonable, contractor may submit typical physical sample label(s) for each major application to the engineer for review/approval, at its discretion.

2.03 EMERGENCY AND STANDBY POWER RECEPTACLE IDENTIFICATION

A. Receptacles fed from emergency or standby power sources (such as emergency generators) shall be provided with factory-marked engraved coverplates as follows:

1. Emergency System source: Red engraved lettering to read "EMERGENCY".
2. Legally-Required or Optional Standby Generator source:

    a. If only part of facility is fed with generator backup: Black engraved lettering to read "FED FROM GENERATOR".
    b. If entire facility is fed with generator backup: No "….GENERATOR…" label required.

2.04 INSTRUMENT AND CONTROL DEVICE IDENTIFICATION

A. Instruments and control device labels shall be black-on-white engraved Bakelite nameplates permanently affixed to the equipment or the adjacent, visible mounting surface with silicone adhesive or stainless steel wire ties.

2.05 RACEWAY IDENTIFICATION

A. Raceway labels shall be white thermal transfer marker plates permanently affixed to the associated raceway with stainless steel wire ties, with two wire ties (one on either end of marker plate to provide a flush installation) where possible. Labels shall be Panduit #M300X series or equal.

PART 3 - EXECUTION

3.01 GENERAL

A. Any proposed deviation in identification methods and materials from those described herein shall be submitted to Engineer for review and comment prior to installation.

B. Contractor shall provide all labeling or identification required by applicable local, state and national codes. These specifications do not intend to itemize all code-required labeling or identification requirements.

C. All labels/identification shall be positioned such as to be readable from the normal perspective without adjusting wiring/cables/labels. For example, labels/identification of wires/cables within cable trays shall be positioned to point towards the viewer (typically downward for overhead cable trays, or upward for cable trays within trenches).

D. All labels/identification (except for handwritten labels on concealed pullbox/junction box covers as noted below) shall be typewritten/printed/engraved in a neat, workmanlike, permanent, legible, consistent and meaningful manner. Labels shall not be handwritten unless specific approval is granted by engineer.

3.02 WIRE AND CABLE IDENTIFICATION

A. General:

1. Where cabling is exposed (such as within cable trays), provide two wire ties per cable (one on either end of marker plate to provide a flush installation). Where cabling is concealed (such as within pullboxes/wireways), one wire tie per cable will be acceptable.

B. Intermediate Locations:

1. Thermal transfer labels shall be securely fastened to all wiring and cabling in the following locations:

   a. Wireways
   b. Pullboxes/Junction boxes larger than 4-11/16"
   c. Pullboxes/Junction boxes through 4-11/16" where wires and cables are not easily identifiable via the color coding and box labeling
   d. Vaults & Manholes
   e. Approximately every 50 feet within cable trays (especially at locations where cables exit or diverge). Labels within cable trays shall be grouped (rather than being pre-labeled on cables and pulled into cable trays).
   f. Other similar intermediate locations.

2. Labels shall be stamped or printed with the following data so that the feeder or cable can be readily identified and traced:

   a. From where the circuit originates (including panel designation and circuit number):

      1) Ex: "FROM: PP-A CIR. 3 (IN MAIN ELEC ROOM)"

   b. To where the circuit extends (using the common name of the equipment):

      1) Ex: "TO: RTU-6 (ON ROOF)"

   c. The purpose of the circuit:

      1) Ex: "POWER"

   d. The set number (If parallel power feeds are used).

      1) Ex: "SET NO. 3 OF 4"

C. Circuit/Cable Termination Locations:

1. Where multiple termination points exist within a circuit origination point (panelboard, switchboard, MCC, starter, etc.) or other similar circuit endpoint (control panel, etc.), labels shall be securely fastened to all ungrounded and neutral conductors to clearly identify the terminal and/or circuit number associated with each conductor. For example, within lighting panels, each phase and neutral conductor shall be labeled near the terminals at a clearly visible location with the

associated circuit number(s), so that if all conductors were unterminated, the labels would clearly indicate which conductor was associated with each circuit.

D. Refer to Specification Section 26 05 19 for all color-coding requirements of wires and cables.

3.03 PULLBOX & JUNCTION BOX IDENTIFICATION

A. Concealed pullboxes/junction boxes:

1. Front surface of all pullbox/junction box covers in concealed areas (such as above lay-in ceilings) or within mechanical/electrical rooms (and other similar areas where appearance of boxes is not an issue) shall be neatly marked with the ID of circuits/cables contained with permanent black marker on cover of box (Ex: "RP-1A Cir. 1, 2 & 3"). Additionally, front surface of box shall be painted red where box contains fire alarm system cabling.

B. Exposed pullboxes/junction boxes:

1. Interior surface of all pullbox/junction box covers in exposed areas shall be labeled "Power", "Telecommunications", "Fire Alarm" or with other similar general text neatly with permanent black marker to indicate function of box. Circuit/cable labeling within box (see above) shall identify specific cables contained. Additionally, interior surface of cover shall be painted red where box contains fire alarm system cabling.

C. Where pullboxes/junction boxes are named on contract documents (Ex:"PULLBOX #3"), an engraved nameplate shall be installed on the front surface of the box to identify the name.

3.04 ELECTRICAL DISTRIBUTION & UTILIZATION EQUIPMENT IDENTIFICATION

A. General:

1. All new and existing equipment modified by this project shall include arc-flash warning labels in accordance with NEC article 110.16.

B. All Panels, Motor Control Centers, Switchboards, Switchgear, Transformers, Etc.:

1. Engraved nameplates identifying name of equipment, nominal voltage and phase of the equipment and where the equipment is fed from shall be installed on front surface of all panels, motor control centers, switchboards, switchgear, transformers, etc.:

a. Ex: First Line: "NAME: RP-A", Second Line: "120/208V-3Ø-4W", Third Line: "FED FROM: PP-A CIR. 4 (IN MAIN ELEC ROOM)"

2. Refer to Panelboard Specification Sections for additional labeling requirements (circuit directory cards, permanent circuit labels, permanent circuit numbers, etc.) required inside panelboards.

C. Safety/Disconnect Switches and Utilization Equipment (HVAC Equipment, Pumps, Powered Valves, Control Panels, Starters, Etc.)::

1. Engraved nameplates identifying equipment being fed and where the equipment is fed from shall be installed on front surface of all disconnect switches (including both visible blade type switches and toggle-type switches) and on utilization equipment (where not clearly identified by immediately adjacent local disconnect switch):

    a. Ex: First Line: "RTU-6", Second Line: "FED FROM: PP-A CIR. 5"

2. Where safety/disconnect switches are installed on the load side of variable frequency drives, the safety/disconnect switch shall be furnished with an additional engraved nameplate to read: "WARNING: TURN OFF VFD PRIOR TO OPENING THIS SWITCH".
3. Safety/Disconnect switches feeding equipment that is fed from multiple sources (such as motors with integral overtemperature contacts that are monitored via a control system) and Utilization Equipment fed from multiple sources shall be furnished with an additional BLACK-ON-YELLOW engraved nameplate to read: "WARNING: ASSOCIATED EQUIPMENT FED FROM MULTIPLE SOURCES – DISCONNECT ALL SOURCES PRIOR TO OPENING COVER".

D. Emergency Systems:

1. A sign shall be placed at the service entrance equipment (and at any remote shunt trip operators, or similar, for service equipment) indicating the type and location of on-site emergency power sources (such as generators, central battery systems, etc.) per NEC requirements.
2. All boxes and enclosures (including transfer switches, generators, power panels, junction boxes, pullboxes, etc.) dedicated for emergency circuits shall be permanently marked with white-on-red engraved nameplates so they will be readily identified as a component of an emergency circuit or system.
3. Where an Essential Electrical System (EES) is installed, all enclosures, raceways and equipment that are components of the EES shall be readily identified as such. Raceway shall be identified at intervals not exceeding 25 ft.

E. Services:

1. All Service Equipment:

    a. Engraved nameplates identifying maximum available fault current, including date the fault current calculation was performed, in accordance with NEC article 110.24.

        1) Ex: First Line: "AVAILABLE FAULT CURRENT: 16,154 AMPS", Second Line: "DATE CALCULATED: JULY 8, 2013"

b. All service entrance equipment shall be clearly labeled as being service entrance rated.

2. Where a building or structure is supplied by more than one service (or any combination of branch circuits, feeders and services), a permanent plaque or directory shall be installed at each service disconnect location denoting all other services, feeders & branch circuits supplying that building or structure and the area served by each, per NEC requirements.

3.05 INSTRUMENT AND CONTROL DEVICE IDENTIFICATION

A. New Instruments and control devices (whether furnished by contractor or not) shall be labeled with black-on-white engraved nameplates permanently affixed to the equipment or to the adjacent, readily-visible mounting surface with silicone adhesive or stainless steel wire ties.

1. Instruments and process control devices (float switches, etc.) shall be labeled with instrument name and, where available, instrument ID number.
2. Pushbutton stations shall be labeled with equipment being controlled. Labels shall be installed on front surface (or adjacent mounting surface) of all pushbutton stations.
3. Thermostats and other similar HVAC control devices installed in process areas shall be labeled with equipment being controlled. Labels shall be installed on front surface (or adjacent mounting surface) of all thermostats and other similar HVAC control devices.

3.06 RACEWAY IDENTIFICATION

A. Each exposed raceway shall be labeled at the point where it becomes concealed, such as where it enters a concrete floor slab, a concrete wall, the ground, etc.

B. Each raceway entering in-grade or on-grade pullboxes/junction boxes, where the conduits are only visible inside the box, shall be labeled within the box at the point where the raceway becomes concealed.

C. Raceway nameplates shall identify:

1. The location of the other end of the raceway ("TO MCC-1" or similar). If the other end of the raceway is at an intermediate, named pullbox ("INSTRUMENTATION PULLBOX #4" or similar), that pullbox name shall be labeled rather than the endpoint of the circuitry.

3.07 OTHER IDENTIFICATION

A. Factory-engraved coverplates identifying functions of light switches and other similar devices shall be installed where so required by plans/specifications.

END OF SECTION 26 05 53

SECTION 26 05 73
Power Distribution System Electrical Studies

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. THE WORK UNDER THIS SECTION INCLUDES BUT IS NOT LIMITED TO THE FOLLOWING:

1. Power Distribution System Electrical Studies.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Short Circuit Studies, Protective Devices Evaluation Studies, Protective Device Coordination Studies and Arc Flash Hazard Studies shall be performed by the same entity, which shall be a Professional Engineer registered in the state where the equipment will be installed. The studies shall be per the requirements set forth in the latest edition of NFPA 70E-Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E, Annex D.

B. The studies shall be submitted to the Engineer prior to shipment of any electrical distribution equipment.

C. The studies shall include all portions of all electrical systems affected by the project (including any existing systems/equipment) from the utility service to any existing equipment at the facility (including all existing equipment fed from the same service point as any new equipment) and to all new equipment installed under this contract. All induction motors 50 HP or below and fed from the same bus may be grouped together. All induction motors greater than 50 HP shall be included individually with associated starters and feeder impedance. See individual study sections below for additional scope requirements.

D. The studies shall be performed using the latest revision of the SKM Systems Analysis Power*Tools for Windows (PTW) or EasyPower software program.

E. Normal system connections and those which result in maximum fault conditions shall be adequately covered in the study.

F. The contractor shall be responsible for collecting data on any existing or proposed electrical equipment, devices, conductors, etc. as required to prepare the study, and shall supply pertinent electrical system conductor, circuit breaker, generator, and other component and system information in a timely manner to allow the studies to be completed prior to shipment of equipment.

G. The Power Distribution System Electrical Studies shall be performed by Square 'D' or

Cutler Hammer; or a third-party vendor if specifically approved by the engineer prior to preparation of the studies.

H. The proposed vendor shall have completed a minimum of five (5) equivalent Arc-Flash Hazard Studies in the past three (3) years.

2.02 SHORT CIRCUIT STUDY

A. The Short Circuit Study shall be performed with aid of a computer program. The study input data shall include the power company's short circuit contribution, resistance and reactive components of the branch impedances, X/R ratios, base quantities selected, and other source impedances.

B. Short circuit momentary duty values and interrupting duty shall be calculated on each individual basis with the assumption that there is a three-phase bolted short circuit at the respective switchgear bus, switchboard, low voltage motor control center, distribution panelboard, and other significant locations throughout the system.

C. The short circuit tabulation shall include symmetrical and asymmetrical fault currents, and X/R ratios. For each fault location, the total duty on the bus, as well as the individual contributions from each connected branch, including motor back EMF current contributions shall be listed with its respective X/R ratio.

2.03 PROTECTIVE DEVICE EVALUATION STUDY

A. The Protective Device Evaluation Study shall be performed to determine the adequacy of circuit breakers, switches, transfer switches, and fuses by tabulating and comparing the short circuit rating of these devices with the calculated fault currents. Appropriate multiplying factors based on system X/R ratios and protective device rating standards shall be applied.

B. Any problem areas or inadequacies in the equipment due to short circuit currents shall be promptly brought to the Engineer's attention.

