ADDENDUM NO. 1

TO CONTRACT DOCUMENTS FOR THE
IRRIGATION QUALITY 511 (IQ-511) PUMP STATION PIPING IMPROVEMENTS

January 11, 2021

TO ALL PROSPECTIVE BIDDERS AND OTHER CONCERNED:

Contractor's submitting proposals for the above-referenced project shall take note of the following changes, additions, deletions, clarifications, etc., to the Plans and Specifications which in accordance with the Contract Documents shall become a part of and have precedence over anything shown or described otherwise.

NOTE: Bidders must acknowledge receipt of all addenda on the Bid Proposal Form – Article 2 (Page 17) of the Contract Documents.

Issued by:

BAXTER & WOODMAN, INC.

PLEASE ACKNOWLDEGE RECEIPT OF **ADDENDUM NO. 1** BY SIGNING BELOW and emailing to jhiscock@baxterwoodman.com AS SOON AS POSSIBLE.

_____
Planholder

_____
By

_____
Date

ADDENDUM NO. 1
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IRRIGATION QUALITY 511 (IQ-511) PUMP STATION PIPING IMPROVEMENTS
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GENERAL

A. The minutes of the pre-bid conference are attached and are hereby made a part of the Contract Documents.

B. Attached for your records is a copy of the pre-bid meeting attendees list.

REVISIONS TO FRONT-END DOCUMENTS

A. INSTRUCTIONS TO BIDDERS – Article 1

1. Revise Section 1 n. as follows:

   n. "Engineer" shall mean the engineer designated by the District as its engineering representative during the course of construction to make appropriate inspection and computation of payments, whether acting directly or through properly authorized agents, inspectors or representatives of the Engineer, acting within the scope of duties entrusted to them. ~~The Engineer may or may not be an employee of the District.~~ **The Engineer on this project is Baxter & Woodman, Inc.**

B. SPECIAL CONDITIONS – Article 9

1. Revise 9.33 Permits as follows:

   9.33 Permits

   Unless otherwise identified in Section ~~01000~~ **01010** of the Technical Specifications, Contractor shall be responsible for obtaining any and all permits (i.e. building permits) necessary for the Work under this Contract and pay the costs thereof, said permits may be included as part of the Contract Documents. If differences between the specifications and conditions of the permits exist, the permits shall govern.

REVISIONS TO TECHNICAL SPECIFICATIONS

A. Revise Inside Cover as follows:

CONTRACT DOCUMETNS AND TECHNICAL SPECIFICATIONS FOR IRRIGATION ~~QUALIY~~ **QUALITY** 511 (IQ-511_ PUMP STATION PIPING IMPROVEMENTS

B. Technical Specification Section 01025 entitled "Measurement and Payment"

1. Revise Item 1.01 E. as follows:

E. All required manufacturer testing and certification shall be included in the unit prices shown in the proposal and Contract. Density testing required for compacted backfilling, and concrete strength and materials testing required at the time of construction shall be arranged for by Contractor and paid for by the ~~District~~ **Contractor** . Water quality monitoring testing required for the dewatering permit shall be arranged for by the Contractor and paid for by the ~~District~~ **Contractor**.

C. Technical Specification Section 13300 entitled "Instrumentation and Controls"
1. Replace Technical Specification Section 13300 entitled "Instrumentation and Controls" in its entirety with the updated Technical Specification Section 13300 included with this Addendum No. 1.

D. Technical Specification Section 16010 entitled "Basic Electrical Requirements"
1. Replace Technical Specification Section 16010 entitled "Basic Electrical Requirements" in its entirety with the updated Technical Specification Section 16010 included with this Addendum No. 1.

E. Technical Specification Section 16050 entitled "Basic Wiring and Methods"
1. Replace Technical Specification Section 16050 entitled "Basic Wiring and Methods" in its entirety with the updated Technical Specification Section 16050 included with this Addendum No. 1.

F. Technical Specification Section 16110 entitled "Raceway"
1. Replace Technical Specification Section 16110 entitled "Raceway" in its entirety with the updated Technical Specification Section 16110 included with this Addendum No. 1.

G. Technical Specification Section 16120 entitled "Conductors"
1. Replace Technical Specification Section 16120 entitled "Conductors" in its entirety with the updated Technical Specification Section 16120 included with this Addendum No. 1.

H. Technical Specification Section 16450 entitled "Grounding"
1. Replace Technical Specification Section 16450 entitled "Grounding" in its entirety with the updated Technical Specification Section 16450 included with this Addendum No. 1.

I. Technical Specification Section 16500 entitled "Lighting"
   1. Replace Technical Specification Section 16500 entitled "Lighting" in its entirety with the updated Technical Specification Section 16500 included with this Addendum No. 1.

CONTRACTOR QUESTIONS/COMMENTS THAT HAVE BEEN SENT TO ENGINEER

1. Question/Comment:

   What is the Engineer/Budget/Project Estimate?

   Response:

   $475,000

2. Question/Comment:

   Why are the Plans & Specs for this bid, (found on your website), Not called what your bid is but called another bid's name?

   Response:

   The correct plans and contract book for this project have been uploaded to the District's website.

3. Question/Comment:

   Please send all of us Instructions/Invite on Attending the Virtual Pre-Bid on 01/05/2021 @ 2PM

   Response:

   Invitations were sent for the virtual pre-bid meeting. The virtual link for the bid opening will be available on the District's website.

4. Question/Comment:

   What is the Site Location Address?

   Response:

   2500 Jupiter Park Drive, Jupiter, FL 33458

5. Question/Comment:

   Do we send Question to you or to the Engineer? If it is to the Engineer, What is his Name, Phone #, & E-mail?

Response:

Please send all questions to the District's Purchasing Agent:

Hazel Figureoa
Purchasing Agent
Loxahatchee River Environmental Control District
2500 Jupiter Park Drive
Jupiter, FL 33458
Phone: 561-401-4026
Email: hazel.figueroa@lrecd.org

The Engineer's contact information is as follows:

Jeffrey Hiscock, P.E.
Baxter & Woodman, Inc.
Phone: 561-425-7760
Email: jhiscock@baxterwoodman.com

6. Question/Comment:

On drawing I-2, PE/LT-0003 and PE/LT-0004 are shown to be provided new by the I&C supplier. The specification does not list a spec for these level instruments. Please provide.

Response:

Please refer to updated Technical Specification Section 13300 included with this Addendum No. 1.

7. Question/Comment:

Is COI required for this project?
If so what name should we use: Loxahatchee River Environmental District or just Loxahatchee River District?

Response:

Please read Section 9.08 for insurance requirements. The District's legal name is "Loxahatchee River Environmental Control District."

LOXAHATCHEE RIVER ENVIRONMENTAL CONTROL DISTRICT

Irrigation Quality 511 (IQ-511)
Pump Station Piping Improvements
PRE-BID CONFERENCE MINUTES
(2:00 P.M.; JANUARY 5, 2021)

Introductions:

Kris Dean, P.E. – Deputy Director & Director of Engineering at Loxahatchee River Environmental Control District
Kara Fraraccio, C.P.A – Director of Finance and Administration at Loxahatchee River Environmental Control District
Jeffrey Hiscock, P.E. – Project Manager at Baxter & Woodman
Courtney Marshall, P.E. – Project Engineer at Baxter & Woodman
Kaitlin Kublank, P.E. – Project Engineer at Baxter & Woodman

1. Purpose of Pre-Bid Meeting:

This pre-bid meeting has been scheduled to acquaint the prime contractors and others with the bid documents for the Irrigation Quality 511 (IQ-511) Pump Station Piping Improvements project. Baxter & Woodman, is the Engineer of Record for the project. Hillers Eclectic Engineers are also on the design team. Loxahatchee River Environmental Control District (District) is the Owner.

Baxter & Woodman will provide construction administration and part-time inspection services for the Project. A District field representative will also be visiting the site.

2. Interpretation of Addenda:

When questions raised are deemed appropriate by the Engineer, in its sole discretion, they shall be answered in the form of Addenda. **No oral answers to questions will be given.** All Addenda so issued shall become a part of the Contract Documents and must be acknowledged. To receive consideration, such questions shall be submitted in writing to the District/Engineer not less than ten (10) calendar days before the established date for the opening of Bids. Therefore, all questions need to be submitted to the District/Engineer prior to close of business on Friday, January 9, 2020.

Jeffrey Hiscock indicated that an addendum with answers to all questions will be issued after the deadline.

3. Scope of Project:

The total work for the Irrigation Quality 511 (IQ-511) Pump Station Piping Improvements consists of furnishing all labor, materials, equipment and all incidentals and appurtenances for the installation of approximately 75 LF of 36-inch DIP reclaimed water main, bypass influent bay structure, connection to the existing wet well at the IQ-511 pump station and improvements at Diversion Structure "B" including replacement of a sluice gate, pedestal, stem cover, lighting and the addition of an electric actuator with associated power and controls. The affected roadway shall be milled and overlaid. Construction also includes dewatering, testing and all restoration work for a complete and operating system. The work will be on private property owned by the District.
Estimated quantities are shown on the Bid Form of the Front-Ends.

Jeffrey Hiscock elaborated on the scope by presenting the Site Plan (Sheet 4 of 20 of the Drawings) and explained the purpose of the project and how the proposed improvements will work with the existing pipe system connecting the existing stabilization ponds to the pump station.

4. Permits:

The following permits will be secured by LRECD:

- PBCHD – Minor Revision to a Wastewater Facility or Activity Permit. **(Not required)**
- FDEP **(Pending)**

The Contractor will need to secure a NPDES permit (if required), a dewatering permit from SFWMD and a Building permit from the Town of Jupiter. Contractor to pay all permit fees.

Jeffrey Hiscock explained that the County Health Department indicated that a permit was not required, but forwarded the request to FDEP which has not indicated yet if they will require a permit. This may be addressed on the upcoming addendum.

5. Project Schedule:

Bids are to be submitted by 2:00 PM local time on January 19, 2021, with the bond submitted by 2:00 PM local time on January 21, 2021. Bids will be opened on January 21, 2021 at 2:00 P.M. at the office of the Loxahatchee River District, 2500 Jupiter Park Drive, Florida. Substantial Completion shall be achieved within 120 consecutive calendar days from the date of NTP. Final Completion shall be achieved within 95 consecutive calendar days from the date of actual Substantial Completion.

Contractor shall pay to the District as LD's, and not as a penalty, $500.00 per day for each and every calendar day Substantial Completion is delayed.

If Final Completion is not reached within 95 days of actual Substantial Completion, Contractor shall pay to the District as LD's, and not as a penalty, $150.00 per day for each and every calendar day Final Completion is delayed.

6. Experience Questionnaire:

A questionnaire is included in the Proposal section (Article 2a) that must be filled out and submitted with your Bid. Failure to submit this completed questionnaire could result in your bid being non-responsive. Don't wait until the last minute to try and fill this out, it is extensive. Also, the project experience needs to be listed for the Prime Contractor and not Sub-Contractors.

7. Sub-Contractors:

The amount of subcontract work shall not exceed sixty percent (60%) of the Work. The bid proposal requires that all sub-contractors be identified.

8. Bid Security:

A copy of the Bid Bond or Certified Check in the amount of 10% of the total bid price must be submitted with the bid and a hard copy submitted by 2:00 PM local time on January 21, 2021. Refer to Bid Security – Article 3 of the Front-End Documents.

9. Examination of Site:

Each bidder is responsible for necessary site investigations to determine all above ground conditions and sub-surface conditions and the facilities needed to execute the work in accordance with the Contract Documents.

All potential bidders should inspect the project site before preparing and submitting their bid package. **To gain access to the site, bidders need to contact the District at (561) 747-5700.**

10. Bid Proposal:

Contract Price is based on unit price total of bid items 1- 20. Each pay item is defined in Specification Section 01025 "Measurement and Payment".

11. Pre-Construction Conference:

Pre-construction meeting will be held immediately upon execution of the Contract by the District.

12. Existing Utilities:

Contractor is fully responsible for coordination of <u>all</u> utility companies (e.g. FP&L, AT&T, Natural Gas, Cable TV, traffic signal communication, etc.) and for repairing, at no expense to the District, utilities damaged during construction. This includes pot-holing conflicts as required by the Contract Documents.

13. Key Concerns:

- Access to District facilities must be provided at all times to the District.

- Down time of IQ-511 pump station must be minimized. Connection from new influent bay to wet well must be done quickly. All work essential to the function of the pump station (sluice gate, reclaimed water main and influent bay) needs to be completed prior to this final connection to minimize downtime.

- Contractor will be responsible for complying with local noise ordinances. Sound attenuating enclosures and devices shall be supplied on all construction equipment, as required to comply.

- Contractor is responsible for obtaining a staging area as well as any access/land use agreements required to perform the work. Contractor shall coordinate with the District on staging area limits within the work site.

  Kris Dean indicated that a staging area can be provided onsite.

- Contractor will be required to clean-up work areas and remove trash daily.

- Construction trailer is not required.

- Construction Inspections:

  Baxter & Woodman will provide part-time construction inspector for the duration of the project.

  The District will provide part-time construction inspector for the duration of the project.

- All areas shall be restored to match existing.

- Updated as-built shop drawings shall be submitted by Contractor each month with payment request.

- All sod disturbed during construction will be replaced in kind.

  Kris Dean indicated that no irrigation lines are in this area.

- All bidders are required to submit corporate financial information as outlined in Article 2 of the Proposal document which is entitled "Condensed Current Financial Statement". Alternatively, bidders may submit a full Financial Statement. A balance sheet will not be permitted in lieu.

- The Engineer's Estimate for the project is $475,000.

No Questions were asked at the meeting. Kris Dean provided some information as follows:

- **Notice to Proceed will be issued on a mutually agreed upon date within 180 days of the Contract Award.**

- **All bidders are required to submit their OSHA Form 300A and Experience Modification Rating letter as outlined in Article 2, Paragraph 25 – Health, Safety and Environmental Performance.**

- **All bidders shall be familiar with the requirements of Article 2, Paragraph 26. The Contractor Evaluation Report is recorded for every District project. Previous experience on District projects used for future awards**

- **All bidders are required to provide the minimum insurance amounts as outlined in Article 9, Paragraph 9.08 – Contractor Insurance.**

- **Bids will be opened in the District's board room. Bid opening can be attended either in-person or remotely via GoToWebinar. A link to GoToWebinar will be posted on the District's website the day of the Bid Opening.**

Loxahatchee River Environmental Control District

IRRIGATION QUALITY 511 (IQ-511)
PUMP STATION PIPING IMPROVEMENTS

PRE-BID MEETING – 2:00 P.M.; JANUARY 5, 2021

Sign-In Sheet

Name	Company	Phone Number	Email
Kara Fraraccio	Loxahatchee River Environmental Control District	561-747-5700	Kara.fraraccio@lrecd.org
Hazel Figueroa	Loxahatchee River Environmental Control District	561-747-5700	Hazel.figueroa@lrecd.org
Kris Dean	Loxahatchee River Environmental Control District	561-747-5700	Kris.dean@lrecd.org
Jeffrey Hiscock	Baxter & Woodman	561-425-7760	jhiscock@baxterwoodman.com
Kaitlin Kublank	Baxter & Woodman	815-459-1260	kkublank@baxterwoodman.com
Greg Doan	TLC Diversified	941-722-0621	gdoan@tlcdiversified.com
Bert Jaimes	Felix Associates	772-220-2728	bjaimes@felixassociates.net
Shelley McDougle	Intercounty Engineering, Inc.	954-972-9800	smcdougle@intercountyengineering.com
Carl Morsch	Man-Con, Inc.	954-427-0230	carlm@mancon.ws

Loxahatchee River Environmental Control District

IRRIGATION QUALITY 511 (IQ-511)
PUMP STATION PIPING IMPROVEMENTS

PRE-BID MEETING – 2:00 P.M.; JANUARY 5, 2021

Sign-In Sheet

Name	Company	Phone Number	Email
Rafael Vega	Ric-Man Construction Florida	954-426-1221	rvega@ric-manfl.com
Kevin Schwiderson	Foster Marine Contractor	561-683-0034	kevin@foster-marine.net
Doug Wyckoff	Holland Pump	321-297-6372	dougw@hollandpump.com

SECTION 13300
INSTRUMENTATION AND CONTROLS

PART 1 – GENERAL

1.01 SUMMARY

A. The Contractor shall furnish, install and place into service operating process instrumentation, control systems and panels including accessories, related to the IQ-511 Bypass Piping system, all as shown on plans and specified herein.

1. Modify existing PLC/RIO panel located at the Electrical Room No.2 and add new input/output (I/O) signals using existing spare I/O points and add new I/O module as shown. Field verify spare I/O points location and adjust accordingly. Make all necessary modifications, terminations, etc. for a complete and working PLC system in place.

2. Furnish and install new level instruments, mounting brackets, junction boxes, etc. as shown on drawings and as specified in this specification complete in place.

3. See electrical drawings and specifications for additional work required of the instrument contractor and for relocation and modification instructions for equipment not necessarily shown on the instrument drawings.

4. The Contractor shall modify existing plant PLC/RIO and SCADA programs to include new control strategy as describes in section 2.12 of this specification. Coordinate with District to obtain the latest copy for the existing plant PLC and IQ pump station PLC program and modify as required by this project. Contractor shall modify the existing Plant SCADA system to add new information and control relating to this project. The existing SCADA system is VTSCADA system and will have enough spare points for this project.

B. Work Includes: Engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and District training for a complete Instrumentation and Control System.

Major parts are:

1. Modification of existing PLC/RIO panel at Electrical Room No.2

2. Start-up and testing of new I/O points and control strategy.

C. Instrument and Control (I&C) Supplier work scope:

1. For I&C equipment and ancillaries provide the following:

a. Completing detail design.

b. Required Submittals.

c. Equipment and ancillaries.

d. Instructions, details, and recommendations to, and coordination with, Contractor for proper installation.

e. Verify readiness for operation.

f. Verify the correctness of final power and signal connections.

g. Adjusting and calibrating.

h. Starting up.

i. Testing and coordination of testing.

j. Training.

k. Specifications/documents including: System External Specification, System Internal Specification, I/O Checklist, Site Acceptance Test Plan.

l. Loop checks.

m. As-built documentation for I/O added to the existing system.