2.04 PROTECTIVE DEVICE COORDINATION STUDY

A. The Protective Device Coordination Study shall be performed to provide the necessary calculation and logic decisions required to select or to check the selection of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low voltage breaker trip characteristics and settings. The objective of the study is to obtain optimum protective and coordination performance from these devices.

B. The coordination study shall show the best coordination attainable for all breakers down through the largest breaker at each piece of distribution equipment. Coordination study shall demonstrate selective coordination where required by applicable codes or contract documents.

C. Phase and ground overcurrent protection shall be included as well as settings of all other

adjustable protective devices. Where ground fault protection is used, coordination of the ground fault protection with the first downstream overcurrent phase protection device shall be demonstrated.

D. All restrictions of the National Electrical Code shall be adhered to and proper coordination intervals and separation of characteristic curves be maintained.

2.05 ARC-FLASH HAZARD STUDY

A. The Arc-Flash Hazard Study shall be performed with the aid of computer software intended for this purpose in order to calculate Arc-Flash Incident Energy (AFIE) levels and flash protection boundary distances.

B. The Arc-Flash Hazard Study shall be performed in conjunction with a short-circuit Study and a time-current coordination Study.

C. The Arc-Flash Hazard Study shall be performed for the following equipment:

1. All Distribution Equipment – This includes but is not limited to the following:

    a. Switchgear
    b. Switchboards
    c. Motor Control Center
    d. All Lighting and Power Panelboards
    e. Fused Disconnect Switches rated greater than 100A

2. Separately enclosed devices fed from protection device rated greater than100A - This includes but is not limited to the following:

    a. Control Panels
    b. VFD's
    c. RVSS

D. A generic Arc-Flash label shall be applied to other electrical equipment that has not been included in the study. This includes but is not limited to the following equipment:

1. Non-fused Disconnect Switches
2. Fused Disconnect Switches rated 100A or less
3. Transformers
4. Control Panels, VFD's, RVSS, etc. rated 100A or less

E. Where a main protective device is provided, the study shall be performed on the line side and load side of the main. The worst-case result shall be used for the study result and label.

F. The Study shall be performed under worst-case Arc-Flash conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

G. Where incident energies are calculated to fall within the high marginal region of a given Hazard/Risk Category Level, the Hazard/Risk Category Level shall be increased one level.

H. The Arc-Flash Hazard Study shall be performed in compliance with the latest IEEE Standard 1584, the IEEE Guide for Performing Arc-Flash Calculations. Where IEEE 1584 does not have a method for performing the required arc-flash calculations (such as for single phase equipment), calculations shall be performed and system shall be modeled using modules/methods as recommended by the arc flash software supplier (for example, using SKM Unbalanced/Single Phase Studies module for modeling single phase systems).

I. Equipment labels to identify AFIE and appropriate Hazard/Risk Category in compliance with NFPA 70E and ANSI Z535.4 (latest version of these requirements) shall be provided to the Electrical Contractor. The Electrical Contractor shall affix the labels to the distribution equipment devices as directed by the equipment manufacturer. These labels shall, at a minimum, include the following:

1. WARNING label.
2. Hazard/Risk Category.
3. Arc Flash Boundary Distance.
4. Incident Energy (in cal/cm2) at Working Distance.
5. Shock Hazard Voltage.
6. Limited Approach Boundary Distance.
7. Restricted Approach Boundary Distance.
8. Prohibited Approach Boundary Distance.
9. Equipment Name.
10. Name of Firm who prepared the Study.
11. Project Number of the Firm who prepared the Study.
12. Date that the Study was prepared.
13. Method for calculating analysis data.
14. Statement to read: "Any system modification, adjustment of protective device settings, or failure to properly maintain equipment will invalidate this label" (or equivalent).

PART 3 - EXECUTION

3.01 SUBMITTAL REQUIREMENTS

A. The results of the studies shall be summarized in a final report. The report shall include the following sections:

1. General:

a. Description, purpose, basis and scope of the studies
b. Single line diagram of the portion of the power system which is included within the scope of the work. The single line diagram shall fit on one sheet of paper

(size as required) unless approved otherwise by engineer. The following information shall be shown on the single line diagram:

1) Device Name
2) Branch Fault Currents with directional indicators
3) General Location (for busses only)
4) Other basic component information such as cable type, cable length, breaker rating, buss short circuit rating, transformer voltages, transformer size, fuse size, etc..

2. Short Circuit Study:

   a. Tabulation of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties, and commentary regarding same.

3. Protective Device Evaluation/Coordination Study:

   a. Protective devices time versus current coordination curves**,** tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
   b. Fault current calculations including definitions of terms and a guide for interpretation of computer printout.
   c. Documentation from utility company on their letterhead showing their anticipated values of available short circuit currents X/R ratios and protective devices with which the power distribution system will coordinate.
   d. Time-current characteristics of the respective protective devices shall be plotted on log-log paper. Plots shall be printed in color with a dedicated color and pattern for each curve for clear identification.
   e. Plots shall include complete titles, respective single line diagrams and legends, and associated power company's relay or fuse characteristics, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breakers trip curves and fuses.
   f. The coordination plots shall indicate the type of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing inrush and ANSI transformer withstand parameters, cable thermal overcurrent withstand limits and significant symmetrical and asymmetrical fault currents.
   g. The coordination plots for phase and ground protective devices shall be provided on a system basis.
   h. A sufficient number of separate curves shall be used to clearly indicate the coordination achieved.

4. Arc-Flash Hazard Study:

   a. Tabulation of device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment classes and AFIE levels.
   b. Recommendations for reducing AFIE levels and enhancing worker safety.

B. Furnish all labor, materials, calculations, electrical equipment, technical data and incidentals required to provide a complete short circuit study, coordination study and arc flash hazard study of protective devices, busses, etc. from the utility service to any existing equipment at the facility and all new equipment installed under this contract.

C. The study shall comply with the following applicable provisions and recommendations of the latest revisions of the following: ANSI C37.5, IEEE Standard No. 399, and IEEE Standard No. 141.

D. Submit calculations and results of the short circuit, protective device evaluation and coordination and arc flash hazard studies prior to submitting shop drawings for new equipment. Contractor shall verify that all proposed equipment is properly rated per the short circuit and protective device evaluation portions of the study prior to releasing equipment for manufacturing.

E. Submit a copy of a sample typical arc flash label layout (meeting requirements outlined above) that will be used for the project.

F. Submit final electronic copies of all SKM program files/models/input data/etc. used to perform the study to the owner with final close-out documents. These files shall be complete as required to allow future users to recreate the study.

3.02 INSTALLATION

A. Contractor shall adjust all breaker settings as recommended by the coordination study prior to energizing equipment.

B. Contractor shall affix arc flash hazard notification labels (as determined by the results of this study) to each piece of distribution equipment prior to energization of equipment. A generic arc-flash warning label shall be affixed to any electrical equipment not included in the analysis as outlined above.

C. Where short circuit rating of equipment is dependent on setting of upstream overcurrent device, provide and install label for equipment indicating the required settings of the associated device.

END OF SECTION 26 05 73

SECTION 26 27 26
Wiring Devices

PART 1 - GENERAL

1.01 DESCRIPTION

A. Wiring Devices

B. Plates

C. Finishes

PART 2 - PRODUCTS

2.01 WIRING DEVICES AND PLATES

A. Switches shall be AC type, extra-heavy duty industrial grade (unless otherwise shown) of ratings shown on drawings. Switches shall be as manufactured by Hubbell, P & S, Sierra, Bryant, GE, Arrow Hart or equal.

B. Receptacles shall have blade configuration and shall be heavy duty industrial grade (unless otherwise shown) of current and voltage rating as shown on drawings. Receptacles shall be as manufactured by Hubbell, P & S, Sierra, Bryant, GE, Arrow Hart or equal.

C. All GFCI-type receptacles shall continuously self-test and shall trip/deny power if the receptacle does not provide proper GFCI protection or if the line/load terminations are miswired and shall provide visual indication of power status, trip conditions, ground fault conditions and end-of-life status.

D. Each wiring device shall have a plate (see "Finishes" section below for specific requirements).

2.02 FINISHES

A. All wiring devices (switches, receptacles, etc.) shall be colored to match the coverplates described below. For instance, all items covered by stainless steel, aluminum or malleable iron plates shall be gray in color.

B. Coverplates for recessed, wall-mounted electrical items (switches, receptacles, telephone outlets, etc.) shall be stainless steel unless shown otherwise.

C. Coverplates, trim rings, etc. for recessed, floor-mounted electrical items (floor outlets, underfloor duct junctions, etc.) shall match finish of building hardware (302/304 stainless steel, brass, etc.) in area installed.

D. Coverplates for exposed electrical items (switches, receptacles, telephone outlets, etc.) shall be of same material as exposed boxes (see Outlet Box Specification for required material type) and shall have beveled edges.

E. Coverplates for receptacles in wet locations shall be metallic, extra-duty, in-use type, rated for wet locations per NEC requirements unless noted otherwise.

F. See "Electrical Identification" specification section for coverplate labeling requirements.

PART 3 - EXECUTION

3.01 GENERAL MOUNTING

A. Symbols on drawings and mounting heights are approximate. The exact locations and mounting heights shall be determined on the job, and it shall be the Contractor's responsibility to coordinate with all trades to secure correct installation. For example, Contractor shall coordinate exact mounting heights over counters, in or above backsplashes, in block walls, and at other specific construction features.

B. Verify all door swings with Architectural. Locate boxes for light switches within four inches of door trim on swing side (not hinge side) of door.

C. Devices and associated plates shall not be used as support; outlet boxes shall be rigidly supported from structural members.

D. Mount all straight-blade receptacles vertically with ground pole up, unless specifically noted otherwise.

E. Unless otherwise shown or required by local handicap codes, outlet boxes shall be the following distances above the finished floor unless otherwise noted.

1. Receptacles and telephone outlets in offices and other finished areas: 1'-6" to the center of the box.
2. Receptacles and telephone outlets in equipment rooms and other unfinished areas: 4'-0" to the center of the box.
3. Receptacles over counters: As Noted
4. Switches, general: 4'-0" to the top of the box.
5. Push-button, etc., general: 4'-0" to the top of the box.
6. Other device types: verify with engineer prior to rough-in.

END OF SECTION 26 27 26

SECTION 26 28 16
Safety Switches And Fuses

PART 1 - GENERAL

1.01 DESCRIPTION

A. Safety Switches

B. Fuses

C. Branch Feeders

D. Feeders

PART 2 - PRODUCTS

2.01 SAFETY SWITCHES

A. Safety switches shall be quick-make, quick-break, NEMA heavy duty type HD, fused or nonfused as shown. Switch blades shall be fully visible in the off position.

B. Safety switches shall be furnished with transparent internal barrier kits to prevent accidental contact with live parts. Barriers shall provide finger-safe protection when the switch door is open and shall allow use of test probes and removal of fuses without removing barrier.

C. Fused switches shall have provisions for class R, rejection type fuses.

2.02 FUSES (600V)

A. Fuses for all branch switches shall be Bussman Mfg. Co., Dual Element, Class "R" Fusetron.

B. Fuses for main switch/switches shall be Bussman Mfg. Co. Hi-Cap.

2.03 MANUFACTURER

A. Safety switches shall be as manufactured by Square 'D' or Cutler Hammer.

B. Fuses shall be as manufactured by Bussman Mfg. Co. or equal.

PART 3 - EXECUTION

3.01 SAFETY SWITCHES

A. Safety switches shall be installed as shown on the plans and in accordance with N.E.C.

B. Locations shown for safety switches on plans are diagrammatical only. Exact locations shall be field coordinated by contractor as required to provide code-required clearances.

C. Switch enclosures shall be rated NEMA I indoors in dry locations and NEMA 4X stainless steel outdoors and in wet or process areas.

D. Adequate support shall be provided for mounting safety switches. Safety switches shall not be mounted to the associated equipment (unless the safety switch is furnished with the equipment).

3.02 FUSES

A. Fuses shall be sized as shown on drawings, unless a smaller size is required by the associated equipment supplier, in which case the contractor shall provide fuses sized as directed by the associated equipment supplier at no additional cost.

B. Provide not less than one spare set of fuses for each size used. Provide an additional spare set for each five sets of same size fuses used.

END OF SECTION 26 28 16

SECTION 26 29 00
Manufactured Control Panels

PART 1 - GENERAL

1.01 SCOPE

A. This section describes control stations, PLC panels, motor control panels, manufactured control panels, and other similar panels specified herein. Specifications herein are intended as an extension of requirements in other Divisions of these specifications where reference is made to Electrical Specifications.

1.02 DEFINITIONS

A. "Control Stations": Enclosures (with all required accessories) containing only door-mounted pushbuttons, indicator lights and/or selector switches (no electronic components or starter/controller equipment).

B. "Control Panels": Enclosures (with all required accessories) containing equipment/devices other than door-mounted pushbuttons, indicator lights and/or selector switches (such as electronic components, starter/controller equipment, etc.).

1.03 SUBMITTALS

A. Provide the following for each control panel:

1. A job-specific, custom wiring diagram

    a. The wiring diagram shall clearly show all components (whether the components are mounted internal or external to the control panel enclosure).
    b. All wires and terminal blocks shall be clearly labeled.
    c. Diagram shall be in accordance with NEMA/ICS standards.

2. Size, type and rating of all system components.
3. Unit frontal elevation and dimension drawings.
4. Internal component layout diagrams.
5. Manufacturer's product data sheets for all components.

B. A Bill of Materials shall be included with catalog information on all components.

C. Information shall be included on any proprietary logic component sufficient to demonstrate its ability to perform the required functions.

D. The following calculations shall be submitted:

1. Thermal calculations showing amount of panel cooling/ventilating/heating required for each control panel, per ambient requirements listed below and operating temperature limitations of all equipment/devices within each control panel. See Part 2 below for requirements for forced air ventilation rather than air conditioning.

Panel shall be oversized, interior equipment/devices shall be derated, and solar shielding shall be provided, etc, as required to allow the use of forced air ventilation as the cooling method. Air conditioning, ventilation, and/or heating equipment shall each have ratings/capacities at least 20% larger than required by calculations below unless noted otherwise:

a. Thermal calculations used for sizing cooling/ventilation systems for each control panel located in exterior or non-conditioned spaces shall assume:

1) Ambient exterior air temperature ranges of -5 degrees F to 105 degrees F.
2) Full solar contact where applicable (not applicable where enclosures are fully protected from solar contact using solar shields separated from panel enclosure with standoffs or similar).
3) No wind.
4) Heat loss from interior equipment (electronics, etc.) per equipment supplier's information.

b. Thermal calculations used for sizing heating systems for each control panel shall assume:

1) Ambient exterior air temperature ranges of -5 degrees F to 105 degrees F.
2) No heat loss by interior components of control panel.
3) No solar gain on exterior of control panel.
4) Doubling of heating wattage required to account for wind where control panels are located outdoors.
5) Minimum temperature difference (due to heating) of 10 degrees F to prevent condensation, regardless of equipment temperature limitations.

2. Load calculations showing the sizing of all power supplies provided (with spare capacity as specified). Power supplies shall each have ratings/capacities at least 20% larger than required by load calculations unless noted otherwise.
3. Load calculations showing the sizing and anticipated runtime of all Uninterruptible Power Supply systems provided (with spare capacity as specified).

PART 2 - PRODUCTS

2.01 GENERAL

A. Control panels shall be Underwriters' Laboratories labeled by the panel manufacturer. Control panel manufacturers not capable of applying the U.L. label to their products are unacceptable.

B. All human interface equipment/devices (indicator lights, selector switches, pushbuttons, time switches, displays, keypads, and other similar items used for control, adjustments or monitoring) shall be mounted on the non-energized side of enclosure door(s) in such a way as to be accessible without exposing the user to energized parts.

2.02 RATINGS

A. All Control Panels shall have short circuit current ratings at least equal to the lesser of the following, unless noted otherwise on plans:

1. The short circuit current rating of the electrical distribution equipment that feeds the Control Panel.
2. 150% of the available fault current at the Control Panel as determined by a Short Circuit Current study prepared by a licensed professional electrical engineer.

B. All equipment/devices installed within control panels shall be rated to operate in ambient temperatures of 50 degrees C (122 degrees F) or higher.

2.03 ENCLOSURES

A. All enclosures (with any required accessories or auxiliary items) shall fit within the space shown on the Plans. Any costs associated with furnishing equipment which exceeds the available space shall be borne by the Contractor.

B. Enclosures (with any required accessories or auxiliary items) shall be suitable for the environment where installed.

C. Enclosure materials shall be as follows unless noted otherwise:

1. Control Stations:

a. Where located in extremely corrosive areas (chlorine rooms, fluoride rooms, etc.): NEMA 4X of non-metallic construction (with non-metallic hardware) compatible with the associated chemical(s).
b. Where located in other wet, process or outdoor areas: NEMA 4X of type 304 stainless steel construction (with stainless steel hardware).
c. Where located in dry, non-process, indoor areas (such as electrical rooms): NEMA 1 of die cast zinc/aluminum construction.

2. Control Panels:

a. Where located in extremely corrosive areas (chlorine rooms, fluoride rooms, etc.): NEMA 4X of non-metallic construction (with non-metallic hardware) compatible with the associated chemical(s).
b. Where located in other wet, process or outdoor areas: NEMA 4X of type 304 stainless steel construction (with stainless steel hardware).
c. Where located in dry, non-process, indoor areas (such as electrical rooms): NEMA 1 or 12.

D. Control Panel Enclosure Construction:

1. Non-metallic control panel enclosure material, where specified, shall be reinforced polyester resin or equivalent, with a minimum thickness of 3/16 inch for all surfaces except those requiring reinforcement. Panels shall be precision molded to form a one piece unit with all corners rounded. Exterior surfaces shall be gel-coated to

provide a corrosion-resistant maintenance-free satin finish which shall never need painting. Color pigments shall be molded into the resin. Color shall be grey.

2. Metallic control panel enclosures, where specified, shall be fabricated using a minimum of 14 gauge steel for wall or frame mounted enclosures and a minimum of 12 gauge for freestanding enclosures. Continuously weld all exterior seams and grind smooth. Reinforce sheet steel with steel angles where necessary support equipment and ensure rigidity and preclude resonant vibrations.
3. Use pan-type construction for doors.
4. Door widths shall not exceed 36-inches.
5. Mount doors with full length, heavy duty piano hinge with hinge pins.
6. Provide gasket completely around each door opening.
7. Mount and secure all internal components to removable back plate assembly.
8. For NEMA 1 or 12 enclosures, provide handle-operated key-lockable three point stainless steel latching system for each door.
9. For NEMA 4X enclosures, provide provisions for padlocking all doors and provide clamps on three (3) sides of each door.

E. Control panel enclosures (and associated backpanels and other similar accessories) shall be manufactured by Hoffman Engineering Co., or Saginaw Control & Engineering.

2.04 CONTROL PANEL ACCESSORIES:

A. Panel ventilation systems shall be provided if so required by the application to maintain temperatures within the acceptable ranges of the interior equipment. In no case (regardless of temperature ratings of internal equipment) shall maximum temperatures within control panels be allowed to exceed 50 degrees C (122 degrees F). Panel Air Conditioners or Heat Exchangers (to satisfy the specified thermal calculation requirements) are generally NOT acceptable unless specifically stated otherwise in these specifications, and shall not be provided for panels without specific written direction from the engineer PRIOR to submission of panel shop drawings. Panels shall be oversized, provided with standoffs/shields, and/or ventilated as required to meet the contract requirements. Thermostats shall be provided to control cooling without need of manual operation. Thermostat setpoints shall be as per recommendations of the equipment suppliers. See above for thermal calculation requirements. Cooling units shall be as manufactured by Hoffman Engineering Co., Rittal or approved equal and shall be thermostatically controlled.

B. Space heaters shall be provided for condensation and temperature control. Thermostats AND hygrostats (or combination hygrotherm controllers) shall be provided to control heating requirements (based on temperature and relative humidity within enclosure) without need of manual operation. Setpoints shall be as per recommendations of the equipment suppliers. See above for thermal calculation requirements. Space heaters and associated control devices shall be as manufactured by Hoffman Engineering Co., Rittal, Stego or approved equal.

C. NEMA 4X control panels shall be provided with vapor-phase corrosion inhibitor(s) (chemical combinations that vaporize and condense on all surfaces in the enclosed area, to protect metal surfaces/devices within the enclosed area from corrosion). Corrosion

inhibitor shall be Hoffman #AHCI series (sized as required by the enclosure volume to be protected) or equal.

D. For outdoor panels, stainless steel solar shields for front, top and each side of panel, supported to associated panel face with standoffs as required (to allow free air flow between solar shield and panel enclosure), shall be provided where required to limit solar loading on panel to allow use of a ventilated panel design rather than an air-conditioned panel design.

E. Provide a sun shield over all LCD displays in exterior-mounted panels. Sun shield shall be collapsible to fully protect LCD display from UV light when not in use, shall provide side and top shielding when in use, shall be constructed of stainless steel and shall be installed such as to maintain NEMA 4X ratings of enclosures.

F. Provide a clear polycarbonate gasketted hinged door or window to encompass all indicators, controllers, recorders, etc. mounted on NEMA 4 and 4X enclosures.

G. Provide interior mounting panels and shelves constructed of minimum 12 gauge steel with white enamel finish. Provide metal print pocket with white enamel finish on inside of door.

H. Provide interior LED light kit, mounted at top of interior of panel, and switched to turn "ON" when door is opened for the following control panels:

1. Control panels with outer dimensions greater than 20" wide or 30" high.
2. Control panels containing PLCs or other similar programmable devices.

I. Control panels containing VFDs or Reduced Voltage Soft Starters shall include a door mounted digital keypad for adjusting the starter parameters and viewing process values and viewing the motor and starter statuses without opening the enclosure deadfront door.

2.05 CONTROL COMPONENTS

A. General:

1. All pushbuttons, pilot lights, selector switches and other control devices shall be separate, standard size (full 30mm) and shape, heavy duty oil-tight units.

    a. Devices in extremely corrosive areas (chlorine rooms, fluoride rooms, etc.) shall be of non-metallic construction.
    b. Devices in other areas shall be of chrome-plated construction.

2. All components and devices so that connection can be easily made and so there is ample room for servicing each item.
3. Door-mounted indicators, recorders, totalizers and controllers shall be located between 48" and 72" above finished floor level.
4. Door-mounted indicator lights, selector switches and pushbuttons shall be located between 36" and 80" above finished floor level.

5. All devices and components shall be adequately supported to prevent movement. Mounting strips shall be used to mount relays, timers and other devices suitable for this type of mounting.

B. Pilot Lights:

1. All pilot lights to be cluster LED type & push to test.

C. Pushbuttons:

1. All STOP operators within control stations located at equipment shall be provided with padlockable lockout provisions and a minimum of two (2) sets of contact blocks.
2. Emergency shutoff pushbutton devices shall be as follows unless noted otherwise:

    a. 44mm diameter, mushroom-style, maintained contact push buttons
    b. With a minimum of one (1) normally open dry contact and three normally closed dry contacts.
    c. Connections made such that pushing "in" the button will shutoff the associated equipment.
    d. Provided with a red engraved nameplate with ½" lettering to read "Emergency Shutoff".
    e. Provided with padlockable lockout provisions

D. Relays:

1. Control relays shall have the following characteristics, unless noted otherwise:

    a. General purpose, plug-in type.
    b. Minimum mechanical life of 10 million operations.
    c. Coil voltage as indicated or required by application.
    d. Single-break contacts rated 12 amperes, resistive at 240 volts.
    e. Contacts as shown on wiring diagrams plus a minimum of one (1) spare N.O. contact and one (1) spare N.C. contact. At a minimum, each individual relay shall have 3PDT contacts. Where required, multiple control relays shall be provided (to provide the required quantities of contacts) for each "relay" function shown on plans/diagrams.
    f. Furnished with RC transient suppressor to suppress coil-generated transients to 200% of peak voltage.
    g. LED on/off indicator light and manual operator.
    h. Industry standard wiring and pin terminal arrangements.
    i. Equal to Square D 8501KP series with matching plug-in socket.

2. Interposing/isolation relays used to isolate discrete output field wiring (and where required for voltage translation for other discrete signals) to/from PLC inputs/outputs shall be terminal-block style. Terminal-block style relays shall have the following characteristics, unless noted otherwise:

    a. Minimum mechanical life of 10 million operations.

b. Single-break contacts rated 6 amperes, resistive at 120 volts.
c. One (1) N.O. contact per relay.
d. Furnished with integral transient protection.
e. LED on/off indicator light.
f. DIN-rail mounted.
g. Equal to Square D type Zelio RSL.

3. Timer relays shall be electronic, adjustable plug-in devices meeting the following characteristics, unless noted otherwise:

a. General purpose, plug-in type.
b. Minimum mechanical life of 10 million operations.
c. Single-break contacts rated 10 amperes, resistive at 240 volts.
d. Contacts as shown on wiring diagrams plus a minimum of one (1) spare N.O. contact and one (1) spare N.C. contact. At a minimum, each relay shall have DPDT contacts (2 N.O. & 2N.C.). Where required, multiple timer or control relays shall be provided (to provide the required quantities of contacts) for each "relay" function shown on plans/diagrams.
e. Rotary-thumbwheel adjustments for time value, timing range and function.
f. Time value adjustments from .05 seconds to 999 hours
g. Selectable Timing Functions, including the following:

1) On Delay
2) Interval
3) Off Delay
4) One Shot
5) Repeat Cycle-Off
6) Repeat Cycle-On
7) On/Off Delay
8) One Shot Falling Edge
9) Watchdog
10) Trigger On Delay

h. Accuracy shall be $\pm$ 2% and repeatability shall be $\pm$ 0.1%.
i. Furnished with integral transient protection.
j. LED indicator light(s) for "timing" and "on/off status"
k. Held in place with hold-down spring
l. Equal to Square D type JCK with matching plug-in socket.