2. Verify the following work, not by I&C Supplier, is provided:

a. Correct type, size, and number of signal wires with their raceways.

b. Correct electrical power circuits and raceways.

c. Correct size, type, and number of I&C related pipes, valves, fittings, and tubes.

d. Correct size, type, materials, and connection of process mechanical piping for in-line primary elements.

3. For equipment not provided under I&C Supplier, but directly connected to equipment required by I&C Supplier:

a. Obtain from Contractor, manufacturer's information on installation, interface, function, and adjustment.

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

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

d. Test to demonstrate required interface and operation with existing Plant PLC System.

e. Examples of items in this category, but not limited to the following:

1) Motorized valves.

f. Examples of items not in this category:

1) Internal portions of equipment provided under Division 16, Electrical, that are not directly connected to equipment under I&C System.

2) Internal portions of I&C Systems provided as part of package systems and that are not directly connected to equipment provided under I&C System.

4. Wiring external to equipment provided by I&C Supplier:

a. Special control and communications cable such as fiber optic cable: Provided by I&C Supplier.

D. Software Engineering work scope:

1. I&C contractor shall perform the programming of the IQ-511 Bypass system control in the existing PLC system as well as the SCADA system.

2. Start-up support, including system testing and loop checks.

3. System training.

1.02 SINGLE INSTRUMENT SUPPLIER

A. The Contractor shall assign to the Single Instrument and Control (I&C) supplier full responsibility for the functional operation of all new instrumentation systems. The Contractor shall have said supplier perform all engineering necessary in order to select, to furnish, to program, to supervise installation, connection, to calibrate, to place into operation of all sensors, instruments, alarm equipment, control panels, accessories, and all other equipment as specified herein. The I&C supplier shall have a maintenance office within a 150 mile radius of the project.

B. The single instrument and controls supplier shall demonstrate his ability to successfully complete projects of similar sizes and nature. Provide references (including phone number and contact name) for at least three projects successfully completed in which the following tasks were performed: system engineering, documentation including panel assembly, schematics and wiring diagram, programming, field testing, calibration and start-up, operator instruction and maintenance training.

C. The foregoing shall enable the Contractor and the District to be assured that the full responsibility for the requirements of this Section shall reside in an organization which is qualified and experienced in the water management field and its process technology on a functional systems basis.

D. The single I&C supplier shall have a UL approved shop and shall build all panels according to UL 508A.

1.03 INSTALLATION WORK

A. Manufacturer's organization, or any division thereof, to accomplish the physical installation of any elements, instruments, accessories or assemblies specified herein. However, the Contractor shall employ installers who are skilled and experienced in the installation and connection of all elements, instruments, accessories and assemblies; portions of their work shall be supervised or checked as specified in Part 3, herein.

1.04 PREPARATION OF SUBMITTAL OF DRAWINGS AND DATA

A. It is incumbent upon the Contractor to coordinate the work specified in these Sections so that a complete well I&C system shall be provided and shall be supported by accurate Shop and record Drawings. As a part of the responsibility as assigned by the Contractor, the Single I&C supplier shall prepare and submit through the Contractor, complete organized Shop Drawings, as specified in Part 2.02, herein. Interface between instruments, motor starters, etc. shall be included in his Shop Drawing submittal.

B. During the period of preparation of this submittal, the Contractor shall authorize direct, informal liaison between his Single I&C supplier and the Engineer for exchange of technical information. As a result of this liaison, the Engineer may authorize certain minor refinements and revisions in the systems as specified informally, but these shall not alter the scope of work or cause increase or decrease in the Contract Price. During this informal exchange, no oral statement by the Engineer shall be construed to give formal approval of any component or method, nor shall any statement be construed to grant formal exception to, or variation from these Specifications.

1.05 ADDITIONAL TECHNICAL SERVICES

A. At no separate additional cost to the District, the Contractor shall provide the following services of qualified technical representatives of the Single I&C supplier (See Part 3, herein).

1. To supervise installation and connection of all instruments, elements, and components of every system, including connection of instrument signals to primary measurement elements and to final control elements such as pumps, valves, and chemical feeders;

2. To make all necessary adjustments, calibrations and tests; and

3. To instruct plant operating and maintenance personnel on instrumentation. This time shall be in addition to whatever time is required for other facets of work at the site, and shall be during the District's normal working days and hours.

1.06 GUARANTEE

A. The Contractor shall guarantee all equipment and installation, as specified herein, for a period of one (1) year following the date of completion of the work. To fulfill this obligation, the Contractor shall utilize technical service personnel designated by the Single I&C supplier to which the Contractor originally assigned project responsibility for instrumentation. Services shall be performed within two (2) calendar days after notification by the District.

1.07 ADDITIONAL PROVISIONS

A. The applicable provisions of the following Sections under Electrical Work shall apply to work and equipment specified herein, the same as if stated in full, herein:

1. Codes and Standards

2. Equipment, Materials and Workmanship

3. Testing

4. Grounding

5. Equipment Anchoring

6. Conductor and Equipment Identification

7. Terminal Cabinets and Control Compartments

8. Process Control Devices

1.08 NEWEST MODEL COMPONENTS

A. All meters, instruments, and other components shall be the most recent field proven models marketed by their manufacturers at the time of submittal of Shop Drawings unless otherwise specified to match existing equipment. All technical data publications

included with submittals shall be the most recent issue.

1.09 INSPECTION OF THE SITE AND EXISTING CONDITIONS

A. The instrumentation drawings were developed from past record drawings and information supplied by the District.

B. Before submitting a bid, visit the site and determine conditions at the site and at all existing structures in order to become familiar with all existing conditions and instrumentation and control systems which will, in any way or manner, affect the work required under this Contract. No subsequent increase in Contract cost will be allowed for additional work required because of the Contractor's failure to fulfill this requirement.

1.10 RELATED WORK

A. Division 16 – Electrical

PART 2 - PRODUCTS

2.01 INSTRUMENTATION CRITERIA

A. DESIGNATION OF COMPONENTS:

In these Specifications and on the Drawings, all systems, meters, instruments, and other elements are represented schematically, and are designated by numbers, as derived from criteria in Instrument Society of American Standard ANSI/ISA S5.1-1973. The nomenclature and numbers designated herein and on the Drawings shall be employed exclusively throughout Shop Drawings, data sheets, and similar materials. Any other symbols, designations, and nomenclature unique to the manufacturers standard methods shall not replace these prescribed above, used, herein and on the Drawings. Existing PLC system at this site are Allen-Bradley Controllogix PLC family. Existing spare I/O points will be used for new signals to be added under this Contract. Contractor shall modify the existing PLC panel and add all necessary relays, surge suppressors, terminal blocks, fuses, etc. for a complete and functional PLC system.

2.02 DETAILED SYSTEMS DRAWINGS AND DATA

A. CONTENT:

The Contractor shall submit detailed Shop Drawings and data prepared and organized by the Single I&C supplier designated at the time of bidding. The quantity of submittal sets required shall be six (6). These Drawings and data shall be submitted as a complete bound package at one time within 80 calendar days after date of Notice to Proceed and shall include:

1. Drawings showing definite diagrams for every instrumentation loop system. These

diagrams shall show and identify each component of each loop or system using legend and symbols from ISA Standard S5.4, each having the format of ISA Standard S5.1 as used on the Project Drawing. (Each system or loop diagram shall be drawn on a separate Drawing sheet.)

2. Data sheets for each component, together with a technical product brochure or bulletin. The data sheets shall show:

   a. Component function description used herein and on the Drawings;

   b. Manufacturer's model number or other product designation;

   c. Project tag number used herein and on the Drawings;

   d. Project system loop of which the component is a part;

   e. Project location or assembly at which the component is to be installed;

   f. Input and output characteristics;

   g. Scale range and units (if any) and multiplier (if any);

   h. Requirements for electric supply (if any);

   i. Requirements for air supply (if any);

   j. Materials of component parts to be in contact with, or otherwise exposed to, process media;

   k. Calibration curves as required.

   l. Special requirements or features.

3. A complete index shall appear in the front of each bound submittal volume. A separate technical brochure or bulletin shall be included with each instrument data sheet. The data sheets shall be indexed in the submittal by systems or loops, as a separate group for each system or loop. If, within a single system or loop, a single instrument is employed more than once, one data sheet with one brochure or bulletin may cover all identical uses of that instrument in that system. Each brochure or bulletin shall include a list of tag numbers for which it applies. System groups shall be separated by labeled tags.

4. Drawings showing both schematic and wiring diagrams for control circuits. Complete details on the circuit interrelationship of all devices within and outside each control panel shall be submitted first, using schematic control diagrams. Subsequent to return of this first submittal by the Engineer, piping and wiring diagrams shall be prepared and submitted for review by the Engineer; the diagrams

shall consist of component layout Drawings to scale, showing numbered terminals on components together with the unique number of the wire to be connected to each terminal. Piping and wiring diagrams shall show terminal assignments from all primary measurement devices, such as flow meters, and to all final control devices, such as samplers, pumps, valves, and chemical feeders. The Contractor shall furnish all necessary equipment supplier's Shop Drawings to facilitate inclusion of this information by the I&C system supplier.

5. Schematic and wiring diagram criteria shall be followed as established in NEMA Standards Publication ANSI/NEMA 1CS-1-1978, "Industrial Control and Systems."

6. Assembly and construction Drawings for each control panel and for other special enclosed assemblies for field installation. These Drawings shall include dimensions, identification of all components, surface preparation and finish data, nameplates, and the like. These Drawings also shall include enough other details, including prototype photographs, to define exactly the style and overall appearance of the assembly; a finish treatment sample shall be included.

7. Installation, mounting and anchoring details for all components and assemblies to be field-mounted, including conduit connection or entry details.

8. Complete and detailed bills of materials. A master Bill of Materials listing all field mounted devices, control panels and other equipment that shall be shipped to the job site. A Bill of Materials for each control panel listing all devices within the panel.

9. Modifications to existing equipment. A complete description of all proposed modifications to existing instrumentation equipment, control panels, control devices, cabinets, etc., shall be submitted with the Shop Drawings complete with detailed Drawings of the proposed modifications.

B. ORGANIZATION AND BINDING:

1. The organization of initial Shop Drawing submittal required above shall be compatible to eventual inclusion with the Technical Manuals submittal and shall include final alterations reflecting "as built" conditions. Accordingly, the initial multiple copy Shop Drawing submittal shall be separately bound in 3-ring binders of the type specified under Part 2.03, herein, for the Technical Manuals.

2.03 TECHNICAL MANUALS

A. Submit final technical manuals for the Owner and the Engineer, as a condition of acceptance of the project. Each set shall consist of one (1) or more volumes, each of which shall be bound in a standard size, three-ring, loose-leaf, vinyl plastic hard cover binder suitable for bookshelf storage. Binder ring size shall not exceed 3.0 inches.

B. Initially, electronic copy of draft/preliminary technical manual shall be submitted to the

Engineer for favorable review after return of favorably reviewed Shop Drawings and data required under Part 3, herein. The preliminary technical manual shall be revised and/or amended as required and the requisite final technical manual shall be submitted to the Engineer fifteen (15) days prior to start-up of systems.

C. In addition to updated Shop Drawing information to reflect actual existing conditions, each set of technical manuals shall include installation, connection, operating, trouble-shooting, maintenance, and overhaul instructions in complete detail. This shall provide the District with comprehensive information on all systems and components to enable operation, service, maintenance, and repair. Exploded or other detailed views of all instruments, assemblies, and accessory components shall be included together with complete parts lists and ordering instructions.

2.04 SPARE PARTS

A. None.

2.05 CONTROL PANELS

A. GENERAL:

New control panels shall be furnished and installed under this Contract, if shown on drawings. They shall house the instrumentation, PLC's control devices, indicating lights, motor starters, control transformers, overload relays, all necessary accessories, wiring and terminal blocks as necessary and as shown on the Drawings and as described herein. Control panel doors shall be equipped with a door latch kit or a fast operating clamp assembly as applicable. Each control panel shall 480V AC, 3-phase external power supply. 120 volt AC control voltage in a control panel shall be supplied with a control transformer externally mounted specified elsewhere in this Section. Each control panel shall be properly grounded and as such be provided with a ground terminal block. Control panels shall be properly sized for installation through new and existing entry ways and custom fit for locations as shown on the drawings. Refer to electrical one line drawings and instrumentation drawings for additional information. Control panels shall be manufactured to UL 508A standards and shall bear a UL508A label. Control panels shall meet the requirements of NEC article 419 for short circuit ratings. Refer to electrical drawings for required fault current ratings.

B. CONSTRUCTION:

1. OUTDOOR:

All outdoor control panels shall be NEMA 3R with drip shield kit, 3 point latch mechanism and 304L stainless steel 14 gauge construction. Provide sunshield on top and on each side as per control panel detail as shown on drawings.

2. COOLING

Control panels shall have sufficient cooling and/or ventilation not to

exceed the maximum operating temperature of any of the internal components. Ambient temperature limits shall be 90 degrees F for indoor and 100 degrees F for outdoor control panels. Outdoor control panels with electronic equipment shall be furnished with sun shields around and on top of the control panels.

C. SIGNAL AND CONTROL CIRCUIT WIRING: (INTERNAL)

1. WIRE TYPE AND SIZES

Conductors shall be flexible stranded copper wire; these shall be U.L. listed Type THHN and shall be rated 600 volts. Wire for control signal circuits and alarm input circuits shall be 16 AWG. All instrumentation cables shall be shielded No. 20 AWG minimum with a copper drain wire. All special instrumentation cable such as between sensor and transmitter shall be supplied by the I&C supplier.

2. WIRE INSULATION COLORS

Conductors supplying 120 volt AC power on the line side of a disconnecting switch shall have a black insulation for the ungrounded conductor. Grounded circuit conductors shall have white insulation. Insulation for ungrounded 120 volt AC control circuit conductors shall be red. All wires energized by a voltage source external to the control board(s) shall have yellow insulation. Insulation for all DC conductors shall be blue.

3. WIRING INSTALLATION

All wires shall be run in plastic wireways except (1) field wiring, (2) wiring run between mating blocks in adjacent sections, (3) wiring run from components on a swing-out panel to components on a part of the fixed structure, and (4) wiring run to panel mounted components. Wiring run from components on a swing-out panels to other components on a fixed panel shall be made up in tied bundles. These shall be tied with nylon wire ties, and shall be secured to panels at both sides of the "hinge loop" so that conductors are not strained at terminals.

Wiring run to control devices on the front panels shall be tied together at short intervals with nylon wire ties and secured to the inside face of the panel using adhesive mounts.

Wiring to rear terminals on panel mount instruments shall be run in plastic wireways secured to horizontal brackets run above or below the instruments in about the same plane as the rear of the instruments.

Shields of shielded instrument cable shall only be grounded on one side of each cable run. The side to be grounded shall always be in the field as applicable.

Care shall be exercised to properly insulate the ungrounded side, to prevent ground loops from occurring.

Conformance to the above wiring installation requirements shall be

reflected by details shown on the Shop Drawings for the Engineer's review.

4. WIRE MARKING

Each signal, control, alarm, and indicating circuit conductor connected to a given electrical point shall be designated by a single unique number which shall be shown on all Shop Drawings. These numbers shall be marked on all conductors at every terminal using permanently marked heat-shrink plastic. Instrument signal circuit conductors shall be tagged with unique multiple digit numbers. Black and white wires from the circuit breaker panelboard shall be tagged including the one (1) or two (2) digit number of the branch circuit breaker.

5. TERMINAL BLOCKS

Terminal blocks shall be molded plastic with barriers and box lug terminals, and shall be rated 15 amperes at 600 volts. White marking strips, fastened securely to the molded sections, shall be provided and wire numbers or circuit identifications shall be marked thereon with permanent marking fluid. Terminal blocks shall be General Electric Type CR 151A1 with mounting rack, equivalent by Cinch-Jones or equal.

D. PAINTING:

Control panels shall be thoroughly cleaned and sandblasted per SSPC-SP-6 (Commercial Blast) after which surfaces shall receive a prime coat (Amercoat 185, Koppers 622HB, or equal) 3-mils dry, followed by two (2) or more finish coats (Amercoat 5401, Koppers 501, or equal) 3-mils dry, for a total thickness of the complete system of 6 mils. The inside surfaces shall have a white finish coat.

2.06 ACCESSORIES

A. General purpose relays in the control panels shall be plug in type with contacts rated 10 amperes at 120 volts AC. The quantity and type of contacts shall be as shown on the Drawings. Each relay shall be enclosed in a clear plastic heat and shock resistant dust cover. Sockets for relays shall have screw type terminals. Relays shall be Potter and Brumfield Type KRP or KUP, Square-D Type K, or equal.

B. Time delay relays shall be solid state on-delay or off-delay type with contacts rated 10 amperes at 120VAC. Units shall include adjustable dial with graduated scale covering the time range in each case. Time delay relays shall be Agastat Series 7000, Omron series H3, SSAC type TDM or approved equal.

C. Additional slave relays shall be installed when the number or type of contacts shown exceed the contact capacity of the specified relays and timers.

D. Switches and indicating lights shall be round 30.5mm configuration, heavy duty and corrosion resistant. Legend plate shall be standard size square style laminate with white field and black markings as shown.

E. Indicating lights shall have 6VAC lamps and integral transformer for operation from 120VAC, unless otherwise noted. Lens color shall be as noted. All indicating lights shall be push-to-test type. Pushbuttons shall include full guard with flush button and selector switches shall include a black non-illuminated knob on switch, unless otherwise noted. Contact arrangement and configuration shall be as shown.

F. Circuit breakers shall be single pole, 120 volt, 15 ampere rating or as required to protect wires and equipment and mounted inside the panels as shown.

G. Nameplates shall be supplied for identification of all field mounted elements, including flow meters and their transmitters. These nameplates shall identify the instrument, or meter, descriptively, as to function and system. These nameplates shall be fabricated from black-face, white-center, laminated engraving plastic. A nameplate shall be provided for each signal transducer, signal converter, signal isolator, each electronic trip, and the like, mounted inside the control panels. These shall be descriptive, to define the function and system of such element. Adhesives shall be acceptable for attaching nameplates. Painted surfaces must be prepared to allow permanent bonding of adhesives. Nameplates shall be provided for instruments, function titles for each group of instruments and other components mounted on the front of the control panels as shown. These nameplates and/or individual letters shall be fabricated from VI-LAM, Catalog No. 200, manufactured by N/P Company, or equivalent by Formica, or equal. Colors, lettering, style and sizes shall be as shown or as selected by the Engineer.