2.06 DC POWER SUPPLIES

A. DC Power supplies shall be provided where specified elsewhere, or as required by design of system. Power supplies shall be industrial type, AC-to-DC switching, output voltage as required, 120vac input, size as required for the initial application plus 50% spare capacity.

B. Redundant power supplies with diode isolation shall be provided so that the loss of one power supply does not affect system operation. The back-up supply systems shall be

designed so that either the primary or the back-up supply can be removed, repaired, and returned to service without disrupting the system operation.

C. Power supply output shall be protected by secondary overcurrent protection device(s).

D. The power distribution from multiloop supplies shall be selectively fused so that a fault in one instrument loop will be isolated from the other loops being fed from the same supply.

E. Each power supply shall meet the following requirements.

1. Regulation, line: 0.4% for input from 105 to 132vac.
2. Regulation, load: 0.8%
3. Ripple/Noise: 15mV RMS / 200 mV peak to peak
4. Operating temperature range: 0 deg C - 60 deg C
5. Overvoltage protection
6. Overload Protection
7. Output shall remain within regulation limits for a least 16ms after loss of AC power at full load.
8. Output status indicator.
9. UL listing

F. Power supplies shall be manufactured by Puls, Sola, Phoenix Contact or equal.

2.07 UNINTERRUPTIBLE POWER SUPPLIES

A. Uninterruptible power supplies (UPSs) shall be provided where specified elsewhere, or as required by design of system. Power supplies shall be industrial type, size as required for the initial application plus 50% spare capacity unless noted otherwise.

B. Battery runtime shall be as specified elsewhere. If no other specification for battery runtime is specified, battery runtime shall be 12.5 minutes at full load.

C. UPSs shall be double-conversion, on-line type.

D. UPSs shall be rated for operation in -20 degrees C to 55 degrees C ambient temperatures.

E. UPS batteries shall be hot-swappable and 12-year rated when installed in 25 degrees C environment and 4-year rated when installed in 50 degrees C environment.

F. UPSs shall include dry contacts for the following alarm points:

1. Loss of Input Power Alarm
2. Low Battery Alarm

G. UPSs shall be manufactured by Falcon UPS or approved equal.

2.08 DISCONNECTS

A. A main disconnect switch or circuit breaker shall be supplied integral to all control panels. The main disconnect or circuit breaker shall be accessible/operable without exposing the operator to energized sections of the control panel(s), and shall be lockable in the open/off position.

B. Individual circuit breakers shall be provided integral to the manufactured control panel for each separate power circuit originating within the control panel.

C. Where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated (or can be adjusted to is 1200A or higher, breakers shall be electronic trip and shall be provided with arc energy-reducing maintenance switching (with local status indicator) to reduce arc flash energy per NEC 240.87 requirements.

D. Manufacturers:

1. Square 'D' or Cutler Hammer.

2.09 COMBINATION STARTERS

A. All combination starters shall utilize a unit disconnect. Magnetic starters shall be furnished in all combination starter units unless specifically shown otherwise. All starters shall utilize full NEMA/EEMAC rated contactors (size 1 minimum).

B. Starters shall be provided with a three-pole, external (door mounted) manual reset, solid state overload relay. Solid state overload relay shall have switch-selectable trip class and shall provide protection from:

1. Overload.
2. Phase Unbalance.
3. Phase Loss.
4. Ground Fault (Class II detection).

C. Unless specifically shown otherwise, each combination starter or each group of starters shall be furnished with a control circuit transformer including two primary protection fuses and one secondary fuse (in the non-ground secondary conductor). The transformer shall be sized to accommodate the contactor(s) and all connected control circuit loads (including motor space heaters and other similar loads where specified). The transformer rating shall be fully visible from the front when the unit door is opened. Unless otherwise indicated, control voltage shall be 120V AC. Control power shall be provided by individual unit control power transformers.

D. When a unit control circuit transformer is not provided, the disconnect shall include an electrical interlock for disconnection of externally powered control circuits.

E. Auxiliary control circuit interlocks shall be provided where indicated. Auxiliary interlocks shall be field convertible to normally open or normally closed operation.

F. NEMA/EEMAC Size 1-4 starters shall be mounted directly adjacent to the wireway so

that power wiring (motor leads) shall connect directly to the starter terminals without the use of interposing terminals. Larger starters shall be arranged so that power wiring may exit through the bottom of the starter cubical without entering the vertical wireway.

G. Each starter shall be equipped with a minimum of the following control devices:

1. Door-mounted reset button.
2. Two (2) field-reversible (N.O./N.C.) auxiliary contacts
3. For reversing and two-speed starters: Four (4) field-reversible (N.O./N.C.) auxiliary contacts
4. Additional control devices as indicated on plans.

H. Control Wiring Terminal Blocks

1. Terminal blocks shall generally be:

a. Feed-thru, screw-in type
b. DIN rail mounted
c. Furnished with the stationary portion of the block secured to the unit bottom plate
d. Furnished with unit-mounted control terminal blocks for each field wire.
e. Rated for the voltage and current of the proposed application per UL/NEC standards.
f. Sized (by supplier) for the associated wire gauges/types/quantities.
g. Phoenix Contact UT-4 series, Weidmuller WDU-4 series (or equivalent) unless required otherwise by application.

I. Nameplates

1. Each unit shall be properly labeled with an engraved phenolic nameplate with a white background and black letters.
2. Each pilot device shall be properly labeled with a legend plate or an engraved phenolic nameplate.

J. Manufacturers:

1. Square 'D' or Cutler Hammer.

2.10 WIRING

A. Refer to Section 26 05 19 for all wiring types/applications.

B. All wiring shall be identified on each end with hot stamped, shrink tube type, or self-laminating vinyl permanent wire markers to correspond with numbering shown on wiring diagrams.

C. All connections shall be made on terminals with no splices.

D. All wiring runs shall be along horizontal or vertical routes to present a neat appearance. Angled runs will not be acceptable. Group or bundle parallel runs of wire in plastic wire duct where practical.

E. All wiring runs shall be securely fastened to the panel or wire duct by means of plastic wire ties. Adequately support and restrain all wire runs to prevent sagging or movement.

F. AC power wiring and instrumentation/analog wiring shall be run separate.

G. Color code all internal wiring (not field wiring) as follows:

1. Line and load circuits: Black (B)
2. AC control wiring: Red (R)
3. Externally-Powered control wiring: Yellow (Y)
4. Neutral wiring: White (W)
5. Low voltage DC(+)pos: Blue (BL)
6. Low voltage DC(-)neg: Blue/White Tracer (BL/W)
7. Grounding: Green (G)

H. Terminal strips shall be provided for all input and output wiring. No more than two (2) wires shall be connected to one (1) terminal block.

2.11 ELECTRICAL SURGE AND TRANSIENT PROTECTION

A. General

1. Function: Protect the system against damage due to electrical surges.

B. Application: As a minimum, provide surge and transient protection (with proper grounding) at the following locations as described below:

1. Power Input High Frequency Noise Filtering:

a. 120VAC Control panels with integral UPSs, PLCs, or other electronic/microprocessor equipment that is susceptible to failure or improper operation due to high frequency/harmonic input transients shall be provided with series-connected high-frequency noise filters on the line input (downstream of any panel main disconnects/breakers). Filters shall be as manufactured by Edco/Emerson/Islatrol or equal (exact type(s) as required by application).

2. Power Input Surge Protection:

a. Provide surge protection device at any connection of 120VAC power to panels containing programmable logic controllers, remote I/O equipment, UPS's, transmitters, radios, VFDs, Reduced Voltage Soft Starters or other electronic equipment. Device shall:

1) Be mounted internal to the associated panel, with dedicated overcurrent protection.
2) Be of two-part (base and SPD), DIN-rail mountable construction.
3) Have 15kA total nominal discharge current per line (based on 8/20μs waveform).
4) Have maximum continuous operating voltage (MCOV) rating as required by the associated circuit voltage.
5) Visually indicate operational status.
6) Be Dehn DEHNguard series or equal by MTL Technologies or Phoenix Contact, or may be combined with the High Freqency Noise Filtering device required above.

b. Provide surge protection device at any connection of multi-pole AC power to panels containing programmable logic controllers, remote I/O equipment, UPS's, transmitters, radios, VFDs, Reduced Voltage Soft Starters or other electronic equipment. Device shall:

1) Be mounted internal to the associated panel, with dedicated overcurrent protection.
2) Provide protection for all phases.
3) Have 40kA (per phase) peak surge current rating.
4) Have maximum continuous operating voltage (MCOV) rating as required by the associated circuit voltage.
5) Visually indicate operational status.
6) Be Square D SDSA or HWA series or equal.

3. Analog I/O Panel Terminations Surge Protection:

a. Provide surge protection device at the PLC (or similar) panel connection of each analog I/O signal. Device shall:

1) Be mounted internal to the associated panel.
2) Be of two-part (base and SPD), DIN-rail mountable construction.
3) Have the following nominal discharge current ratings:

(a) D1 Lightning impulse current (10/350 μs) per line: 1 kA
(b) C2 Total nominal discharge current (8/20 μs): 20 kA
(c) C2 Nominal discharge current (8/20 μs) per line: 10 kA

4) Have maximum continuous operating voltage (MCOV) rating as required by the associated signal.
5) Manufacturer and Model:

(a) DEHN BSP M4 BE 24 (926 324) with 920300 base.
(b) Phoenix Contact 2801263 with included base.
(c) Weidmuller 1093400000 with 8951710000 base.

4. Discrete I/O Panel Terminations Surge Protection:

a. Provide isolation relay at the PLC (or similar) panel connection of each discrete output signal (within the associated panel). See above for isolation relay requirements.

5. Low Voltage Power Supply Load Side Surge Protection:

a. Provide surge protection device at the PLC (or similar) panel on the load side of each low voltage power supply that has low voltage connections extending external to the panel. Device shall:

1) Be mounted internal to the associated panel.
2) Be of two-part (base and SPD), DIN-rail mountable construction.
3) Have 10kA total nominal discharge current per line (based on 8/20μs waveform).
4) Have maximum continuous operating voltage (MCOV) rating as required by the associated utilization voltage.
5) Be as manufactured by Dehn, MTL Technologies, or Phoenix Contact.

6. Network Panel Terminations Surge Protection:

a. Provide surge protection device at the PLC (or similar) panel connection of each network cable. Device shall:

1) Be mounted internal to the associated panel.
2) Be of DIN-rail mountable construction.
3) Have 1kA total nominal discharge current per line (based on 8/20μs waveform).
4) Be designed specifically for the associated network connection type (Ethernet, RS485, RS232, etc.).
5) Be MTL Zonebarrier series or equal.

7. Antenna Cable Terminations Surge Protection:

a. Provide surge protection device at the connection of antenna cable to the radio panel. Device shall:

1) Be mounted internal to the associated panel.
2) Provide coarse protection via replaceable gas-filled surge voltage arrestor
3) Be Phoenix Contact CN-LAMBDA series or equal.

C. Installation and grounding of suppressor: As directed by manufacturer. Provide coordination and inspection of grounding.

PART 3 - EXECUTION

3.01 DELIVERY, STORAGE & HANDLING

A. Provide Site and warehouse storage facilities for all equipment.

B. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers, and related equipment as recommended by the capsule manufacturer.

C. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

D. Cover panels and other elements that are exposed to dusty construction environments.

3.02 INSTALLATION

A. Provide enclosure mounting supports as required for floor, frame or wall mounting. All supports in exterior, wet or process areas shall be stainless steel unless noted otherwise. All floor-mounted panels or other similar distribution equipment shall be mounted on 6" concrete housekeeping pads unless specifically shown otherwise. The general design intent is that centers of control panels be mounted at heights that are easily accessible. Design intent is that devices on panel fronts (pushbuttons, selector switches, pilot lights, HMIs, ETMs, breaker handles, etc.) generally be mounted as close to 5'-0"a.f.f. as possible, no higher than 6'-7"a.f.f (per NEC requirements) and no lower than 3'-6"a.f.f., where possible, without specific approval of the owner or engineer. Additionally, every effort shall be made to provide a professional, consistent, neat, and workmanlike finished appearance of panel installations. For example, tops of adjacent panels shall be mounted at matching heights where possible/reasonable.

B. All enclosures used outside shall be solid bottom unless otherwise specified. All cable and piping openings shall be sealed watertight. Cable and piping shall enter the enclosure as shown on drawings or specified herein.

C. All equipment and components shall be solidly grounded to the control panel. One grounded terminal unit shall be provided in each control panel for connection to plant ground system. Grounding digital and analog components shall be performed in accordance with the instrument supplier's installation recommendations. Signal ground shall be solidly connected to the ground system so as to prevent ground loops

3.03 PAINTING

A. For enclosures other than NEMA 4X stainless steel or fiberglass:

1. Completely clean all surfaces so that they are free of corrosive residue. Then, phosphatize all surfaces for corrosion protection.
2. Prime with two (2) coats and finish with one coat of factory finish textured polyurethane. Paint shall be Sherwin-Williams Polane "T" or approved equal.
3. Color to be selected during shop drawing review phase.

3.04 IDENTIFICATION & DOCUMENTATION

A. Refer to specification section 26 05 53 for additional requirements.

B. Control panel power supply source, type, voltage, number or circuit ratings shall be identified inside control panels and on drawings.

C. All interior devices and components shall be identified with thermal transfer labels with black letters on white background. Labels shall be placed on the subpanel and not the component. Marking system shall be a Brother "PTouch II" or equal. Lettering shall be 1/4" high.

D. All front panel mounted devices such as push buttons shall be identified by the use of engraved bakelite nameplates or legend plates. Nameplates shall be 1/8" thick, white with black core.

E. Where a panel includes a PLC or other network-connected device that is intended to be connected to another system (such as a plant SCADA system) via a network connection, the panel supplier shall provide an Interface Control Document (ICD) to the other system supplier (such as the SCADA Integrator). This document shall itemize the following for each networked parameter that is capable of being monitored or controlled by the other system:

1. Parameter Name/Function (ex: Pump No. 1 On/Off Status)
2. Parameter Type (discrete or analog, input or output)
3. Parameter register ID/location

F. Where a panel includes a touchscreen or other programmable HMI display and is to be monitored by another system (such as a plant SCADA system), the panel supplier shall provide copies of the HMI display code and screenshots of all proposed HMI screens to the other system supplier (such as the SCADA Integrator) for their use in duplicating the associated HMI.

G. A job-specific, custom wiring diagram for each control panel (not including control stations without relays) shall be provided to the contractor prior to installation for making the appropriate electrical connections. The wiring diagram shall clearly show all control components connected to the panel (whether the components are mounted internal or external to the enclosure). All wires and terminal blocks shall be clearly labeled. A laminated copy of the final wiring diagram for each unit shall be installed inside the door of the associated panel, and submitted to the owner with the as-built documentation.

3.05 OWNER TRAINING

A. Fully train the owner in the proper operation of all control panels/equipment, describing and demonstrating full operation, including function of each door-mounted device.

3.06 SPARE EQUIPMENT

A. Provide the following spare equipment:

1. Fuses: 10% (minimum of 3) of each size and type utilized, mounted within a pocket within the associated control panel.
2. Where control panel contains programmable controller (or similar equipment): Flash drive containing copies of all final programs utilized within the control panel, with provisions/cable assemblies as required to connect the flash drive provided to the

controller to download the programs. Flash drive shall be attached to retractable cord (long enough to reach the associated port) attached to the inside of the panel door.

END OF SECTION 26 29 00

SECTION 26 29 16
Reduced Voltage Soft Starters, 600vac

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. These specification requirements are for solid state reduced voltage motor controllers rated 600VAC and below, herein referred to as soft starters.

B. They are for use with AC motors to reduce the current in-rush as well as mechanical shocks that can result from starting or stopping a motor across the line.

1.02 QUALITY ASSURANCE

A. The electronic "soft starter" shall be listed by an independent testing laboratory in accordance with UL 508 - Industrial Control Equipment.

B. The soft start shall carry the CE mark for indication of compliance to low voltage and EMC directives in accordance with EN / IEC 60947-4-2.

C. The manufacturer shall be a certified ISO 9001 facility.

1.03 SUBMITTALS

A. Submittals shall be furnished in accordance with Specification Section 26 05 00.

B. Provide the following for each Soft Start unit:

1. A job-specific, custom wiring diagram

    a. The wiring diagram shall clearly show all control components connected to the starter (whether the components are mounted internal or external to the soft start enclosure).
    b. All wires and terminal blocks shall be clearly labeled.
    c. Diagram shall be in accordance with NEMA/ICS standards.

2. Size, type and rating of all system components.
3. Enclosure frontal elevation and dimension drawings.
4. Internal component layout diagrams.
5. Available conduit entry and exit locations.
6. Manufacturer's product data sheets for all components.

C. Standard catalog sheets showing voltage, horsepower, maximum current ratings and recommended replacement parts with part numbers shall be furnished for each different horsepower rated Soft Starter shall be provided.

1.04 WARRANTY

A. An eighteen-month warranty shall be provided on materials and workmanship from the date of owner acceptance/substantial completion after completion of startup.

PART 2 - PRODUCT

2.01 MANUFACTURERS

A. The soft starter equipment shall be:

1. Square 'D' or Cutler Hammer.
2. Or pre-approved equal meeting the detailed requirements of this specification. Note that all "named" Manufacturers are obligated to meet the detailed requirements of this specification. Any proposed exceptions shall be clearly stated at bid time, citing the reason for noncompliance, and the cost for providing a conforming product. Failure to provide a detailed list of proposed exceptions may cause a bid to be deemed non-responsive. The Engineer will be the sole determiner of the acceptability of a proposed exception.

2.02 GENERAL DESCRIPTION

A. Refer to Specification 26 29 00 (Manufactured Control Panels) as applicable for additional requirements (for enclosure, component types, etc.).

B. Unless otherwise specifically directed or allowed by engineer, all interior components of equipment shall be mounted to the backpanel within the enclosure (not to interior sides of enclosure).

C. The soft starter shall be provided complete with a main circuit breaker disconnect means for Type 1 short circuit overcurrent protection as follows:

1. Short circuit withstand rating shall be equal to or greater than the AIC rating listed on the plans for the distribution equipment (motor control center, panelboard, switchboard, etc.) that feeds the soft starter.
2. Where the soft starter installed within a motor control center, refer to Motor Control Centers Specification Section 26 24 19.
3. Sized by manufacturer per NEC requirements for corresponding motor load.

D. The soft starter shall utilize an SCR bridge consisting of at least two SCRs per phase to control the starting and stopping of industry standard motors.

1. SCR stacks shall be arranged horizontally for proper heat management.
2. Heat sinks sized for specified Starts Per Hour without requiring auxiliary cabinet cooling fans.

E. The soft start shall provide torque control for linear acceleration independent of motor load or application type without external feedback. The gating of the SCRs shall be controlled in such a manner to ensure stable and linear acceleration ramp.

F. The soft starter shall be controlled by a microprocessor that continuously monitors the

current and controls the phasing of the SCRs. Analog control algorithms will not be allowed.

G. All soft starter power ratings shall utilize the same control board/module.

H. A shorting contactor shall be standard on soft starters in all enclosure configurations. Protective features and deceleration control options integral to the soft starter shall be available even when the shorting contactor is engaged.

2.03 MOTOR DATA

A. Each Soft Starter shall be sized to operate the AC motors defined to match load schedules and other specification documents as follows:

1. Motor Horsepower and voltage rating(s) – See electrical drawings and schedules.
2. Motor full load amperes, RPM and service factor ratings as stated within the individual motor specification documents.

B. The Soft Starter manufacturer shall be responsible for verifying each exact motor amperage, horsepower, voltage, RPM and service factor with motor equipment supplier prior to submitting shop drawings.

2.04 ENVIRONMENTAL RATINGS

A. The soft start shall be designed to operate in an ambient temperature 0°C to 40°C (14°F to 104°F). For ambient temperatures between 40°C and 60°C (104°F and 140°F), derate the current by 2% per °C above 40°C (104°F).

B. Storage temperature range shall be -25°C to 70°C (-13°F to 158°F).

C. Maximum relative humidity shall be 95%, non-condensing or dripping water, conforming to IEC 60947-4-2.

D. The soft starter shall be designed to operate in altitudes up to 1000m (3300 ft). For higher altitudes, derate by 2.2% for each additional 100 m (330 ft) with a maximum of 2000m (6600 ft).

2.05 ELECTRICAL RATINGS

A. The soft starter shall be capable of operation between + / - 10% of nominal voltage rating.

B. The soft start shall automatically adapt for operation at 50 or 60 Hz, with a frequency tolerance of +/- 5%. By configuration, it shall be capable of operation at a supply line frequency that can vary by +/- 20% during steady state operation.

C. The soft start unit amperage shall be the greater of the following:

1. 110% of the NEC amperage rating associated with the horsepower rating shown on the plans (for heavy duty Class 20 starting).
2. 100% of the unit amperage rating shown on the plans (for heavy duty Class 20 starting).

D. The soft start shall be capable of supplying 400% of rated full load current (of the soft starter) for 23 seconds at maximum ambient temperature. The soft starter shall also be capable of 10 evenly spaced starts per hour at 400% of full rated current (of the soft starter) for 12 seconds per start.

E. The soft start shall have a coordinated short circuit rating equal to or in excess of the minimum value listed on the piece of distribution equipment that feeds the soft start. This rating shall be listed on the nameplate. When a power distribution system electrical study (including short circuit stud, etc.) is a part of the project, contractor shall further verify that all proposed equipment is properly rated (per the results of the study) prior to submitting shop drawings.

F. The SCRs shall have a minimum P.I.V. rating of 1800 Vac. Lower rated SCRs with MOV protection are not acceptable.

G. A seismic qualification label shall be provided for all wall and floor mount units to comply with the latest IBC and NFPA 5000 guidelines where installed in seismic zones C, D, E or F.

2.06 ADJUSTMENTS AND CONFIGURATIONS

A. All programming/configuration devices, display units, and field control wiring terminals shall be accessible on the front of the control module. Exposure to control circuit boards or electrical power devices during routine adjustments is prohibited.

B. Digital indication shall provide, as a minimum, the following conditions:

1. Soft starter status - ready, starting/stopping, run.
2. Motor status - current, torque, thermal state, power factor, operating time, power in kW.
3. Fault status - Motor thermal overload, soft starter thermal fault, loss of line or motor phase, line frequency fault, low line voltage fault, locked rotor fault, motor underload, maximum start time exceeded, external fault, serial communication fault, line phase reversal fault, motor overcurrent fault.

C. The soft starter shall be preset to the following for adjustment-free operation in most applications:

1. Linear (torque-controlled) acceleration ramp of 15 seconds.
2. Current limitation to 300% of the motor full load current rating.
3. Class 10 overload protection.
4. Motor current preset per NEC / NFPA 70 table 430.150 for standard hp motors.

D. The exact acceleration ramp time/type, current limitation, overload protection type and

motor current shall be set in the field by the startup technician prior to equipment startup as recommended/approved by the motor supplier.

E. A digital keypad shall be utilized to configure the following operating parameters as required:

1. Motor full load amps adjustable from 40 to 130% of the soft starter's rating.
2. Current limitation on starting adjustable from 150 to 700% of the motor current rating, not to exceed 500% of the soft starter rating.
3. Linear (torque-controlled) acceleration ramp adjustable from 1 to 60 seconds.
4. Initial torque adjustable from 10 to 100% of nominal motor torque.
5. Torque limit adjustable from 10 to 200% of nominal motor torque.
6. Maximum start time adjustable from 10 to 999 seconds.
7. Voltage boost adjustable from 50 to 100% of the nominal supply voltage.
8. Selection of freewheel, soft stop or braking.
9. Linear (torque-controlled) deceleration ramp time adjustable from 1 to 60 seconds.
10. Threshold to change to freewheel from a controlled deceleration ramp to freewheel stop: adjustable from 0 to 100% of the nominal motor torque.
11. Braking torque level adjustable from 0 to 100% effectiveness.
12. Selection of Class 2, 10, 10A, 15, 20, 25 or 30 motor thermal overload protection.

F. A digital keypad shall be utilized to configure the following controller parameters as required:

1. Selectable automatic reset operation.
2. Cancellation of the torque control loop for multi-motor installations.
3. Adjustment of the stator loss estimation for specialty motors.
4. Assignment of soft starter inputs and output control terminals.
5. Activation of line phase reversal protection.
6. Reset of motor thermal state.
7. Return to factory settings.
8. Activation of test mode for use with low power motors.
9. Indication of elapsed time in hours of starting, running and stopping.

G. Output relays shall provide the following status indications:

1. One Form A (N.O.) minimum for indication of fault.
2. One Form A (N.O.) for indication that acceleration ramp is complete and current is below 130% motor FLA (end of start).
3. One Form A (N.O.) assignable to one of the following functions: motor thermal alarm, motor current level alarm or motor underload alarm.

H. Additional inputs and outputs shall be available to provide the following status indications:

1. Two assignable control inputs for the following functions: force to freewheel stop, external fault input, disable serial link control, external motor overload reset or general fault reset.

2. Two assignable logic-level signal outputs for the following functions: motor thermal overload alarm, "motor powered" signal, motor overcurrent alarm, or motor underload alarm.
3. One analog output shall be available for 4 to 20 milliamp indication of motor current, motor torque, motor power, motor thermal state, or power factor.
4. Other inputs/outputs as shown on electrical drawings.

I. Relay and I/O functions listed above shall be isolated with respect to common.

2.07 PROTECTION

A. A microprocessor-based thermal protection system shall be included which continuously calculates the temperature-rise of the motor and soft starter and provides:

1. A motor overload pre-alarm that indicates by relay contact or logic output that the motor windings have exceeded 130% of its rated temperature rise. This function shall be for alarm only.
2. A motor overload fault shall stop the motor if the windings have exceeded 140% of temperature-rise.
3. An electronic circuit with a time-constant adjustable to the motor's thermal cooling time-constant ensuring the memorization of the thermal state even if power is removed from the soft starter.