H. Provide UL listed, specification grade, totally enclosed, ac type, quiet tumbler switches meeting NEMA WD 1 performance standards and Federal Specification W-S-896E, and capable of control of 100 percent tungsten filament and fluorescent lamp loads. Use switches rated at 20 amps, 120/277 volts. Provide operating handles colored brown. Use switches with screw terminals.

2.07 CIRCUIT BREAKER, 0 TO 600 VOLTS

A. NEMA AB I, UL 489 listed for use at location of installation.

B. Minimum Interrupt Rating: As shown or as required.

C. Thermal-magnetic, quick-make, quick-break, indicating type, showing ON/OFF and TRIPPED indicating positions of the operating handle.

D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Locking: Provisions for padlocking handle.

F. Multipole breakers to automatically open all poles when an overload occurs on one-pole.

G. Enclosure: as shown on dawing.

H. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position.

I. Do not provide single-pole circuit breakers with handle ties where multipole circuit breakers are shown.

2.08 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS) PROTECTION (INSTRUMENTATION)

A. GENERAL:

TVSS protection shall be provided to protect the electronic instrumentation system from induced surges propagating along the signal and power supply lines. The protection systems shall be such that the protective level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level, and be maintenance free and self-restoring. Instruments shall be housed in a suitable case, properly grounded. Ground wires for all TVSS shall be connected to a good earth ground and where practical, each ground wire run individually and insulated from each other. These protectors shall be mounted within the instrument enclosure or a separate NEMA 4X junction box coupled to the enclosure.

B. POWER SUPPLY:

Protection of all 120 VAC instrument power supply lines shall be provided. Control panels shall be protected by line noise suppressing isolation transformers and TVSS. Field instruments shall be protected by TVSS. For control panels, the line noise suppressing isolation transformer shall be Topaz Series 30 Ultra isolators or approved equal. The suppressor shall be Edco HSP-121 and U.L. 1449 compliant.

C. ANALOG SIGNALS:

Protection of analog signal lines originating and terminating not in the same building shall be provided by TVSS. For analog signal lines, the TVSS shall be Edco PC-642. For field mounted two-wire instruments, the TVSS shall be encapsulated in stainless steel pipe nipples and shall be Edco SS64 series, and U.L. 497B compliant.

For field mounted four-wire 120VAC instruments, the TVSS shall be in a NEMA 4X polycarbonate enclosure, Edco SLAC series.

2.09 WIRING DEVICES

A. Receptacle, Ground Fault Circuit Interrupter: Duplex, specification grade, tripping at 5 mA.

1. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps, capable of interrupting 5,000 amps without damage.

2. Size: For 2-inch by 4-inch outlet boxes.

3. Standard Model: NEMA WD 1 with No. 12 AWG copper USE/RHH/RHW-XLPE insulated pigtails and provisions for testing.

4. Feed-Through Model: NEMA WD 1, with No. 12 AWG copper USE/RHH/RHW-XLPE insulated pigtails and provisions for testing.

5. Manufacturers:
   a. Pass and Seymour.
   b. Bryant.
   c. Leviton.
   d. Hubbell.
   e. Arrow Hart.

2.10 TRANSIENT VOLTAGE SURGE SUPPRESSION (POWER)

A. This section describes the material and installation requirements for transient voltage surge suppression devices (TVSS) in switchboards, panelboards, and motor control centers for the protection of all AC electrical circuits.

B. TVSS shall be listed and component recognized in accordance with UL 1449 4th edition and UL 1283.

C. TVSS shall be installed and warranted by and shipped from the electrical distribution equipment manufacturer's factory.

D. TVSS shall provide surge current diversion paths for all modes of protection; L-L, L-N, L-G, N-G in WYE systems, and L-L, L-G in DELTA systems.

E. TVSS shall be modular in design. Each module shall be fused with a surge rated fuse.

F. A UL approved disconnect switch shall be provided as a means of disconnect in the switchboard device only.

G. TVSS shall meet or exceed the following criteria:
   1. Maximum surge current capability (single pulse rated) shall be:

      a. Service entrance switchboard 300kA

      b. Branch panelboards, outdoor panels 150kA

      c. Motor control centers 80kA

   2. UL 1449 Listed and Recognized Component Suppression Voltage Ratings shall not exceed the following:

Voltage	L-N	L-G	N-G
208Y/120	400V	400V	400V
480Y/277	800V	800V	800V

H. TVSS shall have a minimum EMI/RFI filtering of -44dB at 100kHz with an insertion ration of 50:1 using MIL STD 220A methodology.

I. TVSS shall be provided with 1 set of NO/NC dry contacts.

J. TVSS shall have a warranty for a period of five years, incorporating unlimited replacements of suppressor parts if they are destroyed by transients during the warranty period. Warranty will be the responsibility of the electrical distribution equipment manufacturer.

K. Approve manufactures are:

1. Cutler Hammer

2. General Electric

2.11 FUSE, 0 to 600 VOLTS

A. Current-limiting, with 200,000 ampere rms interrupting rating.

B. Provide to fit mountings specified with switches and features to reject Class H fuses.

C. Motor and Transformer Circuits, 0- to 600-Volt:

1. Amperage: 0 to 600.
2. UL 198E, Class RK-1, dual element, with time delay.
3. Manufacturers:
   a. Bussmann; Type LPS-RK.
   b. Littlefuse; Type LLS-RK.

D. Feeder and Service Circuits, 0- to 600-Volt:

1. Amperage: 0 to 600.
2. UL 198E, Class RK-I, dual element, with time delay.
3. Manufacturers:
   a. Bussmann; Type LPS-RK.
   b. Littlefuse; Type LLS-RK.

2.12 CONTROL STRATEGY DESCRIPTIONS

A. The control strategies are written descriptions of the programming required to implement regulatory and sequential control of the unit processes. Control strategies shall fully reside in the memory of the designated PLC. Coefficients pertaining to control strategies

shall be modifiable through the operator interface in the monitoring / control mode. Contractor shall include an additional 12 hours on-site to fine tune control system and make minor software modifications in order to resolve any logic discrepancies encountered during start-up, and supply the District with a complete functional system. This shall be part of the bid package with no additional cost to the District.

B. IQ-511 Bypass Piping Control Strategy:

The signals and control of new gate actuator and existing concentrate valve shall be programmed in the existing plant PLC program. There is an existing fiber optic connection between plant PLC system and existing IQ-511 pump station PLC system. The plant PLC system shall communicate (data exchange) with the IQ-511 pump station PLC system.

Existing IQ-511 pump station PLC control strategy will remain and shall function independent of the "IQ Bypass mode" operation. The control strategy for IQ Bypass piping control shall be programmed in the Plant PLC system. A copy of the existing PLC program is available from the District, if needed.

The operator shall manually select the IQ-511 Bypass mode from the SCADA screen when it is desired to place in the IQ Bypass Mode operation. Additionally, the operator shall manually close the 36" valve on the pipe that discharges water from Diversion Structure "B" to the IQ storage lakes (Valve "A" on Contract Drawings) and shall also manually close the valve on the 36" intake pipe from the IQ storage lakes to the IQ-511 pump station (Valve "B" on Contract Drawings) before placing the "IQ Bypass Mode" in operation. "IQ Bypass Mode" selection on the SCADA screen or PLC logic shall only be available when the level of pond outlet box is at elevation 18.5' or above (adjustable from SCADA screen). If the level is below 18.5' (adjustable) at the pond outlet box, the "IQ Bypass Mode" shall be disabled by the PLC logic. The level of pond outlet box will be the same as the level of stabilization pond (lined).

If IQ Bypass mode is selected, the PLC logic shall automatically open the new motorized gate "A" at Diversion Structure "B" to a preset opening position (40%, field adjustable) and let the water flows into the IQ wetwell. The PLC logic shall monitor the IQ-511 wetwell level and adjust the gate position automatically to keep the IQ wetwell level at elevation 14' (adjustable) with +/- 0.5' deadband. If the IQ wetwell level exceeds the elevation 16.0' (adjustable), the PLC logic shall automatically close the motorized gate "A" at Diversion Structure "B" and will enable the automatic level control using gate "A" when the IQ wetwell level drops below 14'. The elevation setpoint values and gate open position value shall be fine tune during the startup and adjusted accordingly.

The operator shall manually open the 36" valve on the pipe that discharges water from Diversion Structure "B" to the IQ storage lakes (Valve "A" on Contract Drawings) and the valve on the 36" intake pipe from the IQ storage lakes to the IQ-511 pump station before disabling the "IQ Bypass mode". If IQ Bypass mode is disabled by the operator, the PLC logic shall fully close the new motorized gate "A" at Diversion Structure "B".

New level measurement of Diversion Structure "B" will be used for monitoring purpose only.

C. General Logic Description: The following items are general logic and shall be provided

where applicable, unless otherwise noted in drawings.

- Auto-Manual Start-Stop scheme for all equipment (pump or valves) shall operate on the following way: Any equipment shall have Auto and Manual mode selectable from the HMI screen. In Auto mode the particular pump or valve shall follow the auto control strategy described above. In Manual mode, operator shall be able to Start, Stop, Open or Close pump/ Valve from the HMI screen. VFD pump or modulating valve shall have in addition the manual set point for speed/ position.

- All alarms that are generated by the PLC and have active roll in PLC logic, shall be latched, and shall be resetable from the HMI screens, except the alarms that need to be reset on the field.

- All control valves or gates shall be monitored for PLC position command to the valve and position feed back from the valve or gate. More than 10% discrepancy for analog signals, and any discrepancy for digital signals shall generate an alarm in the HMI.

- All alarms generated by the PLC shall have selectable value in HMI for alarm set point, and selectable time delay.

- All analog input shall have low, low-low, high, and high-high setpoints as well as alarms. Coordinate with Owner during startup and eliminate any of the setpoints/alarms are not applicable.

- All alarms generated by the PLC shall have selectable value in HMI for alarm set point, and selectable time delay.

2.13 INSTRUMENTS

L1. SUBMERSILE PRESSURE TRANSMITTER FOR LEVEL

The submersible level transmitters shall be constructed of 316 stainless steel with a ported nosecap utilizing a micro-machined silicon piezo-resistive pressure sensor. The pressure transmitter shall have a diameter of 0.75" and length of 12.08". The overall accuracy shall be ±0.25% FS BSL with a temperature error band of ± 2.0% FS. The pressure transmitter shall be a loop powered device with a supply voltage of between 9 and 28 Volts dc and have an output of 4 - 20mA. The cell is to be a vented gauge version with 4mA representing atmospheric pressure. The operating temperature range shall be -5 to 150°F (-20 to 60°C). The level range shall be 0 to 115.333 ft H2O (0 to 50 PSI), unless otherwise noted.

The cable jacket shall be ETFE type. The cable containing a vent tube is to be attached to the transducer body with a Gland cable seal. Cable shall be continuous without splices. Provide minimum of 25 feet of cable. Coordinate with mechanical drawings.

A full lightning and surge protection shall be provided through the use of 2 protectors, one is integral to the transducer housing and one is provided for the outside line located at

the PLC or RIO panel and grounded to a DIN-Rail.

A moisture protection shall be provided with a stainless steel vent filter containing desiccant to provide moisture protection for a minimum of 5 years without maintenance, KPSI model 811. The submersible level transmitter shall be
Blue Ribbon Model BC001 Birdcage or Owner pre-approved equal.

The submersible level transmitter shall be supplied with the following optional equipment:

Provide Gland seal for the cable at the stilling well.

A NEMA 4X, 316 stainless steel junction box shall be provided nearest to the transmitter. The junction box shall include a terminal strip, a desiccant and a surge arrester.

2.14 INSTRUMENTS LIST:

TAG NO.	COMPONENT CODE	COMPONENT TITLE	COMPONENT OPTIONS	REMARKS
PE/LT-0003	L1	Pond Outlet Box Level	0 – 25 FT	
PE/LT-0004	L1	Diversion Structure "B" Level	0 - 25 FT	

PART 3 – EXECUTION

3.01 INSTALLATION, CALIBRATION, TESTING, START-UP AND INSTRUCTION

A. GENERAL:

Under the supervision of the Single I&C supplier, all systems specified in this Section shall be installed, connected, calibrated and tested, and in coordination with the Engineer and the District, shall be started to place the processes in operation. This shall include final calibration in concert with equipment specified elsewhere in these Specifications, including pumps, valves, as well as certain existing equipment.

B. Testing

1. All systems shall be exercised through operational tests in the presence of the Engineer in order to demonstrate achievement of the specified performance. Operational tests depend upon completion of work specified elsewhere in these Specifications. The scheduling of tests shall be coordinated by the Contractor among all parties involved so that the tests may proceed without delays or disruption by incomplete work.

2. Check the function of each loop, including set points, alarms, displays, and operator interface. Check one loop of each type and 20% (min.) of all loops. Check data logging, alarm logging, and event logging.

3. Test all non-loop-specific functions including, but not limited to the following:

   a. Demonstrate capacity of system for expansion. Include tests for both storage capacity and processing capacity.

   b. Include tests for timing requirements.

   c. Demonstrate online and offline diagnostic tests, procedures and displays.

   d. Demonstrate Failure Mode and Backup Procedures: Power failure, auto restart, disk backup and reload, retentive outputs.

4. Correct deficiencies found and complete correction of deficiencies prior to shipment to site.

5. Failed Tests shall be repeated and witnessed by the Engineer. With approval of the Engineer certain tests may be conducted by the I&C Supplier and Witnessed by the Engineer during START-UP.

6. See section 3.02 supplements for sample "Loop Status Report" and "Functional Acceptance Test Sheet".

C. INSTALLATION AND CONNECTION:

1. The Contractor shall install and connect all field-mounted components and assemblies under the criteria imposed in Part 1, 1.03, herein. The installation personnel shall be provided with a final reviewed copy of the Shop Drawings and data.

2. The instrument process sensing lines and air signal tubing shall, in general, be installed in a similar manner to the installation of conduit specified under Section 16001. Individual tubes shall be run parallel and near the surfaces from which they are supported.

3. Supports shall be used at intervals of not more than 3 feet of rigid tubing.

4. Bends shall be formed with the proper tool and to uniform radii and shall be made without deforming or thinning the walls of the tubing. Plastic clips shall be used to hold individual plastic tubes parallel. Ends of tubing shall be square cut and cleaned before being inserted in the fittings. Bulkhead fittings shall be provided at all panels.

5. The Contractor shall have a technical field representative of the I&C supplier to instruct these installation personnel on any and all installation requirements; thereafter, the technical field representative shall be readily available by telephone to answer questions and supply clarification when needed by the installation personnel.

6. Where primary elements (supplied by I&C supplier) shall be part of a mechanical system, the I&C supplier shall coordinate the installation of the primary elements with the mechanical system manufacturer.

7. Finally, after all installation and connection work has been completed, the technical field representative shall check it all for correctness, verifying polarity of electric power and signal connections, making sure all process connections are free of leaks, and all such similar details. If the initial inspection finds no deficiencies, the technical field representative shall proceed to the certification to the Contractor. Any completed work that is found to have deficiencies shall have those deficiencies corrected by installation personnel at no additional cost to the District. The technical field representative shall then recheck the work after the identified deficiencies are corrected. If the technical field representative finds deficiencies in the follow-up inspection, then remedial action shall be taken by the Contractor at no cost to the District. This pattern shall be repeated until the installation is free from defect. The technical field representative shall then certify in writing to the Contractor that for each loop or system that he has inspected is complete and without discrepancies.

8. The field representative of the Single I&C supplier shall coordinate all work required to interface the new equipment and control devices with the existing equipment, including all required modifications to existing equipment and related devices.

D. Calibration

1. All instruments and systems shall be calibrated after installation, in conformance with the component manufacturer's written instructions. This shall provide that those components having adjustable features are set carefully for the specific conditions and applications of this installation, and that the components and/or systems are within the specified limits of accuracy. Defective elements that cannot achieve proper calibration or accuracy, either individually or within a system, shall be replaced. This calibration work shall be accomplished by the technical field representatives of the I&C system supplier who shall certify in writing to the Contractor that for each loop or system all calibrations have been made and that all instruments are ready to operate. See section 3.02 supplements for sample "Instrumentation Calibration Sheet".

2. Proof of Conformance - The burden of proof of conformance to specified accuracy and performance is on the Contractor using its designated Single I&C supplier. The Contractor's designer shall supply necessary test equipment and technical personnel

if called upon to prove accuracy and/or performance, at no separate additional cost to the District, wherever reasonable doubt or evidence of malfunction or poor performance may appear within the guarantee period.

E. PRE-COMMISSIONING

1. The I&C Supplier shall test each loop (discrete and analog) to determine if it is functioning correctly. The I&C Supplier shall furnish a loop sheet for each loop to be tested. The loop sheet shall represent the actual "as-built" condition of the loop. The I&C Supplier shall perform a field functional loop test which shall be witnessed by the Engineer and District. If the loop fails the functional test, the I&C Supplier shall coordinate repairs for the Contractor to correct whatever is wrong with the loop. The I&C Supplier shall retest the loop until it is approved.

2. Each loop shall be tested and approved by Engineer and District until all loops have been approved.

F. Start-up and Instruction

1. When all systems are assessed by the Contractor to have been successfully carried through complete operational tests with a minimum of simulation, and the Engineer concurs in this assessment, plant start-up by the District's operating personnel can follow. For a minimum of (2) hours prior to start-up of each well, operating and maintenance personnel shall be instructed in the functions and operation of each system and shall be shown the various adjustable and set point features which may require readjustment, resetting or checking, re-calibration or maintenance by them from time to time. This instruction shall be scheduled at a time arranged with the District at least two (2) weeks in advance. Instruction shall be given by qualified persons who have been made familiar in advance with the systems. All equipment shall be checked during the first year of operation at intervals of three months for a period of not less than one day or as may be required to correct any defects to the satisfaction of the District.