B. The soft starter shall provide line and motor phase loss, phase reversal, underload, stall, and jam protection.

C. The integral protective features shall be active even when the shorting contactor is used to bypass the SCRs during steady state operation.

2.08 CONTROL OPTIONS

A. The soft starter control circuit shall be fed from the line supply and be completely independent of the power circuit and separate from the control logic.

B. The peripheral soft starter control circuitry shall be operated at 120 Vac 60 Hz from a control power transformer included within the enclosure.

C. Operator devices shall be door mounted, functions/types as shown on drawings.

D. All operator devices shall be remote-mounted using supplied 120 Vac control logic. Clearly labeled terminals shall be provided for field installation.

E. All wiring shall be clearly identified on each end to match the wiring diagram(s) provided with the soft starter.

F. Refer to Specification Section 26 24 19 (Motor Control Centers) or Specification Section 26 29 00 (Manufactured Control Panels) as applicable for all operator device and control component requirements (for pushbuttons, indicator lights, selector switches, relays, control wiring, etc).

2.09 COMMUNICATIONS

A. The RVSS shall be able to be connected to communication network type(s) as indicated on plans or required by the SCADA Integrator (exact network/protocol type(s) required shall be as directed by the facility SCADA Integrator). Where no specific network connections are specified on plans or required by the SCADA Integrator, the RVSS shall be provided with at least one of the following network communication options:

   a. Modbus RTU serial
   b. Ethernet TCP/IP
   c. Ethernet IP

B. The communication shall be able to provide access to the control, to the adjustment and to the supervision of the soft starter.

C. No additional compensation will be granted to provide gateways, network components, etc. to properly communicate with the facility SCADA system. Equipment supplier is responsible for verifying all network connection requirements with the SCADA Integrator prior to bid.

2.10 INPUT SURGE PROTECTION

A. Each RVSS that does not have an upstream isolation contactor, and is not mounted within an MCC that has its own main bus surge protection shall be provided with a 3-phase, line-side surge protection device rated 80kA (per phase) or greater. The lead length between the surge protection device and the drive terminals shall be 12" or less. The surge protection device shall be designed / located / isolated such as to prevent / limit potential physical damage to other components within the enclosure if the surge protection device fails.

2.11 SHORTING CONTACTOR

A. A microprocessor shall control the operation of the shorting contactor via an output relay.

B. The shorting contactor shall close, shorting the SCRs after the acceleration ramp is compete and motor current is below 130% of motor FLA, and open on a stop command to allow a deceleration ramp.

C. Overload protection integral to the soft starter shall continue to protect the motor when shorting is engaged.

2.12 ISOLATION CONTACTOR

A. An IEC or NEMA-rated isolation contactor shall be provided that opens when the motor is stopped or when the controller detects a fault condition including a shorted SCR.

B. The isolation contactor shall be located on the line side of the associated controller.

C. When an input isolation contactor is provided, the 120V CPT shall be powered from upstream of the input isolation contactor such that 120V controls and control power to the RVSS are maintained when the input isolation contactor is opened.

PART 3 - EXECUTION

3.01 TESTING

A. All incoming material shall be inspected and/or tested for conformance to quality assurance specifications.

B. Power semiconductors shall be fully tested for proper electrical characteristics, including dv/dt and di/dt.

C. All subassemblies shall be inspected and/or tested for conformance to quality assurance specifications.

D. Each completed unit shall be functionally tested prior to shipment to assure conformance to the specifications.

3.02 DELIVERY, STORAGE AND HANDLING

A. Handling and shipment of the equipment shall be in such a manner to prevent internal component damage, breakage, and denting and scoring of the enclosure finish.

B. Equipment shall be stored indoors in a clean, dry environment as directed by the equipment supplier. Energize anti-condensation space heaters if so required.

1. Verify that the location is ready to receive work and the dimensions are as indicated.
2. Do not install Soft Starter equipment until the building environment can be maintained within the service conditions required by the manufacturer.

3.03 INSTALLATION

A. Installation shall comply with manufacturer's instructions, drawings and recommendations.

B. A job-specific, custom wiring diagram for each soft start unit shall be provided to the contractor prior to installation for making the appropriate electrical connections. The wiring diagram shall clearly show all control components connected to the starter (whether the components are mounted internal or external to the soft start enclosure). All wires and terminal blocks shall be clearly labeled. A laminated copy of the final wiring diagram for each unit shall be installed inside the door of the associated unit.

C. Operations and Maintenance Manuals shall be provided to the owner for all Soft Starter components, control wiring, etc.

D. Operations and Maintenance Manuals shall include hardcopy printouts of all device settings and programming.

E. For safety, reliability, and continuity of warranty, any modifications, alterations, etc. required to conform to the requirements of this specification shall be performed by the Starter manufacturer only. Distributor modifications, third party packaging, etc. of a manufacturer's standard product are specifically disallowed.

3.04 START UP AND TRAINING

A. The services of a qualified manufacturer's service representative shall be available to install, test, and start up all soft starts furnished under this specification. The schedule of the startup(s) shall be determined by the contractor.

B. Services shall include a minimum of eight (8) hours of field/classroom training for owner's personnel on routine operation and maintenance of the specified units.

3.05 SPARE PARTS

A. The following spare parts shall be provided at no extra cost to the Owner:

1. One of each type and size of control fuse.
2. Three of each type and size of power fuse.

END OF SECTION 26 29 16

SECTION 26 43 00
Surge Protective Devices

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes field-mounted SPDs for low-voltage (<1000 V) power distribution and control equipment.

B. The specified unit(s) shall provide effective high energy transient voltage surge suppression, surge current diversion and high frequency noise attenuation in all electrical modes for equipment connected downstream from the facility's meter or load side of the main overcurrent device. The unit(s) shall be connected in parallel with the facility's wiring system.

C. The unit(s) shall be designed and manufactured in North America by a qualified manufacturer of suppression filter system equipment. The qualified manufacturer shall have been engaged in the commercial design and manufacturer of such products for minimum of ten (10) years.

D. All products that are submitted according to these specification will be required to meet this specification in it's entirety for both service and distribution TVSS systems. Any product that is submitted and does not comply with all parts of this specification will be subject to rejection.

1.03 DEFINITIONS

A. VPR: Voltage Protection Rating.

B. SPD: Surge Protective Device(s)

C. $I_{(n)}$: Nominal Discharge Current

1.04 SUBMITTALS

A. See specification section 26 05 00.

B. Product Data: For each type of product indicated. Include:

1. Maximum Single Impulse Surge Current Rating.
2. Surge Life (Repetitive Surge) Rating.
3. UL1449 (Latest Edition) Voltage Protection Ratings (VPR).
4. UL1449 (Latest Edition) Nominal Discharge Current (In).

5. Product dimensions and weights.
6. Furnished specialties and accessories.

C. Qualification Data:

D. Safety Agency File Number.

E. ISO 9001-2008 Certification.

F. ISO 1401-2001 Certification.

G. Operation and Maintenance Data: For SPDs to include all submittal data and any applicable operation and maintenance manuals.

H. Warranties: Sample of special warranties.

1.05 QUALITY ASSURANCE

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

B. The unit shall be UL 1449 Listed and CUL Approved as a Surge Protective Device and UL 1283 Listed as an Electromagnetic Interference Filter

C. Provide 2nd party certified data demonstrating SPD response to ANSI/IEEE C62.41.2-2002 standard waveforms when tested according to IEEE C62.45.

D. Comply with NFPA 70.

E. All SPDs provided within this project at the service entrance, distribution panels, and sub-panels shall be from the same manufacturer.

1.06 PROJECT CONDITIONS

A. Service Conditions: Rate SPDs for continuous operation under the following conditions unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 30 to 150 deg F.
3. Humidity: 0 to 95 percent, non-condensing.
4. Altitude: Less than 13,000 feet above sea level.

1.07 COORDINATION

A. Where field-mounted SPD's are specifically shown on plans, coordinate locations of field-mounted SPDs to allow adequate clearances for maintenance.

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

1.09 EXTRA MATERIALS

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

1. Replaceable Protection Modules: 1 of each size and type installed, where field-replaceable modular SPDs are provided.
2. Fuses: 1 of each size and type installed, where field-replaceable fuses are provided.

PART 2 - PRODUCTS

2.01 SURGE PROTECTIVE DEVICES

A. Manufacturer:

1. Integral Devices: Surge Protective Devices shall be as manufactured by the distribution equipment manufacturer (Square D, etc.), or by Surge Suppression Inc. if all of the performance of this specification are met and all UL listing of the equipment manufacturer are met.
2. External Devices (where specifically specified on plans): Surge Protective Devices shall be as manufactured by the distribution equipment manufacturer (Square D, etc.) or Surge Suppression Inc.

B. Each Surge Protective Device shall:

1. Be internal to the associated distribution equipment (without violating any applicable UL listings) unless specifically shown otherwise on plans.
2. Be UL 1449 (Latest Edition) listed.
3. Have short-circuit current rating complying with UL 1449 (Latest Edition), that matches or exceeds the short-circuit rating of the associated distribution equipment.
4. Be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115% of nominal RMS voltage.
5. Have fuses, rated at 200-kA interrupting capacity.
6. Have a minimum UL 1449 Nominal Discharge Current (I_n) Rating of 20kA.
7. Be fabricated using bolted compression lugs.
8. Provide suppression for seven (7) modes of protection.
9. Have LED indicator lights for power and protection status of each phase.
10. Have audible alarm, with silencing switch, to indicate when protection has failed.
11. Have form-C contacts rated at 2 A and 24-V ac minimum, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with facility monitoring and control system if monitoring by that system is required by plans or other specifications.

12. Have six-digit transient-event counter, mounted to front of equipment door, set to totalize transient surges (externally mounted SPD's may have the transient –event counter monted on the visible face of the SPD).
13. Meet all UL 96A requirements (for Lightning Protection Systems) where the device is installed at a service entrance of the facility. At a minimum, these devices shall:

    a. Be marked as Type 1 or Type 2 SPDs with product Identity consisting of "Surge Protective Device" or "SPD", and identifying all ratings so required by UL96A and the 4 digit alpha numeric Control Number.
    b. Have a minimum UL 1449 Nominal Discharge Current (I_n) Rating of 20kA.
    c. Be UL listed and labeled with holographic label.

C. Peak Single-Impulse Surge Current Rating shall be meet the following minimums unless specifically shown otherwise on plans:

Application	**Per Phase**	**Per Mode**
Service Entrance Devices	240 kA	120 kA
Downstream Devices	160 kA	80 kA

D. The ANSI/UL 1449 voltage protection rating (VPR) in grounded wye circuits, the SPDs shall not exceed the following:

Modes	**208Y/120V**	**480Y/277V**	**600Y/347V**
L-N,L-G, N-G	800	1200	1500
L-L	1200	2000	2500

E. The ANSI /UL 1449 VPR for 240/120 V, 3-wire or 4-wire circuits with high leg shall not exceed the following:

Modes	**240/120V**
L-N,L-G, N-G	1200/800

2.02 ENCLOSURES

A. Where external units are specifically specified on plans, units not mounted within electrical distribution equipment (such as switchboards, MCC's, etc.) shall be provided in enclosures with NEMA enclosure ratings that match or exceed the NEMA enclosure ratings of the equipment from which the units are fed. For example, a unit fed from a NEMA 4X stainless steel panelboard shall also be mounted within a NEMA 4X stainless steel enclosure.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All SPD's shall be integrally-mounted within the associated distribution equipment unless specifically shown otherwise on plans.

B. Install SPDs at service entrance on load side, with ground lead bonded to service entrance ground.

C. Install SPDs downstream of the service entrance with conductors or buses between suppressor and points of attachment as short and straight as possible. The lead lengths between the TVSS unit and the equipment being protected shall not exceed fourteen (14) inches without approval from the engineer. Do not bond neutral and ground. Leads shall be as straight as possible with no sharp bends.

D. Where externally-mounted SPD's are specifically shown on plans, provide circuit breaker as directed by the SPD supplier as a dedicated disconnecting means for SPD unless otherwise indicated.

3.02 FIELD QUALITY CONTROL

A. Ensure that interiors are free of foreign materials and dirt.

B. Check and test switches, pushbuttons, meters for proper operation.

C. Check and test indicating lights for proper operation and color.

D. Perform manufacturer's on site field test procedures.

3.03 STARTUP SERVICE

A. Do not perform insulation resistance (MEGGER) tests of the distribution wiring equipment with the SPDs installed. Disconnect all wires, including neutral, before conducting insulation resistance tests, and reconnect immediately after the testing is over.

3.04 SYSTEM WARRANTY

A. The SPD system manufacturer shall warranty the entire SPD system against defective materials and workmanship for a period of ten (10) years from the date of substantial completion. This warranty is in effect as long as the unit is installed in compliance with the manufacturer's installation, operation, and maintenance manual, UL Listing requirements, and any applicable national or local electrical codes.