G. Plant Shutdowns

1. The Single I&C supplier shall carefully examine all work to be performed relative to existing I&C equipment and the installation of new equipment and control devices. Work shall be scheduled to minimize required plant shutdown times.

H. Coordination with Other Concurrent Projects

1. The single I&C supplier shall coordinate extensively with other I&C suppliers of concurrent projects. Some of the equipment shown in this contract as existing might be installed while this contract is underway.

3.02 SUPPLEMENTS

A. Supplements listed below; following "END OF SECTION" are part of this Specification.

1. Instrumentation Calibration Sheet

2. Loop Status Report

END OF SECTION

LOOP STATUS REPORT

PROJECT NAME:_____

PROJECT NO.:_____

FUNCTIONAL REQUIREMENTS

COMPONENT STATUS

TAG NO.	DELIVERED*	TAG/IDENTIFI-CATION CHECK*	INSTALLATION CHECK	TERMINATION WIRING*	TERMINATION TUBING*	CALIBRATED*

REMARKS

LOOP READY FOR START-UP

BY

DATE

* INITIAL AND DATE WHEN COMPLETE

INSTRUMENTATION CALIBRATION SHEET

COMPONENT CODE: NAME:	MANUFACTURER: MODEL: SERIAL:	PROJECT NUMBER: NAME:

	RANGE	VALUE	UNITS		
□INDIATE/ RECORD	CHART	_____	_____	□ COMPUTE FUNCTIONS	□ CONTROL ACTION (DIRECT/REVERSE) MODES (P/I/D) □ SWITCH UNIT RANGE (VALUE/UNITS) DIFFERENTIAL (FIXED/ADJUSTABLE) RESET (AUTOMATIC/MANUAL)
	SCALE	_____	_____		
□TRANS/ CONVERT	INPUT	_____	_____		
	OUTPUT		_____		

ANALOG							DISCRETE					
REQUIRED			AS CALIBRATED				REQUIRED			AS CALIBRATED		REMARKS CODE
IN	SCALE	OUT	SCALE	OUT	SCALE	OUT	NUMBER	TRIP PT	RESET PT	TRIP PT	RESET PT	
C. MODE SETTINGS: P			I		D							

	COMPONENT CALIBRATED AND READY FOR START-UP BY DATE
	TAG NO.

SECTION 16010
BASIC ELECTRICAL REQUIREMENTS

PART 1 – GENERAL

1.01 RELATED SECTIONS

A. Requirements specified within this section apply to all sections in Division 16, ELECTRICAL. Work specified herein shall be performed as if specified in the individual sections.

1.02 ELECTRICAL SUBCONTRACTOR QUALIFICATIONS

A. The electrical subcontractor shall meet or exceed the criteria described below:

1. The electrical subcontractor shall be licensed in the State of Florida.

2. The electrical subcontractor shall have successfully completed electrical construction on three water or wastewater treatment plant related projects within the past ten years.

3. The electrical subcontractor shall have, in their employ, the following full time employees that will be assigned to perform the electrical work of this contract:

   a. A minimum of (1) Licensed Master Electrician who is overall responsible for the supervision of personnel performing the construction, installation startup and testing of all electrical related facilities and systems.

   b. A minimum of (1) Licensed Journeyman Electrician responsible for the daily construction activities and guidance of the electrical contractor's on site employees. The Licensed Journeyman's primary assignment will be the construction of the electrical facilities of this project until project completion. The Licensed Journeyman shall be certified in the County or shall meet the reciprocity standards of Florida State Statue 489 Part II.

4. The electrical subcontractor shall not be involved in any current or pending litigation which may have a material negative impact on the ability to complete the project. The electrical subcontractor shall provide a statement advising all current or pending litigations.

1.03 DESIGN REQUIREMENTS

A. All electronic boards as part of electrical equipment shall meet the atmospheric conditions of the space the equipment is installed in. All electronic boards which are not installed in a conditioned environment shall be fungus-resistant.

B. All electrical equipment shall be rated for the conditions the equipment is installed in.

1.04 STANDARDS, CODES, PERMITS, AND REGULATIONS

A. Perform all work; furnish and install all materials and equipment in full accordance with the latest applicable rules, regulations, requirements, and specifications of the following:

1. Local Laws and Ordinances.

2. State and Federal Laws.

3. National Electrical Code (NEC).

4. State Fire Marshal.

5. Underwriters' Laboratories (UL).

6. National Electrical Safety Code (NESC).

7. American National Standards Institute (ANSI).

8. National Electrical Manufacturer's Association (NEMA).

9. National Electrical Contractors Association (NECA) Standard of Installation.

10. Institute of Electrical and Electronics Engineers (IEEE).

11. Insulated Cable Engineers Association (ICEA).

12. Occupational Safety and Health Act (OSHA).

13. National Electrical Testing Association (NETA).

14. American Society for Testing and Materials (ASTM).

15. Florida Building Code, including Local County amendments.

B. Conflicts, if any, which may exist between the above items, will be resolved at the discretion of the Engineer.

C. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is mandatory. Construe nothing in the Contract Documents as permitting work not in compliance with these codes.

D. Obtain all permits and pay all fees required by any governmental agency having jurisdiction over the work. Arrange all inspections required by these agencies. On completion of the work, furnish satisfactory evidence to the Engineer that the work is acceptable to the regulatory authorities having jurisdiction.

1.05 ELECTRICAL COORDINATION

A. Work Provided Under this Contract:

1. Demolish two existing solar powered light poles as shown on the drawings.

2. Remove the existing power and control system for the existing concentrate MOV as shown on the drawings.

3. Provide and install a new electrical power and control system for a new Gate "A" MOV and the existing concentrate MOV including modification of the existing MCC and a new breaker panel.

4. Provide and install new light poles and convenience power systems, indicated on the drawings, complete in place.

5. Provide and install new underground conduit duct banks, pull boxes and wiring indicated on drawings complete in place.

6. Provide and install all electrical required to support instrumentation and control systems as shown on the drawings complete in place.

7. Provide and install new grounding system as indicated on the drawings.

8. Provide all miscellaneous electrical including switches, terminations, fittings, wiring, conduit, disconnects, junction boxes, mounting supports, etc. not specified but obviously necessary for a complete working system in place.

B. Temporary Power:

1. Provide temporary power during modification of major electrical equipment that requires power shutting down. Coordinate with Owner for equipment that requires temporary power during shut down.

C. Emergency Power:

1. No new emergency power is needed as part of this project.

1.06 SUBMITTALS

A. The submittal shall be provided with check-marks as stated below:

1. A copy of each specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks (√) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined shall signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation.

2. Electrical equipment submittals shall be made by specification section. Submit one package per specification section and do not group multiple specification sections under one submittal package.

B. Provide a conduit plan/electrical site plan for major power, instrumentation and control conduits, both interior and exterior, showing routing, size and stub up locations for buried or in slab conduits.

1.07 ENVIRONMENTAL CONDITIONS

A. All chemical rooms and areas shall be designated as corrosive.

B. All indoor chemical and process equipment areas shall be considered wet locations.

C. Electrical equipment in rooms designated as Classified by NFPA 70 (national electrical code) as Division 1 or Division 2 shall meet all requirements set forth for that classification as described in NEC article 500.

1.08 INSPECTION OF THE SITE AND EXISTING CONDITIONS

A. The Electrical Drawings were developed from past record drawings and information supplied by the Owner. Verify all scaled dimensions prior to submitting bids.

B. Before submitting a bid, visit the site and determine conditions at the site and at all existing structures in order to become familiar with all existing conditions and electrical system which will, in any way or manner, affect the work required under this Contract.

No subsequent increase in Contract cost will be allowed for additional work required because of the Contractor's failure to fulfill this requirement.

C. Carry out any work involving the shutdown of the existing services to any piece of equipment now functioning in existing areas at such time as to provide the least amount of inconvenience to the Owner. Do such work when directed by the Engineer.

D. After award of Contract, locate all existing underground utilities at each area of construction activity. Protect all existing underground utilities during construction. Pay for all required repairs without increase in Contract cost, should damage to underground utilities occur during construction.

1.09 RESPONSIBILITY

A. The Contractor shall be responsible for:

1. Complete systems in accordance with the intent of these Contract Documents.

2. Coordinating the details of facility equipment and construction for all Specification Divisions which affect the work covered under Division 16, ELECTRICAL.

3. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.

1.10 INTENT OF DRAWINGS

A. Electrical plan Drawings show only general location of equipment, devices, and raceway, unless specifically dimensioned. The Contractor shall be responsible for the proper routing of raceway, subject to the approval of the Engineer.

B. Electrical equipment sizes and characteristics have been based on the following manufacturers:

1. Existing MCC modifications: Square D.

If the Contractor chooses to and is allowed to substitute, the Contractor shall be responsible for fitting all the equipment in the available space as shown on the Drawings or re-designing the space, at no additional cost to the owner, and shall reimburse the engineer for time and materials spent in reviewing revised design.

PART 2 – PRODUCTS

2.01 GENERAL

A. Provide materials and equipment listed by UL wherever standards have been established by that agency. If a UL listing is not available, equipment shall have a label and listing from a nationally recognized testing laboratory (NRTL) acceptable to the authority having jurisdiction (AHJ) over the project location.

B. Equipment Finish:

1. Provide manufacturers' standard finish and color, except where specific color is indicated.

2. If manufacturer has no standard color, provide equipment with ANSI No. 61, light gray color.

PART 3 – EXECUTION

3.01 GENERAL

A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

B. Install work in accordance with NECA Standard of Installation, unless otherwise specified.

3.02 LOAD BALANCE

A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

B. Balance electrical load between phases as nearly as possible on switchboards, panel boards, motor control centers, and other equipment where balancing is required.

C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.03 CHECKOUT AND STARTUP

A. Voltage Field Test:

1. Check voltage at point of termination of power company supply system to project when installation is essentially complete and is in operation.

2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.

3. Unbalance Corrections:
   Make written request to power company to correct condition if balance (as defined by NEMA) exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4 percent of nominal.

   a. Obtain a written certification from a responsible power company official that the voltage variations and unbalance are within their normal standards if corrections are not made.

B. Equipment Line Current Tests:

1. Check line current in each phase for each piece of equipment.

2. Make line current check after power company has made final adjustments to supply voltage magnitude or balance.

3. If any phase current for any piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

C. Startup:

1. Demonstrate satisfactory operation of all 480-volt electrical equipment. Participate with other trades in all startup activities.

2. Assist the I&C Contractor in verifying signal integrity of all control and instrumentation signals.

END OF SECTION

SECTION 16050
BASIC WIRING AND METHODS

PART 1 – GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American National Standards Institute (ANSI):

a. C55, 1, Standard for Shunt Power Capacitors.

b. C62.11, Standard for Metal-Oxide Surge Arrestors for AC Circuits.

c. Z55.1, Gray Finishes for Industrial Apparatus and Equipment.

2. American Society for Testing and Materials (ASTM):

a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

b. A240, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.

c. A570, Standard Specification for Steel, Sheet, and Strip, Carbon, Hot-Rolled, Structural Quality.

3. Federal Specifications (FS):

a. W-C-596, Connector, Receptacle, Electrical.

b. W-S-896E, Switches Toggle, Flush Mounted.

4. National Electrical Contractors Association, Inc. (NECA): 5055, Standard of Installation.

5. National Electrical Manufacturers Association (NEMA):

a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

b. AB 1, Molded Case Circuit Breakers and Molded Case Switches.

c. CP I, Shunt Capacitors.

d. ICS 2, Industrial Control Devices, Controllers, and Assemblies.

e. KS 1, Enclosed Switches.

f. LA I, Surge Arrestors.

g. PB 1, Panelboards.

h. ST 20, Dry-Type Transformers for General Applications.

i. WD I, General Requirements for Wiring Devices.

6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

7. Underwriters Laboratories, Inc. (UL):

a. 67, Standard for Panelboards.

b. 98, Standard for Enclosed and Dead-Front Switches.

c. 198C, Standard for Safety High-Interrupting-Capacity Fuses, Current-Limiting Types.

d. 198E, Standard for Class Q Fuses.

e. 486E, Standard for Equipment Wiring Terminals.

f. 489, Standard for Molded Case Circuit Breakers and Circuit Breaker Enclosures.

g. 508, Standard for Industrial Control Equipment.

h. 810, Standard for Capacitors.

i. 943, Standard for Ground-Fault Circuit Interrupters.

j. 1059, Standard for Terminal Blocks.

k. 1561, Standard for Dry-Type General-Purpose and Power Transformers.

1.02 SUBMITTALS

A. Shop Drawings:

1. Device boxes for use in hazardous areas.

2. Junction and pull boxes for interior and exterior.

3. Hardware.

4. Terminal junction boxes.

5. Panelboards and circuit breaker data.

6. Fuses.

7. Contactors.

8. Transformers.

9. Wiring devices and plates

10. All other miscellaneous material part of this project.

B. Quality Control Submittals:

1. Test Report: Sound test certification for dry type power transformers (O to 600-volt, primary).

1.03 QUALITY ASSURANCE

A. UL Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

B. Hazardous Areas: Materials and devices shall be specifically approved for hazardous areas of the class, division, and group shown and of a construction that will ensure safe performance when properly used and maintained.

PART 2 – PRODUCTS

2.01 OUTLET AND DEVICE BOXES

A. Sheet Steel: Not used.

B. Cast Metal:

1. Box: Cast ferrous metal.

2. Cover: Gasketed, weatherproof, cast ferrous metal, with stainless steel screws.

3 Hubs: Threaded.

4. Lugs (Cast Mounting) Manufacturer:

a. Crouse-Hinds; Type FS or FD.

b. Appleton; Type FS or FD.

C. Cast Aluminum:

1. Material:

a. Box: Cast, copper-free aluminum.

b. Cover: Gasketed, weatherproof, cast copper-free aluminum with stainless steel screws.

2. Hubs: Threaded.

3. Lugs: Cast mounting.

4. Manufacturers:

a. Crouse-Hinds; Type FS-SA or FD-SA.

b. Appleton; Type FS or FD.

D. Nonmetallic:

1. Box: PVC.

2. Cover: PVC, weatherproof, with stainless steel screws.

3. Manufacturer: Carlon; Type FS or FD, with Type E98 or E96 covers.

2.02 JUNCTION AND PULL BOXES

A. Outlet Boxes Used as Junction or Pull Box: As specified under Article OUTLET AND DEVICE BOXES.

B. Large Stainless Steel Box: NEMA 250, Type 4X.

1. Box: 14-gauge, ASTM A240, Type 316 stainless steel.

2. Cover: Hinged with screws.

3. Hardware and Machine Screws: ASTM A167, Type 304 stainless steel.

4. Manufacturers:

   a. Hoffman Engineering Co.

   b. Robroy Industries.

C. Large Nonmetallic Box (Use only for corrosive area and if shown on drawings):

1. NEMA 250, Type 4X.

2. Box: High-impact, fiberglass-reinforced polyester or engineered thermoplastic, with stability to high heat.

3. Cover: Hinged with screws.

4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.

5. Conduit hubs and mounting lugs.

6. Manufacturers:

   a. Crouse-Hinds; Type NJB.

   b. Carlon; Series N, C, or H.

   c. Robroy Industries.

2.03 MINI-POWER ZONE (MPZ) OR MINI-POWER CENTER (MPC) – Not Used

2.04 WIRING DEVICES

A. Switches:

NEMA WD I and FS W-S-896E.

2. Specification grade, totally enclosed, ac type, with quiet tumbler switches and screw terminals.

3. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.

4. Rating: 20 amps, 120/277 volts.

5. Color:

    a. Office Areas: Ivory.

    b. Other Areas: Brown.

6. Switches with Pilot Light: 125-volt, neon light with red jewel, or lighted toggle when switch is ON.

7. Manufacturers:

    a. Bryant.

    b. Leviton.

    c. Hubbell.

    d. Pass and Seymour.

    e. Arrow Hart.

B. Receptacle, Single and Duplex:

1. NEMA WD 1 and FS W-C-596.

2. Specification grade, two-pole, three-wire grounding with screw type wire terminals suitable for No. 10 AWG.

3. High strength, thermoplastic base color.

4. Color:

    a. Office Areas: Ivory.

    b. UPS receptacle: Red.

    c. Other Areas: Brown.

5. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.

6. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.

7. Manufacturers:

    a. Bryant.

    b. Leviton.

    c. Hubbell.

    d. Pass and Seymour.

    e. Sierra.

    f. Arrow Hart.

    h. Or equal.

C. Receptacle, Ground Fault Circuit Interrupter: Duplex, specification grade, tripping at 5 mA.

1. Color: Ivory.

2. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps, capable of interrupting 5,000 amps without damage.

3. Size: For 2-inch by 4-inch outlet boxes.

4. Standard Model: NEMA WD 1 with No. 12 AWG copper USE/RHH/RHW-XLPE insulated pigtails and provisions for testing.

5. Feed-Through Model: NEMA WD 1, with No. 12 AWG copper USE/RHH/RHW-XLPE insulated pigtails and provisions for testing.

6. Manufacturers:

    a. Pass and Seymour.

    b. Bryant.

    c. Leviton.

    d. Hubbell.

    e. Arrow Hart.

    f. Or equal.

D. Receptacle, Special-Purpose:

1. Rating and number of poles as indicated or required for anticipated purpose.

2. Matching plug with cord-grip features for each special-purpose receptacle.

2.05 DEVICE PLATES

A. General: Sectional type plates not permitted.

B. Plastic:

1. Material: Specification grade, 0.10-inch minimum thickness, noncombustible, thermosetting.

2. Color: To match associated wiring device.

3. Mounting Screw: Oval-head metal, color matched to plate.

C. Metal:

1. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.

2. Finish: ASTM A167, Type 302/304, satin.

3. Mounting Screw: Oval-head, finish matched to plate.

D. Cast Metal:

1. Material: Malleable ferrous metal, with gaskets.

2. Screw: Oval-head stainless steel.

E. Engraved:

1. Character Height: 3/16 inch.

2. Filler: Black.

F. Weatherproof:

1. For Receptacles: Gasketed cast metal or stainless steel, with individual cap over each receptacle opening.

2. Mounting Screw: Stainless steel.

a. Cap Spring: Stainless steel.

b. Manufacturers:

i. General Electric.

ii. Bryant.

iii. Hubbell.

iv. Sierra.

v. Pass and Seymour.

vi. Crouse-Hinds; Type WLRD or WLRS.

vii. Bell.

viii. Arrow Hart.

3. For Switches: Gasketed, cast metal incorporating external operator for internal switch.

a. Mounting Screw: Stainless steel.

b. Manufacturers:

i. Crouse-Hinds; DS-181 or DS-185.A

ii. Appleton; FSK-LVTS or FSK-IVS.

G. Raised Sheet Metal: ½-inch high zinc- or cadmium-plated steel designed for one-piece drawn type sheet steel boxes.

2.06 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. NEMA PB I, NFPA 70, and UL 67, including panelboards installed in motor control equipment.

B. Panelboards and Circuit Breakers: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

C. Short-circuit Current Equipment Rating: Fully rated; series connected unacceptable.

D. Rating: Applicable to a system with available short-circuit current as shown on drawings.

E. Where ground fault interrupter circuit breakers are indicated or required by code: 5 mA trip, 10,000 amps interrupting capacity circuit breakers.

F. Integral Transient Voltage Surge Suppression (TVSS) with panelboard assembly as one entity with overall UL rating.

G. Cabinet: As shown on plans.

H. Bus Bar:

1. Material: Copper, full sized throughout length.

2. Provide for mounting of future circuit breakers along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.

3. Neutral: Insulated, rated 150 percent of phase bus bars with at least one terminal screw for each branch circuit.
4. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.

5. Lugs and Connection Points:

   a. Suitable for either copper or aluminum conductors.

   b. Solderless main lugs for main, neutral, and ground bus bars.

   c. Subbed or through-feed lugs as shown.

6. Bolt together and rigidly support bus bars and connection straps on molded insulators.

I. Circuit Breakers:

1. NEMA AB 1 and UL 489.

2. Thermal-magnetic, quick-make, quick-break molded case, of the indicating type showing ON/OFF and TRIPPED positions of operating handle.

3. Noninterchangeable, in accordance with NFPA 70.

4. Locking: Provisions for handle padlocking, unless otherwise shown.

5. Type: Bolt-on circuit breakers in all panelboards.

6. Multipole circuit breakers designed to automatically open all poles when an overload occurs on one pole.

7. Do not substitute single-pole circuit breakers with handle ties for multipole breakers.
8. Do not use tandem or dual circuit breakers in normal single-pole spaces.

9. Ground Fault Interrupter:

   a. Equip with conventional thermal-magnetic trip and ground fault sensor rated to trip in 0.025 second for a 5-milliampere ground fault (UL 943, Class A sensitivity).

   b. Sensor with same rating as circuit breaker and a push-to-test button.

J. Manufacturers:

1. General Electric

2. Square D

3. Siemens.

4. No or approved equal.

2.07 CIRCUIT BREAKER, INDIVIDUAL, 0 TO 600 VOLTS

A. Minimum Interrupt Rating: As shown or as required.

B. NEMA AB I, UL 489 listed for use at location of installation.

C. Thermal-magnetic, quick-make, quick-break, indicating type, showing ON/OFF and TRIPPED indicating positions of the operating handle.

D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Locking: Provisions for padlocking handle.

F. Multipole breakers to automatically open all poles when an overload occurs on one-pole.

G. Enclosure: NEMA 250, Type 12, Industrial Use, 4X – outdoors, wet locations and corrosive areas, unless otherwise shown.

H. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position.

I. Do not provide single-pole circuit breakers with handle ties where multipole circuit breakers are shown.

2.08 FUSED SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. UL 98 listed for use and location of installation.

B. NEMA KS 1 and UL 98 Listed for application to system with available short circuit current of 22,000 amps rms symmetrical.

C. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Fuse mountings shall reject Class H fuses and accept only current-limiting fuses specified.

F. Enclosure: NEMA 250, Type 12, Industrial Use, 4X - outdoors, wet locations and corrosive areas, unless otherwise shown.

G. Interlock: Enclosure and switch to prevent opening cover with switch in the ON position.

H. Provide switch with 2 normally open and two normally closed auxiliary contacts to indicate switch position.

2.09 NONFUSED SWITCH, INDIVIDUAL, 0 TO 600 VOLTS – NOT USED

2.10 FUSE, 0 TO 600 VOLTS

A. Current-limiting, with 200,000 ampere rms interrupting rating.

B. Provide to fit mountings specified with switches and features to reject Class H fuses.

C. Motor and Transformer Circuits, 0- to 600-Volt:

1. Amperage: 0 to 600.

2. UL 198E, Class RK-1, dual element, with time delay.

3. Manufacturers:

a. Bussmann; Type LPS-RK.

b. Littlefuse; Type LLS-RK.

D. Motor and Transformer Circuits, 0- to 250-Volt:

1. Amperage: 0 to 600.

2. UL 198E, Class RK-1, dual element, with time delay.

3. Manufacturers:

a. Bussmann; Type LPN-RK.

b. Littlefuse; Type LLN-RK.

E. Feeder and Service Circuits, 0- to 600-Volt:

1. Amperage: 0 to 600.

2. UL 198E, Class RK-I, dual element, with time delay.

3. Manufacturers:

a. Bussmann; Type LPS-RK.

b. Littlefuse; Type LLS-RK.

F. Feeder and Service Circuits, O- to 250-Volt:

1. Amperage: 0 to 600.

2. UL 198E, Class RK-I, dual element, with time delay.

3. Manufacturers:

a. Bussmann; Type LPN-RK.

b. Littleluse; Type LLN-RK.

G. Feeder and Service Circuits, 0- to 600-Volt:

1. Amperage: 601 to 6,000.

2. UL 198C, Class L, double O-rings and silver links.

3. Manufacturers:

a. Bussmann; Type KRP-C.

b. Littlefuse; Type KLPC.

2.11 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCHES

A. Contact Rating: NEMA ICS 2, Type A600.

B. Selector Switch Operating Lever: Standard.

C. Indicating Lights: Push-to-test LED 30mm.

D. Pushbutton Color:

1. ON or START: Black.

2. OFF or STOP: Red.

E. Pushbuttons and selector switches lockable in the OFF position where indicated.

F. Legend Plate:

1. Material: Aluminum.

2. Engraving: 11 character/spaces on one line, 14 character/spaces on each of two lines, as required, indicating specific function.

3. Letter Height: 7/64 inch.

G. Manufacturers:

1. Heavy-Duty:

a. Square D; Type T.

b. General Electric.

c. Eaton (Crouse-Hinds).

2.12 TERMINAL JUNCTION BOX

A. Cover: Hinged, unless otherwise shown.

B. Terminal Blocks: Provide separate connection point for each conductor entering or leaving box.

1. Spare Terminal Points: 25 percent.

C. Interior Finish: Paint with white enamel or lacquer.

2.13 TERMINAL BLOCK (0 TO 600 VOLTS)

A. UL 486E and UL 1059.

B. Size components to allow insertion of necessary wire sizes.

C. Capable of termination of all control circuits entering or leaving equipment, panels, or boxes.

D. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between the compression screw and yoke.

E. Yoke, current bar, and clamping screw of high strength and high conductivity metal.

F. Yoke shall guide all strands of wire into terminal.

G. Current bar shall ensure vibration-proof connection.

H. Terminals:

1. Capable of wire connections without special preparation other than stripping.

2. Capable of jumper installation with no loss of terminal or rail space.

3. Individual, rail mounted.

I. Marking system allowing use of preprinted or field-marked tags.

J. Manufacturers:

1. Weidmuller.

2. Ideal.

3. Electrovert.

2.14 MAGNETIC CONTACTOR

A. NEMA ICS 2, UL 508.

B. Electrically operated, electrically held.

C. Main Contacts:

1. Power driven in one direction with gravity dropout.

2. Silver alloy with wiping action and arc quenchers.

3. Continuous-duty rated 30 amperes, 600-volt.

4. Three-pole.

D. Control: Two-wire.

E. One normally open and one normally closed auxiliary contact rated 10 amperes at 480-volt.

F. Enclosure: NEMA 250, Type 12, unless otherwise shown.

G. Manufacturers:

1. General Electric.

2. Square D.

3. Allen-Bradley; Bulletin 500 Line.

2.15 MAGNETIC LIGHTING CONTACTOR – NOT USED

2.16 THERMOSTAT – NOT USED

2.17 DRY TYPE TRANSFORMER (0- TO 600-VOLT PRIMARY)

A. UL 1561, NEMA ST 20, unless otherwise indicated.

B. Self-cooled, two winding, UL K-4 rated for nonlinear loads.

C. Insulation Class and Temperature Rise: Manufacturer's standard.

D. Core and Coil:

1. Encapsulated for single-phase units ½ to 25 kVA and for three-phase units 3 to 15 kVA.

2. Thermosetting varnish impregnated for single-phase units 37.5 kVA and above, and for three-phase units 30 kVA and above.

E. Enclosure:

1. Single-Phase, 3 to 10 kVA: NEMA 250, Type 3R, non-ventilated.

2. Single-Phase, 15 kVA and above: NEMA 250, Type 2, ventilated.

3. Three-Phase, 3 to 9 kVA: NEMA 250, Type 3R, non-ventilated.

Three-Phase, 15 kVA and above: NEMA 250, Type 2, ventilated.

5. Outdoor Transformers: NEMA 250, Type 3R.

F. Wall Bracket: For single-phase units, 15 to 37-1/2 kVA, and for three-phase units, 15 to 30 kVA.

G. Voltage Taps:

1. Single-Phase, 3 to 10 kVA: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.

2. Single-Phase, 15 kVA and Above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.

3. Three-Phase, 3 to 9 kVA: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.

4. Three-Phase, 15 kVA and Above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.

H. Impedance: 4.5 percent minimum on units 75 kVA and larger.

I. Maximum Sound Level: NEMA ST 20:

1. 40 decibels for 0 to 9 kVA.

2. 45 decibels for 10 to 50 kVA.

3. 50 decibels for 51 to 150 kVA.

4. 55 decibels for 151 to 300 kVA.

5. 60 decibels for 301 to 500 kVA.

J. Vibration Isolators:

1. Rated for transformer's weight.

2. Isolation Efficiency: 99 percent, at fundamental frequency of sound emitted by transformer.

3. Less Than 30 kVA: Isolate entire unit from structure with external vibration isolators.

4. 30 kVA and above: Isolate core and coil assembly from transformer enclosure with integral vibration isolator.

K. Manufacturers:

1. Square D

2. General Electric.

3. Eaton (Cutler-Hammer).

2.18 LOW VOLTAGE, SURGE ARRESTOR FOR MOTOR

A. NEMA LA1, ANSI C62. 11, UL 1449 3RD edition.

B. Suitable for Type 1 or Type 2 surge protection device.

C. Approved for outdoor applications including: irrigation equipment, lighting fixtures, HVACR controls, and motors.

D. Install at the line side of the motor disconnect where shown on plans.

E. Intermatic model: AG65033, AG65033L3 or approved equal.

2.19 SUPPORT AND FRAMING CHANNELS

A. Material:

1. Dry indoor - galvanized.

2. All Other Areas: ASTM A167, Type 316 stainless steel.

B. Finish:

1. Dry indoor - galvanized.

2. All Other Areas: ASTM A167, Type 316 stainless steel.

C. Inserts: Continuous.

D. Beam Clamps: 316 stainless steel.

E. Manufacturers:

1. B-Line.

2. Unistrut.

2.20 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment Screws: Stainless steel.

C. Color: White, engraved to a black core.

D. Engraving:

1. Pushbuttons/Selector Switches: Name of drive controlled on one, two, or three lines, as required.

2. Panelboards: Panelboard designation, service voltage, and phases.

E. Letter Height:

1. Pushbuttons/Selector Switches: 1/8 inch.

2. Panelboards: 1/4 inch.

2.21 SURGE PROTECTION DEVICE

A. This section describes the material and installation requirements for transient voltage surge suppression devices (TVSS) or surge protective device (SPD) in switchboards, panelboards, main breaker, and motor control centers for the protection of all AC electrical circuits.

B. SPD shall be listed and component recognized in accordance with UL 1449 4th edition and UL 1283.

C. SPD shall be installed and warranted by and shipped from the electrical distribution equipment manufacturer's factory.

D. SPD shall provide surge current diversion paths for all modes of protection; L-L, L-N, L-G, N-G in WYE systems, and L-L, L-G in DELTA systems.

E. SPD shall be modular in design. Each module shall be fused with a surge rated fuse.

F. A UL approved disconnect switch shall be provided as a means of disconnect in the switchboard device only.

G. SPD shall meet or exceed the following criteria:

1. Maximum surge current capability (single pulse rated) shall be:

   a. Service entrance equipment, switchboard, switchgear: 300kA

   b. Branch panelboards & MCC: 200kA

   c. Lighting panelboards: 100kA

2. UL 1449 Listed and Recognized Component Suppression Voltage Ratings shall not exceed the following:

Voltage	L-N	L-G	N-G
208Y/120	700V	700V	700V
480Y/277	1200V	1200V	1200V

H. SPD shall be UL labeled with a 20kA I-nominal (ensuring UL 96A compliance), 200kA Short Circuit Current Rating (SCCR), and labeled as a Type 1 device.

I. SPD shall be provided with 1 set of NO/NC dry contacts, visual LED diagnostics and indications.

J. SPD shall have a warranty for a period of five years, incorporating unlimited replacements of suppressor parts if they are destroyed by transients during the warranty period. Warranty will be the responsibility of the electrical distribution equipment manufacturer.

K. Approve manufactures are:

1. Eaton (Cutler Hammer).

2. General Electric.

3. Siemans.

4. Square D Company.

5. Current Technology.

6. Or Engineer approved equal.

2.22 SMOKE DETECTORS – NOT USED.

2.23 GENERAL PURPOSE RELAYS

A. General purpose relays in the control panels shall be plug in type with contacts rated 10 amperes at 120 volts AC. The quantity and type of contacts shall be as shown on the Drawings. Each relay shall be enclosed in a clear plastic heat and shock resistant dust cover. Sockets for relays shall have screw type terminals. Relay shall be push to test type with LED indication light. Relays shall be Potter and Brumfield Type KRP or KUP, Square-D Type K, or equal.

PART 3 – EXECUTION

3.01 GENERAL

A. Install equipment in accordance with NECA 5055.

3.02 OUTLET AND DEVICE BOXES

A. Install suitable for conditions encountered at each outlet or device in the wiring or raceway system, sized to meet NFPA 70 requirements.

B. Size:

1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.

a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.

2. Ceiling Outlet: Minimum 4-inch octagonal sheet steel device box, unless otherwise required for installed fixture.

3. Switch and Receptacle: Minimum 2-inch by 4-inch sheet steel device box.

C. Locations:

1. Drawing locations are approximate.

2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by Engineer.

3. Light Switch: Install on lock side of doors.

4. Light Fixture: Install in symmetrical pattern according to room layout unless otherwise shown.

D. Mounting Height:

1. General:

a. Measured to centerline of box.

b. Where specified heights do not suit building construction or finish, mount as directed by Engineer.

2. Light Switch: 48 inches above floor.

3. Thermostat: 54 inches above floor.

4. Telephone Outlet: 6 inches above counter tops or 15 inches above floor.

5. Wall Mounted Telephone Outlet: 52 inches above floor.

6. Convenience Receptacle:

a. General Interior Areas: 15 inches above floor.

b. General Interior Areas (Counter Tops): Install device plate bottom or side flush with top of splashback, or 6 inches above countertops without splashback.

c. Industrial Areas, Workshops: 48 inches above floor.

d. Outdoor, All Areas: 24 inches above finished grade.

7. Special-Purpose Receptacle: 54 inches above floor or as shown.

E. Install plumb and level.

F. Flush Mounted:

1. Install with concealed conduit.

2. Install proper type extension rings or plasters covers to make edges of boxes flush with finished surface.

3. Holes in surrounding surface shall be no larger than required to receive box.

G. Support boxes independently of conduit by attachment to building structure or structural member.

H. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws threaded into steelwork.

I. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

J. Provide plaster rings where necessary.

K. Boxes embedded in concrete or masonry need not be additionally supported.

L. Install stainless steel mounting hardware in industrial areas.

M. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.

N. Open no more knockouts in sheet steel device boxes than is required; seal unused openings.

O. Box Type (Steel Raceway System):

1. Exterior Locations:

a. Exposed Raceways: Cast metal.

b. Concealed Raceways: Cast metal.

c. Concrete Encased Raceways: Cast metal.

d. Class I, II, or III Hazardous Areas: Cast metal.

2. Interior Dry Locations:

a. Exposed Rigid Conduit: Cast metal.

b. Concealed Raceways: Sheet steel.

c. Concrete Encased Raceways: Cast metal.

d. Lighting Circuits, Ceiling: Sheet steel.

e. Class I, II, or III Hazardous Areas: Cast metal.

3. Interior Wet Locations:

a. Exposed Raceways: Cast metal.

b. Concealed Raceways: Cast metal.

c. Concrete Encased Raceways: Cast metal.

d. Lighting Circuits, Ceiling: Sheet steel.

e. Class I, II, or III Hazardous Areas: Cast metal.

4. Cast-In-Place Concrete Slabs: Sheet steel.

P. Box Type (Rigid Aluminum Raceway System): Cast aluminum.

Q. Box Type (Nonmetallic Raceway System):

1. Corrosive Locations: Nonmetallic.

2. Exposed Raceways: Nonmetallic.

3. Concealed Raceways: Nonmetallic.

4. Concrete Encased Raceways: Nonmetallic.

R. Box Type, Corrosive Locations (PVC-Coated Rigid Galvanized Steel Raceway System): PVC coated cast metal.

3.03 JUNCTION AND PULL BOXES

A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.

B. Install pull boxes where necessary in raceway system to facilitate conductor installation.

C. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

D. Use outlet box as junction and pull boxes wherever possible and allowed by applicable codes.

E. Installed boxes shall be accessible.

F. Do not install on finished surfaces.

G. Install plumb and level.

H. Support boxes independently of conduit by attachment to building structure or structural member.

I. Install bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units, and machine screws or welded threaded studs on steelwork.

J. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

K. Boxes embedded in concrete or masonry need not be additionally supported.

L. At or Below Grade:

1. Install boxes for below grade conduit flush with finished grade in locations outside of paved areas, roadways, or walkways.

2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.

3. Obtain Engineer's written acceptance prior to installation in paved areas, roadways, or walkways.

4. Use boxes and covers suitable to support anticipated weights.

M. Flush Mounted:

1. Install with concealed conduit.

2. Holes in surrounding surface shall be no larger than required to receive box.

3. Make edges of boxes flush with final surface.

N. Mounting Hardware:

1. Non-corrosive Interior Areas: Galvanized.

2. All Other Areas: Stainless steel.

O. Location/Type:

1. Finished, Indoor, Dry: NEMA 250, Type 1.

2. Unfinished, Indoor, Dry: NEMA 250, Type 12.

3. Unfinished, Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X.

4. Unfinished, Indoor and Outdoor, Wet, Dust, or Oil: NEMA 250, Type 13.

5. Unfinished, Indoor and Outdoor, Hazardous: NEMA 250, Type 7 and Type 9, where indicated.

6. Underground Conduit: Concrete Encased.

3.04 WIRING DEVICES

A. Switches:

1. Mounting Height: See Paragraph OUTLET AND DEVICE BOXES.

2. Install with switch operation in vertical position.

3. Install single-pole, two-way switches such that toggle is in up position when switch is on.

B. Receptacles:

1. Install with grounding slot down except where horizontal mounting is shown, in which case install with neutral slot up.

2. Ground receptacles to boxes with grounding wire only.

3. Weatherproof Receptacles:

a. Install in cast metal box.

b. Install such that hinge for protective cover is above receptacle opening.

4. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for “downstream” conventional receptacles.

5. Special-Purpose Receptacles: Install in accordance with manufacturer's instructions.

C. Multi-outlet Surface Raceway System:

1. Install in accordance with manufacturer's instructions.

2. Wire alternate outlets to each circuit where two-circuit, three-wire supply is shown.

3.05 DEVICE PLATES

A. Securely fasten to wiring device; ensure a tight fit to the box.

B. Flush Mounted: Install with all four edges in continuous contact with finished wall surfaces without use of mats or similar materials. Plaster fillings will not be acceptable.

C. Surface Mounted: Plate shall not extend beyond sides of box unless plates have no sharp corners or edges.

D. Install with alignment tolerance to box of 1/16 inch.

E. Engrave with designated titles, panel and circuit number.

F. Types (Unless Otherwise Shown):

1. Office: Stainless Steel.

2. Exterior: Weatherproof.

3. Interior:

a. Flush Mounted Boxes: Stainless Steel.

b. Surface Mounted, Cast Metal Boxes: Cast metal.

c. Surface Mounted, Sheet Steel Boxes: Stainless Steel.

d. Surface Mounted, Nonmetallic Boxes: Plastic.

3.06 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Heavy-Duty, Oil-tight Type: Locations (Unless Otherwise Shown): Non-hazardous, indoor, dry locations, including motor control centers, control panels, and individual stations.

B. Heavy-Duty, Watertight, and Corrosion-Resistant Type:

1. Locations (Unless Otherwise Shown): Non-hazardous, outdoor, or normally wet areas.

2. Mounting: NEMA 250, Type 4X enclosure.

3.07 TERMINAL JUNCTION BOX

A. Install in accordance with Paragraph JUNCTION AND PULL BOXES.

B. Label terminal junction boxes

C. Label each block and terminal with permanently attached, non-destructible tag.

D. Do not install on finished outdoor surfaces.

E. Location:

1. Finished, Indoor, Dry: NEMA 250, Type 1.

2. Unfinished, Indoor, Dry: NEMA 250, Type 12.

3. Unfinished, Indoor and Outdoor, Wet and Corrosive: NEMA 250, Type 4X.

4. Unfinished, Indoor and Outdoor, Wet, Dust, or Oil: NEMA 250, Type 13.

3.08 DRY TYPE TRANSFORMER (0- TO 600-VOLT PRIMARY)

A. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.

B. Provide moisture-proof, flexible conduit for electrical connections.

C. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.

D. Provide wall brackets for single-phase units, 15 to 167-1/2 kVA, and three-phase units, 15 to 112 kVA.

3.09 SUPPORT AND FRAMING CHANNEL

A. Furnish zinc-rich primer; paint cut ends before installation, where applicable.

B. Install where required for mounting and supporting electrical equipment and raceway systems.

END OF SECTION

SECTION 16110
RACEWAYS

PART 1 – GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): Division I, Standard Specifications for Highway Bridges, Fourteenth Edition.

2. American National Standards Institute (ANSI):

a. C80.1, Rigid Steel Conduit-Zinc Coated.

b. C80.3, Electrical Metallic Tubing-Zinc Coated.

c. CS0.5, Rigid Aluminum Conduit.

d. C80.6, Intermediate Metal Conduit (IMC)-Zinc Coated.

3. American Society for Testing and Materials (ASTM):

a. A123 El, Standard Specification for Zinc-Coated (Galvanized) Coatings on Iron and Steel Products.

b. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.

4. National Electrical Contractors Association, Inc. (NECA): 5055, Standard of Installation.

5. National Electrical Manufacturers Association (NEMA):

a. RN 1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

b. TC 2, Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).

c. TC 3, PVC Fittings for Use with Rigid PVC Conduit and Tubing.

d. TC 6, PVC and ABS Plastic Utilities Duct for Underground Installation.

e. VE 1, Metallic Cable Tray Systems.

6. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC)

7. Underwriters Laboratories, Inc. (UL):

a. 1, Standard for Safety Flexible Metal Conduit.

b. 6, Standard for Safety Rigid Metal Conduit.

c. 360, Standard for Safety Liquid-Tight Flexible Steel Conduit.

d. 514B, Standard for Safety Fittings for Conduit and Outlet Boxes.

e. 514C, Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.

f. 651, Standard for Safety Schedule 40 and 80 PVC Conduit.

g. 651A, Standard for Safety Type EB and Rigid PVC Conduit and HDPF Conduit.

h. 797, Standard for Safety Electrical Metallic Tubing.

i. 870, Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings.

j. 1242, Standard for Safety Intermediate Metal Conduit.

k. 1660, Standard for Safety Liquid-Tight Flexible Nonmetallic Conduit.

1.02 SUBMITTALS

A. Shop Drawings:

1. Manufacturer's Literature:

a. Rigid Rigid aluminum conduit.

b. Electric metallic tubing.

c. PVC Schedule 40 conduit.

d. PVC-coated rigid galvanized steel conduit.

e. Flexible metal, liquid-tight conduit.

f. Flexible, nonmetallic, liquid-tight conduit.

g. Conduit fittings.

h. Raceway tags: Provide samples

i. Wireways.

j. Stainless Steel Conduits.

2. Precast Manholes and Handholes:

a. Dimensional drawings and descriptive literature.

b. Traffic loading calculations.

c. Accessory information.

3. Cable Tray Systems:

a. Dimensional drawings, calculations, and descriptive information.

b. NEMA load/span designation and how it was selected.

c. Support span length and pounds-per-foot actual and future cable loading at locations, with safety factor used.

d. Location and magnitude of maximum simple beam deflection of tray for loading specified.

e. Layout drawings and list of accessories being provided.

4. Conduit Layout – Scale not greater than 1 inch equals 20 feet. Plan and section type, showing arrangement and location of exposed conduit for:

a. Low voltage feeder and branch circuits.

b. Instrumentation and control systems.

c. Communications systems.

d. Empty conduit for future use.

5. Equipment and machinery proposed for bending metal conduit.

6. Method for bending PVC conduit less than 30 degrees.

1.03 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 – PRODUCTS

2.01 CONDUIT AND TUBING

A. Rigid Aluminum Conduit:

1. Meet requirements of ANSI C80.5 and UL6.

2. Material: Type 6063, copper-free aluminum alloy.

B. Electric Metallic Tubing (EMT): Not Used:

C. PVC Schedule 40 Conduit:

1. Meet requirements of NEMA TC 2 and UL 651.

2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.

D. PVC-Coated Rigid Galvanized Steel Conduit: Not Used

E. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105 degrees C insulated conductors.

2. Material: Galvanized steel, with an extruded PVC jacket.

F. Flexible, Nonmetallic, Liquid-Tight Conduit:

1. Material: PVC core with fused flexible PVC jacket.

2. UL 1660 listed for:

a. Dry Conditions: 80 degrees C insulated conductors.

b. Wet Conditions: 60 degrees C insulated conductors.

3. Manufacturers:

a. Carlon; Carflex or X-Flex.

b. T & B; Xtraflex LTC or EFC.

G. Stainless Steel Conduit:

1. Meet requirements of ANSI C80.1 and UL6A.

2. Material: 316 stainless steel, polished to a bright, easily maintainable finish.

H. PVC Schedule 80 Conduit:

1. Meet requirements of NEMA TC 2 and UL 651.

2. UL listed for use in aboveground and underground direct burial, concealed or direct sunlight exposure, including areas subject to physical damage and 90 degrees C insulated conductors.

2.02 FITTINGS

A. Rigid Aluminum:

1. General:

a. Meet requirements of UL 514B.

b. Type: Threaded, copper-free. Set screw fittings not permitted.

2. Insulated Bushing:

a. Material: Cast aluminum, with integral insulated throat, rated for 150 degrees C.

b. Manufacturer: O.Z. Gedney; Type AB.

3. Grounding Bushing:

a. Material: Cast aluminum with integral insulated throat, rated for 150 degrees, with solderless lugs.

b. Manufacturer: O.Z. Gedney; Type ABLG.

4. Conduit Hub:

    a. Material: Cast aluminum, with insulated throat.

    b. Manufacturers:

        i. O.Z. Gedney; Type CHA.

        ii. T & B; Series 370AL.

5. Conduit Bodies:

    a. Manufacturers (For Normal Conditions):

        iii. Appleton; Form 85 threaded Unilets.

        iv. Crouse-Hinds; Mark 9 or Form 7-SA threaded condulets.

        v. Killark; Series O Electrolets.

    b. Manufacturers (For Hazardous Locations):

        vi. Appleton.

        vii. Crouse-Hinds.

        viii. Killark.

6. Couplings: As supplied by conduit manufacturer.

7. Conduit Sealing Fitting Manufacturers:

    a. Appleton; Type EYF-AL or EYM-AL.

    b. Crouse-Hinds; Type EYS-SA or EZS-SA.

    c. Killark; Type EY or EYS.

8. Drain Seal Manufacturers:

    a. Appleton; Type EYDM-A.

    b. Crouse-Hinds; Type EYD-SA or EZD-SA.

9. Drain/Breather Fitting Manufacturers:

    a. Appleton; Type ECDB.

    b. Crouse-Hinds; ECD.

10. Expansion Fitting Manufacturers:

    a. Deflection/Expansion Movement: Steel City; Type DF-A.

    b. Expansion Movement Only: Steel City; Type AF-A.

11. Cable Sealing Fittings: To form watertight nonslip cord or cable connection to conduit.

    a. Bushing: Neoprene at connector entry.

    b. Manufacturer: Appleton CG-S.

B. Electric Metallic Tubing:

1. Meet requirements of UL 514B.

2. Type: Steel body and locknuts with steel or malleable iron compression nuts. Setscrew and drive-on fittings not permitted.

3. Compression Ring: Stainless steel.

4. Coupling Manufacturers:

    a. Appleton; Type 95T.

    b. Crouse-Hinds; Type CPR.

5. Connector Manufacturers:

    a. Appleton; Type 86T.

    b. Crouse-Hinds; Type CPR.

C. PVC Conduit and Tubing:

1. Meet requirements of NEMA TC-3.

2. Type: PVC, slip-on.

D. PVC-Coated Rigid Galvanized Steel Conduit: Not Used

E. Flexible Metal, Liquid-Tight Conduit:

1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.

2. Insulated throat and sealing O-rings.

3. Long design type extending outside of box or other device at least 2 inches.

4. Manufacturer: T & B; Series 5300.

F. Flexible, Nonmetallic, Liquid-Tight Conduit: Meet requirements of UL 514B.

1. Type: One-piece fitting body, complete with lock nut, O-ring, threaded ferrule, sealing ring, and compression nut.

2. Manufacturers:

a. Carlon; Type LT.

b. Kellems; Polytuff.

c. T & B; LT Series.

G. Watertight Entrance Seal Device:

1. New Construction:

a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.

b. Manufacturer: O.Z./Gedney; Type FSK or WSK, as required.

2. Gored-Hole Application:

a. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.

b. Manufacturer: O.Z./Gedney; Series CSM.

H. Hazardous Locations: Approved for use in the atmosphere involved.

1. Manufacturer: Crouse-Hinds; Type ECGJH.

I. Stainless Steel:

1. General:

a. Meet requirements of UL.

b. Type: Threaded, 316 stainless steel. Set screw or compression (threadless) fittings not permitted.

2. Bushing:

a. Material: 316 stainless steel.

b. Manufacturers:

i. Thomas & Betts.

ii. O.Z./Gedney.

2.03 ACCESSORIES

A. Duct Bank Spacers:

1. Type: Nonmetallic, interlocking, for multiple conduit sizes.

2. Suitable for all types of conduit.

3. Manufacturer: Underground Device, Inc.; Type WUNPEECE.

B. Identification Devices:

1. Raceway Tags:

2. Material: Permanent, nylon.

3. Shape: Round.

4. Raceway Designation: Pressure stamped, embossed, or engraved.

5. Tags relying on adhesives or taped-on markers not permitted.

6. Warning Tape:

7. Material: Polyethylene, 4-mil gauge.

8. Color: Red.

9. Width: Minimum 6-inch.

10. Designation: Warning on tape that electric circuit is located below tape.

11. Manufacturers:

    a. Blackburn, Type RT.

    b. Griffolyn Co.

C. Buried Raceway Marker:

1. Material: Sheet bronze, consisting of double-ended arrows, straight for straight runs and bent at locations where runs change direction.

2. Designation: Incise to depth of 3/32 inch, ELECTRIC CABLES. in letters 1/4-inch high.

3. Minimum Dimension: 1/4-inch thick, 10 inches long, and 3/4-inch wide.

D. Wraparound Duct Band:

1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.

2. Manufacturer: Raychem; Type TWDB.

PART 3 –EXECUTION

3.01 GENERAL

A. Conduit and Tubing sizes shown are based on the use of copper conductors.

B. All installed Work shall comply with National Electrical Code (NEC).

C. Crushed or deformed raceways not permitted.

D. Maintain raceway entirely free of obstructions and moisture.

E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.

F. Rigid Aluminum Conduit: Do not install in direct contact with concrete. Use unistrut or back and strap (clamp back strap) for installation on concrete wall or surface.

G. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.

H. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.

I. Group raceways installed in same area.

J. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

K. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.

L. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.

M. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.

N. Install watertight fittings in outdoor, underground, or wet locations.

O. Paint threads, before assembly of fittings, of galvanized conduit installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.

P. All metal conduit shall be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.

Q. Do not install raceways in concrete equipment pads, foundations, or beams.

R. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.

S. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

3.02 INSTALLATION IN CAST-IN-PLACE STRUCTURAL CONCRETE

A. Minimum cover 1-1/2 inches.

B. Provide support during placement of concrete to ensure raceways remain in position.

C. Floor Slabs:

1. Outside diameter of conduit not to exceed one-third of the slab thickness.

2. Separate conduit by minimum six times conduit outside diameter, except at crossings.

3.03 CONDUIT APPLICATION

A. Diameter: Minimum 3/4 inch.

B. Exterior, Exposed:

1. Rigid Aluminum.

C. Interior, Exposed:

1. Rigid Aluminum.

D. Interior, Concealed (Not Embedded in Concrete):

1. PVC Schedule 40.

E. Aboveground, Embedded in Concrete Walls, Ceilings, or Floors:

1. PVC Schedule 40

F. Direct Earth Burial: PVC Schedule 80.

G. Concrete-Encased Raceways: PVC Schedule 40.

H. Under Slabs-On-Grade: PVC Schedule 40.

I. Corrosive Areas, Exterior: Rigid Aluminum.

J. Corrosive Areas, Interior: Rigid Aluminum.

K. NEC Class 1 Division 2 explosive areas: Rigid Aluminum.

L. Lighting Protection: PVC Schedule 40.

3.05 CONNECTIONS

A. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other equipment where flexible connection is required to minimize vibration:

B. Conduit Size 4 Inches or less: Flexible metal, liquid-tight conduit.

C. Conduit Size Over 4 Inches: Non-flexible.

D. Corrosive Areas: Flexible, nonmetallic, liquid-tight or PVC-coated metallic, liquid-tight.

E. Length: 18-inch minimum, 60-inch maximum, of sufficient length to allow movement or adjustment of equipment.

F. Lighting Fixtures in Dry Areas: Flexible steel, non-liquid-tight conduit.

G. Outdoor Areas, Process Areas Exposed to Moisture, and Areas required to be Oil-tight and Dust-Tight: Flexible metal, liquid-tight conduit.

H. Transition from Underground or Concrete Embedded to Exposed: 316 stainless steel with heat shrink as shown on electrical detail drawings. 316 stainless steel nipple shall continue to above grade.

I. Under Equipment Mounting Pads: Rigid Aluminum.

J. Exterior Light Pole Foundations: conduit PVC Schedule 40.

3.06 PENETRATIONS

A. Make at right angles, unless otherwise shown.

B. Notching or penetration of structural members, including footings and beams, not permitted.

C. Fire-Rated Walls, Floors, or Ceilings: Fire-stop openings around penetrations to maintain fire-resistance rating.

D. Apply single layer of wraparound duct band to all metallic conduit in contact with concrete floor slabs to a point 2 inches above concrete surface.

E. Concrete Walls, Floors, or Ceilings (Aboveground): Provide non-shrink grout dry-pack, or use watertight seal device.

F. Entering Structures:

G. General: Seal raceway at the first box or outlet with minimum 2 inches thick expandable plastic compound to prevent the entrance of gases or liquids from one area to another.