B. Any SPD device which shows evidence of failure or incorrect operation, including damage as the result of lightning strikes, during the warranty period shall be replaced by the manufacturer at no charge to the owner. Warranty will provide for multiple exchanges of any inoperable devices at any time during the warranty period which starts at the date of substantial completion of the system to which the surge suppressor is installed.

C. The manufacturer is required to have a nationwide network of factory-authorized local service representatives for repair and service of this product. The manufacturer shall have a dedicated 1-800 telephone number for service problems and questions. This number shall be manned by a knowledgeable factory employee to ensure prompt response to any emergency situation that may arise.

END OF SECTION 26 43 00

SECTION 26 50 00
Lighting Materials And Methods

PART 1 - GENERAL

1.01 DESCRIPTION

A. Lighting Fixtures

B. Drivers

1.02 SUBMITTALS

A. Complete submittals shall be provided identifying all lighting fixture types and options, all lamp types (where applicable) and compliance with all contract requirements. The absence of clear submittal information specifically listing exceptions/deviations from detailed contract requirements will be understood to indicated that the contractor/supplier intends to meet all contract requirements. Refer to specification section 26 05 00 for additional requirements.

PART 2 - PRODUCTS

2.01 GENERAL

A. Lighting fixtures shall be furnished as shown on plans and specified herein. It shall specifically be the responsibility of Contractor to verify exact types ceilings, walls, etc. and recessing depth of all recessed fixtures and furnish the specific mounting trims and accessories of the specified and/or accepted fixture specifically for the ceiling, wall etc. in which each fixture is to be installed.

B. Base bid manufacturers are listed on the lighting fixture schedule. Manufacturers listed without accompanying catalog numbers are responsible for meeting the quality standards, efficiency, maximum wattages and photometric distributions set by the specified product.

C. All lighting fixtures shall be so designed and shall have drivers and other similar items so installed as to function without interruptions or failures when operating in the environment in which they are proposed to be installed. Special attention shall be given to environments with potentially high ambient temperatures such as attic spaces, exterior soffits, confined interior soffits, coves, unconditioned spaces, etc. and shall be addressed by providing fixtures with suitable high ambient temperature ratings, remote mounting of drivers/ballasts, providing approved ventilation, etc. as directed by fixture manufacturer and approved by engineer, at contractor's expense.

D. All fixtures installed such as to create penetrations through fire rated ceiling or wall assemblies shall be labeled as suitable for that purpose or installed with covers, tenting or other means as required to maintain the fire rating of the assembly.

2.02 LED LUMINAIRES

A. For the purpose of these specifications, LED Luminaires shall be defined as the entire LED fixture assembly including LED array, drivers, housing, electronics, etc. that compose the lighting fixture.

B. Furnish and install LED Luminaire of proper size, type, efficacy, delivered lumen output, color temperature, distribution pattern, operational life, and CRI as shown on drawings.

C. LED Luminaires shall be tested in accordance with LM-79 and LM-80 standards.

D. LED drivers shall comply with NEMA 410 standards for inrush current, etc.

E. Exterior, pole mounted LED Luminaires shall be provided with an easily-serviceable, UL recognized surge protection device that meets a minimum 10kA Category C Low operation (IECC C62.41.2-2002). Device shall be wired in front of light engine(s) and driver(s) and shall fail "open" such as to prevent fixture operation after a surge protection failure.

F. LED Luminaires shall have a guarantee-warranty of at least five years unless specifically noted otherwise on contract documents.

G. LED Luminaire assembly shall comply with ambient temperature requirements specified in General section above.

2.03 MANUFACTURER

A. Fixtures and stems shall be manufactured as shown in fixture schedule or approved equals.

B. Drivers shall be as manufactured by Philips/Advance, GE, Lutron, Magnatec, Motorola, EldoLED or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION OF LIGHTING FIXTURES

A. Support:

1. Support of all lighting fixtures shall be responsibility of electrical contractor. All lighting fixture supports shall be installed in accordance with lighting fixture supplier's recommendations.

B. Coordination:

1. Contractor shall coordinate all dimensions & locations of light fixtures prior to rough-in to ensure proper fit and coordination with other trades.
2. Contractor shall verify exact location of light fixture with Reflected Ceiling Plan. If there are any discrepancies, verify exact location with architect.
3. Contractor shall verify exact ceiling types being installed and shall adjust fixture trim types accordingly (prior to submitting light fixture shop drawings).

END OF SECTION 26 50 00

SECTION 27 05 00
Auxiliary System Cables, 0-50v

PART 1 - GENERAL

1.01 DESCRIPTION

A. Cables rated for 0V-50V application

PART 2 - PRODUCTS

2.01 GENERAL

A. Unless specified otherwise, all cables within the scope of this specification section shall:

1. Be rated for exposed cable tray installation.
2. Be plenum rated (Class 1 Control cabling and Instrumentation cabling installed in conduit or exposed in cable tray in non-plenum areas is not required to be plenum-rated).
3. Be UL-rated for the proposed application.
4. Be multi-conductor with overall outer sheath as required by the application. The insulation of each conductor within the overall multi-conductor cable shall be uniquely color-coded. Ground conductors (when provided) within the multi-conductor cable shall have green insulation. Conductors with green insulation shall not be used for conductors other than ground.
5. Utilize copper conductors.
6. Have wire gauge as required to limit voltage drop to acceptable limits determined by the system supplier and to meet all applicable code requirements.
7. Where installed underground, within slab-on-grade or in exterior locations, be rated for wet locations.
8. Where required for specific systems, meet the specific requirements (conductor quantity, wire gauge, insulation type, shielding, etc.) of the system supplier.

2.02 INSTRUMENTATION CABLING

A. In addition to above requirements, and unless specified otherwise, Instrumentation cabling shall:

1. Be #16awg minimum.
2. Be rated for 300V.
3. Have aluminum foil shielding.
4. Have stranded, twisted conductors.
5. Have PVC insulation/jacket with ripcord.
6. Be manufactured by Belden, AlphaWire or General Cable.

2.03 CLASS 1 CONTROL CABLING (120VAC CONTROL CIRCUITS, ETC.)

A. In addition to above requirements, and unless specified otherwise, Class 1 control cabling shall:

1. Be rated for 600V.
2. Be industrial grade.
3. Have stranded conductors.
4. Have sunlight/oil-resistant PVC/Nylon insulation and jacket with ripcord.
5. Be manufactured by Belden, AlphaWire or General Cable.

2.04 CLASS 2 & 3 CONTROL CABLING (FED FROM CLASS 2 OR 3 POWER SUPPLIES)

A. In addition to above requirements, and unless specified otherwise, Class 2 & 3 control cabling shall:

1. Be rated for 300V.
2. Be shielded if so recommended by the system supplier/integrator.
3. Have twisted conductors.
4. Have plenum-rated insulation/jacket with ripcord.
5. Be manufactured by AlphaWire, Belden, General Cable, Superior Essex or West Penn.

2.05 NETWORK CABLING

A. Furnish and install all Ethernet, Fiber Optic and Backbone Copper Telephone cabling in accordance with all BICSI requirements and in accordance with other applicable specification sections.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Routing:

1. All wires and cables shall be installed in conduit unless specifically noted otherwise. Where conduit is not otherwise required by contract documents, 0-50V Cabling located within concealed, accessible ceiling spaces (such as above lay-in ceilings) may be run without conduit if the following requirements are met:

   a. Cabling is plenum-rated, multi-conductor.
   b. Cabling is supported by cable tray or with J-hook supports on intervals not to exceed 5'-0" on center. Cabling shall be supported solely from the cable tray or j-hooks supported from the building structure, without using piping, ductwork, conduit or other items as supports.
   c. Cabling is neatly formed, bundled and tied with plenum-rated Velcro straps on intervals not to exceed 30" on center.
   d. Properly-sized conduit(s) are provided wherever cabling enters an inaccessible or exposed area (such as above gyp board ceilings, within walls or through walls).
   e. Cabling is not a part of a Fire Alarm System, Smoke Control System, Emergency Generator Control System or other life-safety related system.

2. End bushings shall be provided on both ends of all raceway terminations.

3. No splices shall be pulled into conduit.
4. No cabling shall be pulled until conduit is cleaned of all foreign matter.

B. Penetrations:

1. All fire/smoke barrier penetrations shall be made in accordance with a U.L. listed assembly.
2. For cabling not installed in conduit:

    a. Fire/smoke barrier penetrations shall be sealed utilizing an enclosed fire-rated pathway device (STI EZ Path or equal) containing a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed or retrofitted without the need to remove or reinstall firestop materials. The pathway shall be UL Classified and tested to the requirements of applicable ASTM/UL1479 standards.

3. For cabling installed within conduit from endpoint to endpoint:

    a. Fire/smoke barrier penetrations shall sealed utilizing fire caulk or other equivalent firestop systems around perimeters of conduits per UL requirements.

4. For cabling installed within cable trays:

    a. Fire/smoke barrier penetrations shall be sealed with one of the following methods:

        1) Continuous cable tray through the penetration, with a combination of large firestop pillows and small firestop pillows contained, supported and secured (to prevent unauthorized removal) on both sides by aluminum wire mesh and firestop putty. Firestop pillows shall be STI Series SSB or equal and Firestop putty shall be STI Spec Seal or equal.
        2) Cable tray broken at the penetration, with fire/smoke barrier penetrations sealed utilizing an enclosed fire-rated pathway device (STI EZ Path or equal) containing a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed or retrofitted without the need to remove or reinstall firestop materials. The pathway shall be UL Classified and tested to the requirements of applicable ASTM/UL1479 standards.

C. Excess Cabling:

1. Excess cabling shall be neatly coiled within all junction boxes, pullboxes, wireways, etc. and at all terminations as required to allow future re-termination of cabling.

D. Terminations:

1. All conductors/cabling (including spare conductors) shall be properly terminated unless specifically directed otherwise. See below for general termination hardware requirements.
2. Cabling shall be neatly formed, bundled and tied at all terminations.

3.02 SPLICES/CONNECTIONS/TERMINATIONS:

A. Network Cabling:

1. Network and fiber optic cabling shall be continuous from endpoint to endpoint and shall not be spliced unless specifically noted otherwise.

B. Control Cabling:

1. Connections shall be made with T & B Sta-Kon wire joints EPT66M, complete with insulating caps. To be installed with WT161 Tool or C nest of WT11M Tool, Ideal Super - Nuts (not wire nuts), Ideal Wing Nuts, or Buchanan Elec. Products B Cap or Series 2000 Pressure connectors complete with nylon snap on insulators to be installed with C24 pressure tool.

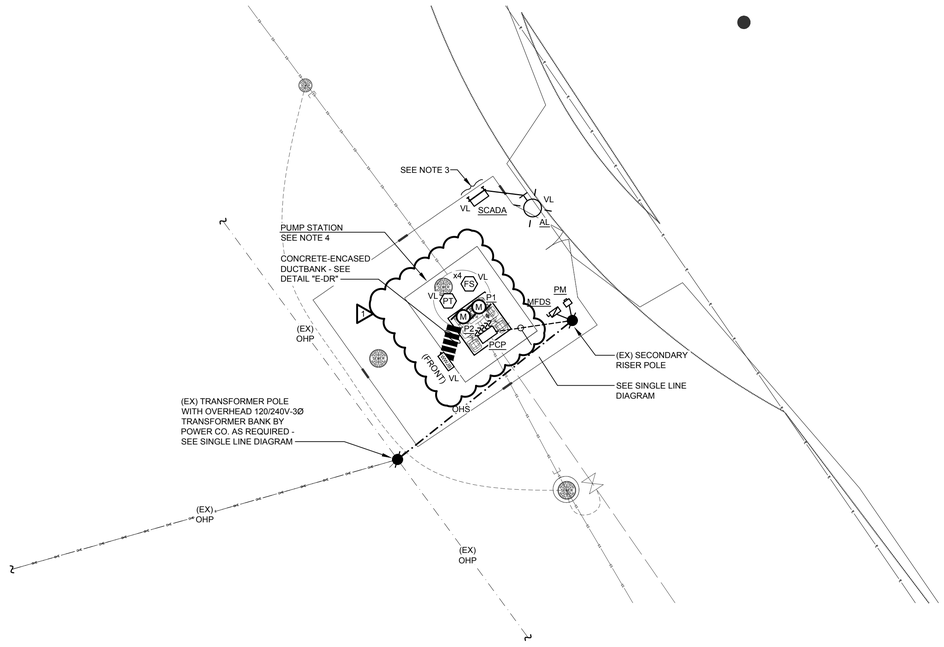
C. Shielded cabling:

1. Unless directed otherwise by the system supplier, 0-50V cable shielding shall be grounded at the PLC/control panel end only (not at the field device end) with a termination kit as directed by the PLC/control panel supplier.
2. Shielded cabling shall be continuous from endpoint to endpoint and shall not be spliced without prior written approval from the Engineer.