H. Concrete Roof or Membrane Waterproofed Wall or Floor:

1. Provide a watertight seal.

2. Without Concrete Encasement: Install watertight entrance seal device on each side.

3. With Concrete Encasement: Install watertight entrance seal device on the accessible side.

4. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.

5. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.

6. Heating, Ventilating, and Air Conditioning Equipment:

    a. Penetrate equipment in area established by manufacturer.

    b. Terminate conduit with flexible metal conduit at junction box or condulet attached to exterior surface of equipment prior to penetrating equipment.

    c. Seal penetration with silicone type sealant as specified in Section 07270, FIRE STOPPING.

7. Corrosive-Sensitive Areas:

    a. Seal all conduits passing through chlorine and ammonia room walls.

    b. Seal all conduits entering equipment panel boards and field panels containing electronic equipment.

    c. Seal penetration with silicone type sealant as specified in Section 07270, FIRE STOPPING.

8. Existing or Precast Wall (Underground): Core drill wall and install watertight entrance seal device.

9. Non-waterproofed Wall or Floor (Underground, without Concrete Encasement):

    a. Provide Schedule 40 galvanized pipe sleeve or aluminum pipe sleeve, or watertight entrance seal device.

    b. Fill space between raceway and sleeve with an expandable plastic compound on each side.

10. Manholes and Handholes:

    a. Metallic Raceways: Provide insulated grounding bushings.

    b. Nonmetallic Raceways: Provide bell ends flush with wall.

c. Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

3.07 SUPPORT

A. Support from structural members only, at intervals not exceeding 8 feet. Do not support from piping, pipe supports, or other raceways. Provide all necessary 316 stainless steel mounting hardware, beam clamp, threaded rod, etc. for a complete support system for exposed raceways.

B. Multiple Adjacent Raceways: Provide ceiling trapeze. For trapeze-supported conduit, allow 40 percent extra space for future conduit.

C. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:

D. Wood: Wood screws.

E. Hollow Masonry Units: Toggle bolts.

F. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.

G. Steelwork: Machine screws.

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

3.08 BENDS

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

B. Make bends and offsets of longest practical radius.

C. Install with symmetrical bends or cast metal fittings.

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

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

F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

G. PVC Conduit:

H. Bends 30-Degree and larger: Provide factory-made elbows for exposed applications. Use 316 stainless steel elblow with heat shrink for underground applications.

I. 90-Degree Bends: Provide rigid aluminum elbows for exposed applications. Use 316 stainless steel elblow with heat shrink for underground applications.

J. Use manufacturer's recommended method for forming smaller bends.

K. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

3.09 EXPANSION/DEFLECTION FITTINGS

A. Provide on all raceways at all structural expansion joints, and in long tangential runs.

B. Provide expansion/deflection joints for 50 degrees F maximum temperature variation.

C. Install in accordance with manufacturer's instructions.

3.10 PVC CONDUIT

A. Solvent Welding:

B. Provide manufacturer recommended solvent; apply to all joints.

C. Install such that joint is watertight.

D. Adapters:

E. PVC to Metallic Fittings: PVC terminal type.

F. PVC to Rigid Metal Conduit or IMC: PVC female adapter.

G. Belied-End Conduit: Bevel the unbelled end of the joint prior to joining.

3.11 PVC-COATED RIGID STEEL CONDUIT – Not Used

3.12 WIREWAYS

A. Install in accordance with manufacturer's instructions.

B. Locate with cover on accessible vertical face of wireway, unless otherwise shown.

3.13 TERMINATION AT ENCLOSURES

A. Cast Metal Enclosure: Provide manufacturer's pre-molded insulating sleeve inside metallic conduit terminating in threaded hubs.

B. NEMA 12 and NEMA 4X Enclosures: Provide conduit hubs

C. Sheet Metal Boxes, Cabinets, and Enclosures:

1. Rigid Aluminum Conduit:

a. Provide one lock nut each on inside and outside of enclosure.

b. Install grounding bushing.

c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad; if neither ground bus nor pad exists, connect jumper to lag bolt attached to metal enclosure.

d. Install insulated bushing on ends of conduit where grounding is not required.

e. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.

2. Electric Metallic Tubing: Provide gland compression, insulated connectors.

3. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.

4. Flexible, Nonmetallic Conduit: Provide nonmetallic, liquid-tight strain relief connectors.

5. PVC Schedule 40 Conduit: Provide PVC terminal adapter with lock nut.

D. Motor Control Center, Switchboard, Switchgear, and Free-Standing Enclosures: Terminate conduit entering bottom with grounding bushing; provide a grounding jumper extending to equipment ground bus or grounding pad.

3.14 UNDERGROUND RACEWAYS

A. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.

B. Cover: Maintain minimum 2-foot cover above conduit and concrete encasement, unless otherwise shown.

C. Make routing changes as necessary to avoid obstructions or conflicts.

D. Couplings: In multiple conduit runs, stagger so that couplings in adjacent runs are not in same transverse line.

E. Union type fittings not permitted.

F. Spacers:

1. Provide preformed, nonmetallic spacers, designed for such purpose, to secure and separate parallel conduit runs in a trench or concrete encasement.

2. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 6 feet.

G. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.

H. Installation with Other Piping Systems:

I. Crossings: Maintain minimum 12-inch vertical separation.

J. Parallel Runs: Maintain minimum 12-inch separation.

K. Installation over valves or couplings not permitted.

L. Metallic Raceway Coating: At couplings and joints and along entire length, apply wraparound duct band with one-half tape width overlap to obtain two complete layers.

M. Concrete Encasement: As specified in Section 03300, Cast-In-Place Concrete.

N. Concrete Color: Gray, dust top of concrete ductbank with powdered red concrete dye before concrete sets and trowel dry onto top of ductbank.

O. Backfill:

P. As specified in Section 02222, Excavation and Backfill for Utilities and Section 02224 Excavation and Backfill for Structures.

Q. Do not backfill until inspected by Engineer.

3.15 EMPTY RACEWAYS

A. Provide permanent, removable cap over each end.

B. Provide PVC plug with pull-tab for underground raceways with end bells.

C. Provide nylon pull cord.

D. Identify, as specified in Paragraph IDENTIFICATION DEVICES, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.16 IDENTIFICATION DEVICES

A. Raceway Tags:

B. Identify origin and destination.

C. Install at each terminus, near midpoint, and at minimum intervals of every 50 feet of exposed Raceway, whether in ceiling space or surface mounted.

D. Provide nylon strap for attachment.

E. Warning Tape: Install approximately 12 inches above underground or concrete-encased raceways. Align parallel to, and within 12 inches of, centerline of runs.

F. Buried Raceway Markers:

G. Install at grade to indicate direction of underground raceways.

H. Install at all bends and at intervals not exceeding 100 feet in straight runs.

I. Embed and secure to top of concrete base, sized 14 inches long, 6 inches wide, and 8 inches deep; top set flush with finished grade.

3.17 PROTECTION OF INSTALLED WORK

A. Protect products from effects of moisture, corrosion, and physical damage during construction.

B. Provide and maintain manufactured watertight and dust-tight seals over all conduit openings during construction.

C. Touch up painted conduit threads after assembly to cover nicks or scars.

D. Touch up damage to coating on PVC-coated conduit with patching compound approved by manufacturer.

END OF SECTION

SECTION 16120
CONDUCTORS

PART 1 – GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American National Standards Institute (ANSI): 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.

2. American Society for Testing and Materials (ASTM):

a. A167, Standard Specification for Stainless and Heat Resisting Chromium-Nickel-Plated Steel Plate, Sheet, and Strip.

b. B3, Standard Specification for Soft or Annealed Copper Wire.

c. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

d. B263, Standard Test Method for Determination of Cross- Sectional Area of Stranded Conductors.

3. Association of Edison Illuminating Companies (AEIC):

a. CS 5, Crosslinked Polyethylene Insulated Shielded Power Cables Rated 5 through 35 kV.

b. CS 6, Ethylene- Propylene-Rubber-Insulated Shielded Power Cables Rated 5 through 69 kV.

4 Insulated Cable Engineer's Association, Inc. (ICEA): T-29-250, Procedure for Conducting Vertical Cable Tray Flame Test with a Theoretical Heat Input of 210,000 Btu/hour.

5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

a. 48, Standard Test Procedures and Requirements or High-Voltage Alternating Current Cable Terminations.

b. 404, Standard for Cable Joints for Use with Extruded Dielectric Cable Rated 5,000V through 46,000V and Cable Joints for Use with Laminated Dielectric Cable Rated 2,500V through 500,000V.

6. National Electrical Contractors Association, Inc. (NECA): 5055, Standard of Installation.
7. National Electrical Manufacturers' Association (NEMA):

   a. CC 1, Electric Power Connectors for Substations.

   b. WC 3, Rubber-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

   c. WC 5, Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

   d. WC 7, Crosslinked-Thermosetting-Polyethylene-lnsulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

   e. WC 8, Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

   f. WC 55, Instrumentation Cables and Thermocouple Wire.

8. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

9. Underwriters Laboratories, Inc. (UL):

   a. 13, Standard for Safety Power-Limited Circuit Cables.

   b. 44, Standard for Safety Rubber-Insulated Wires and Cables.

   c. 62, Standard for Safety Flexible Cord and Fixture Wire.

   d. 486A, Standard for Safety Wire Connector and Soldering Lugs for Use with Copper Conductors.

   e. 486B, Standard for Safety Wire Connectors and Soldering Lugs for Use with Aluminum Conductors.

   f. 510, Standard for Safety Insulating Tape.

   g. 854, Standard for Safety Service-Entrance Cables.

h. 910, Standard for Safety Test Method for Fire and Smoke Characteristics of Electrical and Optical-Fiber Cables Used in Air Handling Spaces.

i. 1072, Standard for Safety Medium-Voltage Power Cables.

j. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

k. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.02 SUBMITTALS

A. Shop Drawings:

1. Wire and cable descriptive product information.

2. Wire and cable accessories for conductors 600 volts and below descriptive product information.

3. Wire and cable accessories for conductors above 600 volts descriptive product information.

4. Wire and cable Identification devices with samples of each type.

5. Cable fault detection system descriptive product information.

B. Quality Control Submittals:

1. Certified Factory Test Report for conductors 600 volts and below.

1.03 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 – PRODUCTS

2.01 CONDUCTORS 600 VOLTS AND BELOW

A. Conform to applicable requirements of NEMA WC 3, WC 5, and WC 7.

B. Conductor Type:

1. 120- and 277-Volt Lighting, No. 10 AWG and Smaller: Stranded copper.

2. 120-Volt Receptacle Circuits, No. 10 AWG and Smaller: Stranded copper.

3. All Other Circuits: Stranded copper.

C. Insulation: Type THHN/THWN, except for sizes No. 6 and larger, with XHHW insulation.

D. Direct Burial and Aerial Conductors and Cables:

1. Type USE/RHH/RHW insulation, UL IC54 listed, Type RHW-2/USE-2.

2. Conform to physical and minimum thickness requirements of NEMA WC 3.

E. Flexible Cords and Cables:

1. Type SOW-A50 with ethylene propylene rubber insulation in accordance with UL 62.

2. Conform to physical and minimum thickness requirements of NEMA WC 8.

F. Cable Tray Conductors and Cables: Type TC.

2.03 600-VOLT RATED CABLE

A. General:

1. Type: TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 20,000 Btu/hr, and NFPA 70, Article 340, or UL 13 Listed Power Limited Circuit Cable meeting requirements of NFPA 70, Article 725.

2. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.

3. Suitable for installation in open air, in cable trays, or conduit.

4. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.

5. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

B. CABLE Type “A”, Wire and Conductors – Not Used

C. Type l-Multiconductor Control Cable:

1. Conductors:

   a. No. 14 AWG, seven-strand copper.

   b. Insulation: 15-mil PVC with 4-mil nylon.

   c. UL 1581 listed as Type THHN/THWN rated VW-I.

   d. Conductor group bound with spiral wrap of barrier tape.

   e. Color Code: In accordance with NEMA WC 5, Method 1, Sequence K-2.

2. Cable: Passes the ICEA T-29-520 210,000 Btu/hr Vertical Tray Flame Test.

3. Cable Sizes:

No. of Conductors	2.02 2.03 Max. Outside Diameter (inches)	2.04 2.05 Jacket Thickness (mils)
3	2.06 0.41	2.07 45
5	2.08 0.48	2.09 45
7	2.010 0.52	2.011 45
12	2.012 0.72	2.013 60
19	2.014 00.83	2.015 60
25	2.016 1.00	2.017 60
37	2.018 1.15	2.019 80

4. Manufacturers:

   a. Okonite Co.

   b. Rome Cable.

D. Type 2-Multiconductor Power Cable:

1. Conductors:

   a. Class B stranded coated copper.

   b. Insulation: Chemically cross-linked ethylene-propylene with Hypalon jacket.

   c. UL 1581 listed as Type EPR rated VW-1.

d. Color Code: Conductors, size No. 8 AWG and smaller, colored conductors, NEMA WC5 Method 1, color 5 per Article POWER CONDUCTOR COLOR CODING. Conductors, size No. 6 AWG and larger, NEMA WC5, Method 4.

2. Cable passes the ICEA T-29-520 210,000 Btu/hr Vertical Tray Flame Test.

3. Cable Sizes:

Conductor Size	Minimum Ground Wire Size	No. Of Conductors	Maximum Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
12	12	2 3 4	0.42 0.45 0.49	45 45 45
10	10	2 3 4	0.54 0.58 0.63	60 60 60
8	10	3 4	0.66 0.72	60
6	8	3 4	0.74 0.81	60
4	6	3 4	0.88 0.97	60 80
2	6	3 4	1.01 1.11	80
1/0	6	3 4	1.22 1.35	80
2/0	4	3 4	1.32 1.46	80
4/0	4	3 4	1.56 1.78	80

4. Manufacturers:

a. Okonite Co.

b. Rome Cable.

E. Type B-No. 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.

1. Outer Jacket: 45-mil nominal thickness.

2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.

3. Dimension: 0.31-inch nominal OD.

4. Conductors:

   a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8

   b. 20 AWG, seven-strand tinned copper drain wire.

   c. Insulation: 15-mil nominal PVC, 600V rated.

   d. Jacket: 4-mil nominal nylon.

   e. Color Code: Pair conductors black and red.

5. Manufacturers:

   a. Okonite Co.

   b. Alpha Wire Corp.

6. The following test shall be performed on instrumentation and control system cables. All tests shall be end-to-end test of installed cables with the ends supported in free air, not adjacent to any ground object. All test data shall be recorded on forms acceptable to the Engineer. Complete records of all tests shall be made and delivered to the Engineer.

   a. Continuity tests shall be performed by measuring wire/shield loop resistances of signal cable as the wires, taken one at a time, are shorted to the channel shield. No loop resistance measurement shall carry by more than $\pm$2 ohms from the calculated average loop resistance valve.

   b. Insulation resistance tests shall be performed by using a 500 volt megohmmeter to measure the insulation resistance between each channel wire, between each channel wire and channel shield, between individual channel shields in a multi-channel cable, between each individual channel and the overall cable shield in multi-channel cable, between each wire and ground, and between each shield and ground. Values of resistance less than 10 megohms shall be unacceptable.

F. Type B1-No. 16 AWG, Twisted, Shielded Triad Instrumentation Cable: Single triad, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.

1. Outer Jacket: 45-mil nominal.

2. Triad Shield: 1.35-mil, double-faced aluminum/synthetic polymer, overlapped to provide 100 percent coverage.

3. Dimension: 0.32-inch nominal OD.

4. Conductors:

a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.

b. 20 AWG, seven-strand, tinned copper drain wire.

c. Insulation: 15-mil nominal PVC.

d. Jacket: 4-mil nylon.

e. Color Code: Triad conductors: black, red, and blue.

5. Manufacturers:

a. Okonite Co.

b. Alpha Wire Corp.

G. Type B2-No. 18 AWG, Multi-Twisted, Shielded Pairs with a Common, Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable, meeting NEMA WC 55 requirements.

1. Conductors:

a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8

b. Tinned copper drain wires.

c. Pair drain wire size AWG 20, group drain wire size AWG 18.

d. Insulation: 15-mil PVC.

e. Jacket: 4-mil nylon.

f. Color Code: Pair conductors black and red with red conductor numerically printed for group identification.

g. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer.

2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.

3. Cable Sizes:

Number of Pairs	Maximum Outside Diameter (inches)	Nominal Jacket Thickness (mils)
4	0.50	45
8	0.68	60
12	0.82	60
16	0.95	80
24	1.16	80
36	1.33	80
50	1.56	80

4. Manufacturers:

a. Okonite Co.

b. Alpha Wire Corp.

H. Type B3-No. 18 AWG, Multi-twisted Pairs with a Common Overall Shield Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable meeting NEMA WC 55.

1. Conductors:

a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8.

b. Tinned copper drain wire size 18 AWG

c. Insulation: 15-mil nominal PVC.

d. Jacket: 4-mil nylon.

e. Color Code: Pair conductors black and red, with red conductor numerically printed for group identification.

2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.

3. Cable Sizes:

Number of Pairs	Maximum Outside Diameter (inches)	Nominal Jacket Thickness (mils)
4	0.46	45
8	0.63	60
12	0.75	60
16	0.83	60
24	1.06	80
36	1.21	80
50	1.42	80

4. Manufacturers:

a. Okonite Co.

b. Alpha Wire Corp.

I. Ethernet Cat. 6 Cable (Copper):

1. Section applies to all Ethernet Cable (Copper) except for Fiber Optic cable.

2. Conductor Physical Characteristics: 4 twisted pairs (8 conductors), 24 AWG solid bare Copper with Polyolefin Insulation. Overall Nominal Diameter: 0.260 inch. Operating Temperature Range: -20'C to +75'C. Model Number – 1533R, Belden Inc.

3. Manufacturer:

a. Belden Inc.

2.04 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

B. Direct Buried: Bare stranded tinned copper.

2.05 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Tape:

1. General Purpose, Flame-Retardant: 7-mil, vinyl plastic, Scotch Brand 33, rated for 90 degrees C minimum, meeting requirements of UL 510.