3.03 LABELING

A. Refer to Specification Section 26 05 53 for all labeling requirements.

END OF SECTION 27 05 00



N

LIFT STATION #1 (309 CRAIG IND. PARK) ELECTRICAL PLAN

SCALE : 1" = 10'-0"

PLAN ABBREVIATION LEGEND

AL	REMOTE ALARM LIGHT - MOUNT AT TOP OF EQUIPMENT STAND - SEE PUMP STATION WIRING DIAGRAM.
FS	WETWELL LEVEL (BACKUP) FLOAT SWITCHES - "x" REPRESENTS THE QUANTITY OF FLOAT SWITCH(ES) - VERIFY MOUNTING AND EXACT LOCATION WITH CIVIL ENGINEER PRIOR TO ROUGH-IN - SEE PUMP STATION WIRING DIAGRAM.
MFDS	MAIN FUSED DISCONNECT SWITCH -SEE SINGLE LINE DIAGRAM.
PCP	PUMP STATION CONTROL PANEL - SEE ASSOCIATED SINGLE LINE DIAGRAM & PUMP STATION WIRING DIAGRAM.
PM	POWER METER - AS DIRECTED BY POWER COMPANY.
PT	WETWELL LEVEL (PRIMARY) SUBMERSIBLE PRESSURE TRANSDUCER - VERIFY MOUNTING AND EXACT LOCATION WITH CIVIL ENGINEER PRIOR TO ROUGH-IN - SEE PUMP STATION WIRING DIAGRAM.
P1	PUMP NO. 1 - SEE PUMP STATION WIRING DIAGRAM FOR RATINGS.
P2	PUMP NO. 2 - SEE PUMP STATION WIRING DIAGRAM FOR RATINGS.
SCADA	SCADA RTU PANEL - SEE ASSOCIATED PUMP STATION WIRING DIAGRAM & SEPARATELY ENCLOSED CONTROL PANEL SCHEDULE.
WWJB	WETWELL JUNCTION BOX - SEE PUMP STATION WIRING DIAGRAM & DETAIL "E-WWJB".

NOTES THIS SHEET ONLY

1. THIS PLAN IS INTENDED TO SHOW ELECTRICAL EQUIPMENT/DEVICE LOCATIONS ONLY. REFER TO ASSOCIATED PUMP STATION WIRING DIAGRAM AND SINGLE LINE DIAGRAM FOR ALL SITE CIRCUITRY REQUIREMENTS, PUMP HP'S, STATION VOLTAGES, ETC.
2. VERIFY EXACT LOCATIONS OF WETWELL LEVEL SENSING DEVICES, SITE LIGHTING, ETC. WITH OWNER & CIVIL ENGINEER PRIOR TO ROUGH-IN.
3. EQUIPMENT STAND - SEE DETAIL "E-ES" FOR ADDITIONAL REQUIREMENTS.
4. PUMP STATION SHALL BE FURNISHED AS A PRE-WIRED ASSEMBLY COMPLETE WITH MAIN BREAKER, PUMP CONTROL PANEL (WITH 120/240V-3Ø DISTRIBUTION AND INTEGRAL 120/240V-1Ø-3W LOAD CENTER), PUMP STARTERS, ASSOCIATED FEEDERS, LIGHTING, RECEPTACLES, PROCESS INTERCONNECTIONS, BRANCH CIRCUITRY, HEATING, HEAT TRACING, FLOAT SWITCHES, LEVEL TRANSDUCER, TWO (2) PUMP MOTORS, HVAC, ETC. (PRE-WIRED BY PUMP STATION SUPPLIER) IN ACCORDANCE WITH DIV. 26/27 SPECIFICATIONS, NEC & NFPA 820 REQUIREMENTS.

REVISIONS

#	DESCRIPTION	DATE	BY
1	ADDENDUM 3 CHANGES/ADDITIONS	2/11/2026	PDB
2			
3			
4			
5			
6			

LS1 @ 309 CRAIG IND. PARK ELECTRICAL PLAN

PROPOSED SEWER UPGRADES - CONTRACT 1
DALLAS COUNTY WATER & SEWER AUTHORITY
DALLAS COUNTY
ALABAMA

THE KELLEY GROUP
• A CIVIL ENGINEERING COMPANY •
800 Corporate Pwky, Suite 100 301 N Dickson St.
Birmingham, Alabama 35242 Tuscumbia, Alabama 35674

ATTENTION:
THIS BAR = 1 INCH ON ORIGINAL DRAWING. ADJUST SCALE IF THIS BAR ≠ 1 INCH.

1"

ALABAMA LICENSED No. 27420 PROFESSIONAL ENGINEER PHILLIP D. BLACK
2/11/2026

PROJECT NO: 220031
DRAWN BY: RGN
CHECKED BY: PDB
SCALE: AS NOTED
DATE: 12/2025

JACKSON, RENFRO & ASSOCIATES, INC.
ELECTRICAL ENGINEERING & DESIGN
31 INVERNESS CENTER PKWY • SUITE 300
BIRMINGHAM, ALABAMA • 35242
PHIL BLACK, PE
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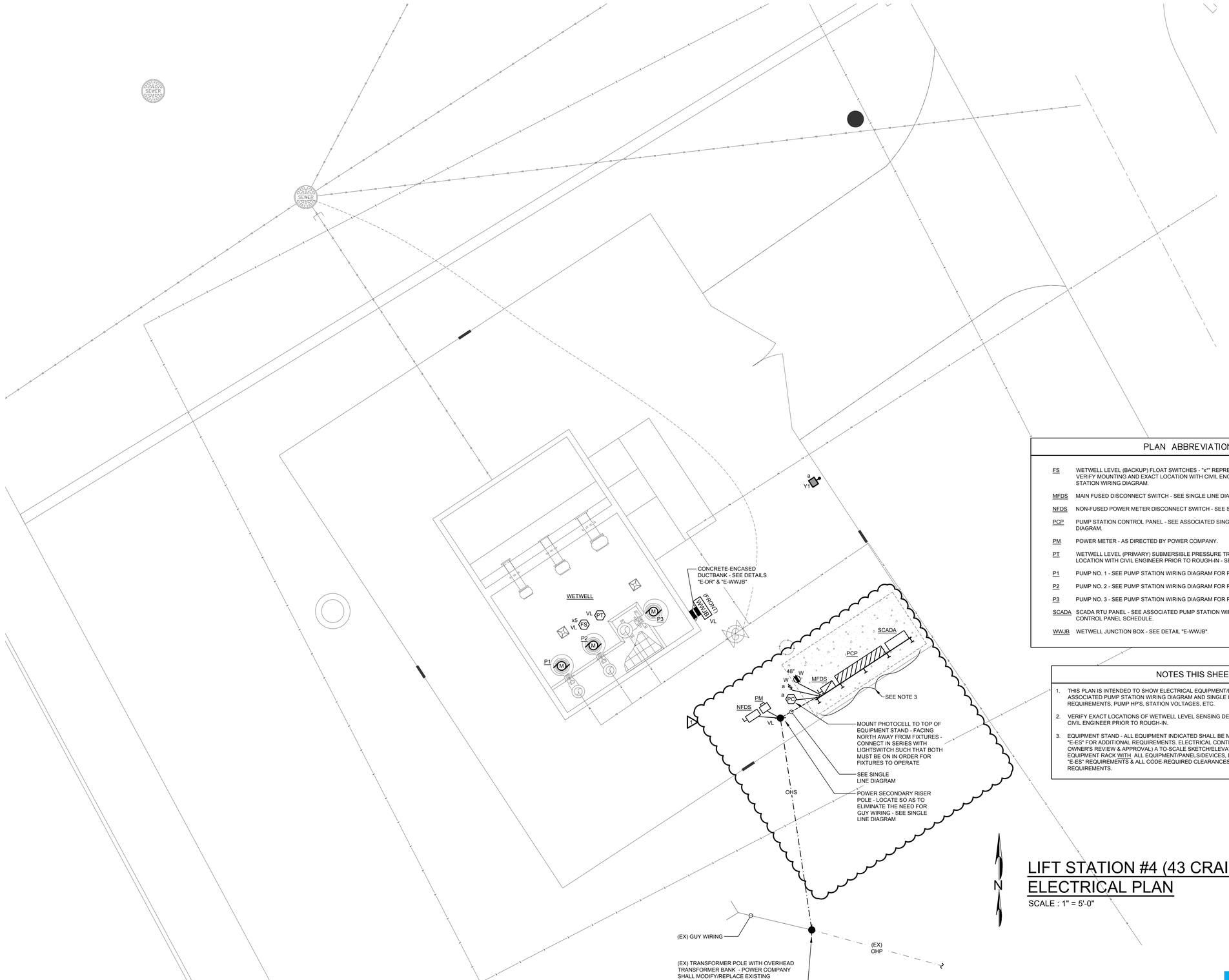
(D) 205.536.7120
(P) 205.995.1078
JRA JOB NO. 225180

SHEET NO.
E5



PLAN ABBREVIATION LEGEND

FS	WETWELL LEVEL (BACKUP) FLOAT SWITCHES - "x" REPRESENTS THE QUANTITY OF FLOAT SWITCH(ES) - VERIFY MOUNTING AND EXACT LOCATION WITH CIVIL ENGINEER PRIOR TO ROUGH-IN - SEE PUMP STATION WIRING DIAGRAM.
MFDS	MAIN FUSED DISCONNECT SWITCH - SEE SINGLE LINE DIAGRAM.
NFDS	NON-FUSED POWER METER DISCONNECT SWITCH - SEE SINGLE LINE DIAGRAM.
PCP	PUMP STATION CONTROL PANEL - SEE ASSOCIATED SINGLE LINE DIAGRAM & PUMP STATION WIRING DIAGRAM.
PM	POWER METER - AS DIRECTED BY POWER COMPANY.
PT	WETWELL LEVEL (PRIMARY) SUBMERSIBLE PRESSURE TRANSDUCER - VERIFY MOUNTING AND EXACT LOCATION WITH CIVIL ENGINEER PRIOR TO ROUGH-IN - SEE PUMP STATION WIRING DIAGRAM.
P1	PUMP NO. 1 - SEE PUMP STATION WIRING DIAGRAM FOR RATINGS.
P2	PUMP NO. 2 - SEE PUMP STATION WIRING DIAGRAM FOR RATINGS.
P3	PUMP NO. 3 - SEE PUMP STATION WIRING DIAGRAM FOR RATINGS.
SCADA	SCADA RTU PANEL - SEE ASSOCIATED PUMP STATION WIRING DIAGRAM & SEPARATELY ENCLOSED CONTROL PANEL SCHEDULE.
WWJB	WETWELL JUNCTION BOX - SEE DETAIL "E-WWJB".

NOTES THIS SHEET ONLY

1. THIS PLAN IS INTENDED TO SHOW ELECTRICAL EQUIPMENT/DEVICE LOCATIONS ONLY. REFER TO ASSOCIATED PUMP STATION WIRING DIAGRAM AND SINGLE LINE DIAGRAM FOR ALL SITE CIRCUITRY REQUIREMENTS, PUMP HP'S, STATION VOLTAGES, ETC.
2. VERIFY EXACT LOCATIONS OF WETWELL LEVEL SENSING DEVICES, SITE LIGHTING, ETC. WITH OWNER & CIVIL ENGINEER PRIOR TO ROUGH-IN.
3. EQUIPMENT STAND - ALL EQUIPMENT INDICATED SHALL BE MOUNTED TO EQUIPMENT STAND - SEE DETAIL "E-ES" FOR ADDITIONAL REQUIREMENTS. ELECTRICAL CONTRACTOR SHALL SUBMIT (FOR ENGINEER'S & OWNER'S REVIEW & APPROVAL) A TO-SCALE SKETCH/ELEVATION OF THE PROPOSED LAYOUT OF THIS EQUIPMENT RACK WITH ALL EQUIPMENT/PANELS/DEVICES, DEMONSTRATING COMPLIANCE WITH DETAIL "E-ES" REQUIREMENTS & ALL CODE-REQUIRED CLEARANCES. SEE SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS.

LIFT STATION #4 (43 CRAIG IND. PARK) ELECTRICAL PLAN

SCALE : 1" = 5'-0"

REVISIONS

#	DESCRIPTION	DATE	BY
1	ADDENDUM 3 CHANGES/ADDITIONS	2/11/2026	PDB
2			
3			
4			
5			
6			

LS4 @ 43 CRAIG IND. PARK ELECTRICAL PLAN

PROPOSED SEWER UPGRADES - CONTRACT 1

DALLAS COUNTY WATER & SEWER AUTHORITY

DALLAS COUNTY

ALABAMA

THE KELLEY GROUP
- A CIVIL ENGINEERING COMPANY -
800 Corporate Pwky, Suite 100 Birmingham, Alabama 35242
301 N Dickson St, Tuscumbia, Alabama 35674

ATTENTION:
THIS BAR = 1 INCH ON ORIGINAL DRAWING. ADJUST SCALE IF THIS BAR ≠ 1 INCH.

1"

PROJECT NO: 220031
DRAWN BY: RGN
CHECKED BY: PDB
SCALE: AS NOTED
DATE: 12/2025

ALABAMA LICENSED No. 27420 PROFESSIONAL ENGINEER PHILIP D. BLACK

2/11/2026

JACKSON, RENFRO & ASSOCIATES, INC.
ELECTRICAL ENGINEERING & DESIGN
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SHEET NO.
E13