2. Flame Retardant, Cold and Weather Resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.

3. Arc and Fireproofing:

a. 30-mil, elastomer

b. Manufacturers and Products:
1) Scotch; Brand 77, with Scotch Brand 69 glass cloth tape binder.
2) Plymount; Plyarc 30, with Plymount Plyglas glass cloth tape binder.

B. Identification Devices:

1. Sleeve: Permanent, PVC, yellow or white, with legible machine-printed black markings.

2. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.

3. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.

C. Connectors and Terminations:

1. Nylon, Self-Insulated Crimp Connectors:

a. Manufacturers and Products:
1) Thomas & Betts; Sta-Kon.
2) Burndy; Insulink.
3) ILSCO.

2. Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:

a. Manufacturers and Products:
1) Thomas & Betts; Sta-Kon.
2) Burndy; Insulink.
3) ILSCO.

D. Cable Lugs:

1. In accordance with NEMA CC I.

2. Rated 600 volts of same material as conductor metal.

3. Insulated, Locking-Fork, Compression Lugs:

   a. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) ILSCO; ILSCONS.

4. Un-insulated Crimp Connectors and Terminators:

   a. Manufacturers and Products:
      1) Square D; Versitide.
      2) Thomas & Betts; Color-Keyed.
      3) ILSCO.

5. Un-insulated, Bolted, Two-Way Connectors and Terminators:

   a. Manufacturers and Products:
      1) Thomas & Betts; Locktite.
      2) Burndy; Quiklug.
      3) ILSCO.

E. Cable Ties: Nylon, adjustable, self-locking, and reusable.

   1. Manufacturer and Product: Thomas & Betts; TY-RAP.

F. Heat Shrinkable Insulation: Thermally stabilized, crosslinked polyofin.

   1. Manufacturer and Product: Thomas & Betts; SHRINK-KON.

2.06 PULLING COMPOUND

A. Nontoxic, non-corrosive, noncombustible, nonflammable, wax-based lubricant; UL listed.

B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.

C. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.

D. Manufacturers and Products:

1. Ideal Co.; Yellow 77.

2. Polywater, Inc.

3. Cable Grip Co.

2.07 MANUFACTURED WIRING SYSTEMS

A. System Rating:

1. 20 amperes load-carrying capacity each phase with final assemblies consisting of maximum of three phase conductors.

2. Composition: Type MC cable with 90 degrees C insulation and stranded copper conductors.

B. Cable Configuration: Three, single-phase, five-wire circuit with standard color wire coding:

1. 208/120-Volt: Black, red, blue, white, green.

2. 480/277-Volt: Brown, orange, yellow, gray, green.

C. Locking Mechanism: Latch/strike with voltage clearly marked on latch.

D. UL 910 listed for use in air handling plenums, listed to connect or disconnect under load, and manufactured in accordance with NFPA 70, Article No. 604.

2.08 WARNING TAPE

A. As specified in Section 16110, RACEWAYS.

2.09 SOURCE QUALITY CONTROL

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

PART 3 – EXECUTION

3.01 GENERAL

A. Conductor installation to be in accordance with NEC.

B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

D. Tighten screws and terminal bolts in accordance with UL 486A for copper conductors.

E. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

F. Bundling: Where single conductors and cables in manholes, handholes, vaults, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 12 inches on center.

G. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

H. Concrete-Encased Raceway Installation: Before installation of conductors, pull through each raceway a mandrel approximately 1/4-inch smaller than raceway inside diameter.

I. Cable Tray Installation:

1. Install wire and cable parallel and straight in tray.

2. Bundle, in groups, all wire and cable of same voltage having a common routing and destination; use cable ties, at maximum intervals of 8 feet.

3. Clamp cable bundles prior to making end termination connections.

4. Separate cables of different voltage rating in same cable tray with barriers.

5. Fasten wires, cables, and bundles to tray with nylon cable straps at the following maximum intervals:

a. Horizontal Runs: 20 feet.

b. Vertical Runs: 5 feet.

3.02 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:

1. No. 6 AWG and Larger. Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 to 2 inches wide.

2. No. 8 AWG and Smaller: Provide colored conductors.

3. Colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
240/120 Volts Three-Phase, Four-Wire Delta, Center Tap Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	White Black Orange Blue
480Y/277 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	Gray Brown Purple Yellow
NOTE: Phase A, B, C implies direction of positive phase rotation		

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

3.03 CIRCUIT IDENTIFICATION

A. Circuits Appearing in Circuit Schedules: identify power, instrumentation, and control conductor circuits, using circuit schedule designations, at each termination and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.

B. Circuits Not Appearing in Circuit Schedules:

1. Assign circuit name based on device or equipment at load end of circuit.

2. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.

C. Method:

1. Conductors No. 3 AWG and Smaller: Identify with sleeves.

2. Cables, and Conductors No. 2 AWG and Larger:

a. Identify with marker plates.

b. Attach marker plates with nylon tie cord.

3. Taped-on markers or tags relying on adhesives not permitted.

3.04 CONDUCTORS 600 VOLTS AND BELOW

A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.

B. No splicing of incoming service conductors and branch power distribution conductors will be allowed.

C. Connections and Terminations:

1. Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 4 AWG through No. 2/0 AWG.

2. Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors No. 4/0 AWG and larger.

3. Install uninsulated bolted, two-way connectors for motor circuit conductors No. 12 and larger.

4. Tape insulate all uninsulated connections.

5. Place no more than one conductor in any single-barrel pressure connection.

6. Install crimp connectors with tools approved by connector manufacturer.

7. Install terminals and connectors acceptable for type of material used.

8. Compression Lugs

a. Attach with a tool specifically designed for purpose.

b. Tool shall provide complete controlled crimp and shall not release until crimp is complete.

c. Do not use plier type crimpers.

D. Do not use soldered mechanical joints.

E. Splices and Terminations:

1. Indoors: No splices are allowed.

2. Outdoors: No splices are allowed.

F. Cap spare conductors and conductors with UL listed end caps.

G. Cabinets, Panels, and Motor Control Centers:

1. Remove surplus wires, bundle and secure.

2. Where conductors pass through openings or over edges in sheet metal, remove bums, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.

H. Control and Instrumentation Wiring:

1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.

2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.

3. No splices are allowed.

4. Where connections of cables installed under this section are to be made under Section 17000 - Control and Information System Scope and General Requirements (PICS), leave pigtails of adequate length for bundled connections.

5. Cable Protection:

a. Under Infinite Access Floors: May be installed without bundling.

b. All Other Areas: Install individual wires, pairs, or triads in flex conduit under the floor or grouped into bundles at least 1/2-inch in diameter.

c. Maintain integrity of shielding of instrumentation cables.

d. Ensure grounds do not occur because of damage to jacket over the shield.

I. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

J. Install Ethernet Cat. 6 Cable (Copper) as per manufacturer recommendation.

END OF SECTION

SECTION 16450
GROUNDING

PART 1 – GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American National Standards Institute (ANSI): C2, National Electrical Safety Code (NESC).

2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

1.02 SUBMITTALS

A Shop Drawings:

1. Product Data:

a. Exothermic weld connectors.

b. Mechanical connectors.

1.03 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 – PRODUCTS

2.01 GROUND ROD

A. Material: Copper clad.

B. Diameter: Minimum 5/8 inch.

C. Length: 20 feet.

2.02 GROUND CONDUCTORS

A. As specified in Section 16120, CONDUCTORS.

2.03 CONNECTORS

A. Exothermic Weld Type:

1. Outdoor Weld: Suitable for exposure to elements or direct burial.

2. Indoor Weld: Use low-smoke, low-emission process.

3. Manufacturers:

a. Erico Products, Inc.; Cadweld and Cadweld Exolon.

b. Thermoweld.

B. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.

1. Manufacturers:

a. Burndy Corp.

b. Thomas and Betts Co.

2.04 GROUNDING WELLS

A. Ground rod box complete with cast iron riser ring and traffic cover marked GROUND ROD.

B. Manufacturers:

1. Christy Co.; No. G5.

2. Lightning and Grounding Systems, Inc.; I-R Series.

PART 3 – EXECUTION

3.01 GENERAL

A. Grounding shall comply with NFPA 70 and ANSI C2.

B. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.

C. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.

D. Bond together system neutrals, service equipment enclosures, exposed non-current-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

E. Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.

F. Shielded Control Cables:

1. Ground shield to ground bus at power supply for analog signal.

2. Expose shield minimum I inch at termination to field instrument and apply heat shrink tube.

3. Do not ground control cable shield at more than one point.

3.02 WIRE CONNECTIONS

A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment-grounding conductor connected at both ends to non-current carrying grounding bus.

C. Connect ground conductors to raceway grounding bushings.

D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.

E. Connect enclosure of equipment containing ground bus to that bus.

F. Bolt connections to equipment ground bus.

G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

3.03 MOTOR GROUNDING

A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment-grounding conductor connected at both ends to non-current carrying grounding bus.

C. Motors Less Than 10 hp: Furnish compression, spade-type terminal connected to conduit box mounting screw.

D. Motors 10 hp and above: Tap motor frame or equipment housing; furnish compression, one-hole, lug type terminal connected with minimum 5/16-inch brass threaded stud with bolt and washer.

E. Circuits 20 Amps or Above: Tap motor frame or equipment housing; install solderless terminal with minimum 5/16-inch diameter bolt.

3.04 GROUND RODS

A. Install full length with conductor connection at upper end.

B. Install with connection point below finished grade, unless otherwise shown.

3.05 GROUNDING WELLS

A. Install inside buildings, asphalt, and paved areas.

B. Install riser ring and cover flush with surface.

C. Place 9 inches crushed rock in bottom of each well.

3.06 CONNECTIONS

A. General:

1. Above grade Connections: Use exothermic weld, mechanical, or compression-type connectors.

2. Below grade Connections: Install exothermic weld type connectors.

3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.

4. Notify Engineer before backfilling ground connections.

B. Exothermic Weld Type:

1. Wire brush or file contact point to bare metal surface.

2. Use welding cartridges and molds in accordance with manufacturer's recommendations.

3. Avoid using badly worn molds.

4. Mold to be completely filled with metal when making welds.

5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

C. Mechanical Type:

1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.

2. Install in accordance with connector manufacturer's recommendations.

3. Do not conceal mechanical connections.

3.07 METAL STRUCTURE GROUNDING

A. Ground metal sheathing and exposed metal vertical structural elements to grounding system.

B. Bond electrical equipment supported by metal platforms to the platforms.

C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.08 MANHOLE AND HANDHOLE GROUNDING

A. Install one ground rod inside each.

B. Ground Rod Floor Protrusion: 4 to 6 inches above floor.

C. Make connections of grounding conductors fully visible and accessible.

D. Connect all non-current-carrying metal parts, and any metallic raceway grounding bushings to ground rod with No. 6 AWG copper conductor.

3.09 TRANSFORMER GROUNDING

A. Bond neutrals of transformers within buildings to system ground network, and to any additional indicated grounding electrodes.

B. Bond neutrals of substation transformers to substation grounding grid and system grounding network.

C. Bond neutrals of pad-mounted transformers to four locally driven ground rods and buried ground wire encircling transformer and system ground network.

3.10 SURGE PROTECTION EQUIPMENT GROUNDING

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

3.11 INSTRUMENT GROUND- SURGE SUPPRESSION

A. Connect all instrument surge protection with #6 insulated copper groundwire (in conduit where above grade) to closest plant ground system

3.12 BONDING

A. Bond to Main Conductor System:

B. All roof mounted ventilators, fans, air handlers, masts, flues, cooling towers, handrails, and other sizeable metal objects.

C. Roof flashing, gravel stops, insulation vents, ridge vents, roof drains, soil pipe vents, and other small metal objects if located within 6 feet of main conductors or another grounded object.

D. Provide air terminals as required.

E. Bond steel columns or major framing members to grounding system per National Electrical Code.

F. Bond each main down conductor to grounding system.

3.13 GROUNDING SYSTEM

A. Grounding Conductor:

B. Completely encircle building structure.

C. Bury minimum 30” below finished grade.

D. Minimum 2 feet distance from foundation walls.

E. Interconnect ground rods by direct-buried copper cables.

F. Connections:

G. Install ground cables continuous between connections.

H. Exothermic welded connections to ground rods, cable trays, structural steel, handrails, and buried and non-accessible connections.

I. Provide bolted clamp type mechanical connectors for all exposed secondary connections.

J. Use bolded offset parapet bases or through-roof concealed base assemblies for air terminal connections.

K. Provide interconnections with electrical and telephone systems and all underground water and metal pipes.

L. Provide electric service arrestor ground wire to building water main.

END OF SECTION

SECTION 16500
LIGHTING

PART 1 – GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).

2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

3. Uniform Building Code (UBC): Section 2329, Earthquake Requirements.

4. Underwriters Laboratories, Inc. (UL):

a. 595, Standard for Safety Marine-Type Electric Lighting Fixtures.

b. 844, Standard for Safety Electric Lighting Fixtures for Use in Hazardous (Classified) Locations.

c. 924, Standard for Safety Emergency Lighting and Power Equipment.

1.02 SUBMITTALS

A. Shop Drawings:

1. Interior Luminaires:

a. Catalog data sheets and pictures.

b. Luminaire finish and metal gauge.

c. Lens material, pattern, and thickness.

d. Candle power distribution curves in two or more planes.

e. Candle power chart 0 to 90 degrees.

f. Lumen output chart.

g.Average maximum brightness data in foot lamberts.

h. Coefficients of utilization for zonal cavity calculations.

i. Mounting or suspension details.

j. Heat exchange and air handling data.

2. Exterior Luminaires:

a. Catalog data sheets and pictures.

b. Luminaire finish and metal gauge.

c. Lens material, pattern, and thickness.

d. IES lighting classification and isolux diagram.

e. Fastening details to wall or pole.

f. Ballast type, location, and method of fastening.

g.For light poles, submit wind loading, complete dimensions, and finish.

3. Lamps:

a. Voltages.

b. Colors.

c. Approximate life (in hours).

d. Approximate initial lumens.

e. Lumen maintenance curve.

f. Lamp type and base.

g. Copy of lamp order, including individual quantities, for Project.

4. Ballasts:

a. Type.

b. Wiring diagram.

c. Nominal watts and input watts.

d. Input voltage and power factor.

e. Starting current, line current, and restrike current values.

f. Sound rating.

g.Temperature rating.

h. Efficiency ratings.

i. Low temperature characteristics.

j. Emergency ballasts rating and capacity data.

5. Photo-Time Control:

a. Wiring diagram.

b. Contact ratings.

6. Photocells:

a. Voltage, and power consumption.

b. Capacity.

c. Contacts and time delay.

d. Operating levels.

e. Enclosure type and dimensions.

f. Temperature range.

1.03 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2 – PRODUCTS

2.01 LUMINAIRES

A. Specific requirements relative to execution of Work of this section is shown on Site Light Pole Detail Drawing.

B. Feed-through type, or separate junction box.

C. Ballasts: Two-lamp when possible.

D. Tandem wired for three-lamp, fluorescent fixtures.

E. Wire Leads: Minimum 18 AWG.

F. Component Access: Accessible and replaceable without removing luminaire from ceiling.

G. Soffit Installations:

1. UL Labeled: SUITABLE FOR DAMP LOCATIONS.

2. Ballast: Removable, prewired.

H. Exterior Installations:

1. UL Labeled: SUITABLE FOR WET LOCATIONS.

2. Ballast: Removable, prewired.

3. When factory-installed photocells are provided, entire assembly shall have UL label.

I. Emergency Lighting:

1. Power Pack: Self-contained, 120-volt transformer, inverter/charger, sealed nickel cadmium battery, and indicator switch in accordance with UL 924.

2. Lighted, push-to-test indicator.

3. Capable of providing full illumination for 1-1/2 hours in emergency mode.

4. Capable of full recharge in 24 hours, automatically upon resumption of normal line voltage.

5. Capable of protecting against excess charging and discharging.

2.02 LAMPS

A. LED

1. Type Efficiency: Energy, Low power consumption. Instant on/off response.

2. Color, Lumens Output, Wattage, etc.: As shown on plans.

3. UL listed.

B. Manufacturers:

1. Sylvania.

2. General Electric.

3. North American Phillips.

4. Or approved equal.

2.03 BALLASTS

A. General:

1. Meet requirements for fixture light output, reliable starting, radio interference, total harmonic distortion, electromagnetic interference, and dielectric rating.

2. Certified by electrical testing laboratories to conform to Certified Ballast Manufacturer's specifications.

B. LED Driver:

1. LED driver shall have built-in heat sink to compensate for the heat.

2. Standard 0-10V Dimming driver, unless otherwise noted on plan.

3. LED driver shall have minimum of 3 year warranty.

4. See drawings for additional information.

2.04 LIGHTING CONTROL AND SWITCHES

A. Photocell:

1. Automatic ON/OFF switching photo control.

2. Housing: Self-contained, die-cast aluminum, unaffected by moisture, vibration, or temperature changes.

3. Setting: ON at dusk and OFF at dawn.

4. Time delay feature to prevent false switching.

5. Field adjustable to control operating levels.

6. Manufacturers:

   a. Tork.

   b. Paragon.

2.05 POLES

A. Rating (with Luminaire): All pole installation shall be suitable for wind loading and appropriate gust factor per applicable zone of installation as defined in the Florida Building Code. The contractor shall include with the shop drawing submittal, a pole wind loading calculation signed and sealed by a structural engineer registered in Florida showing that the proposed installations will meet the given wind loading requirement.

B. Material: Concrete or as shown on plans.

PART 3 – EXECUTION

3.01 LUMINAIRES

A. General:

1. Install in accordance with manufacturer's recommendations.

2. Provide proper hangers, pendants, and canopies as necessary for complete installation.

3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to building and to concrete pole bases required to safely mount.

4. Install plumb and level.

5. Mounting heights shown for wall mounted or pendant mounted luminaires are measured from bottom of luminaire to finished floor or finished grade, whichever is applicable.

6. Install each luminaire outlet box with galvanized stud.

B. Pendant Mounted:

1. Provide swivel type hangers and canopies to match luminaires, unless otherwise noted.

2. Space single-stem hangers on continuous-row fluorescent luminaires nominally 48 inches apart.

3. Provide twin-stem hangers on single luminaires.

C. Pole Mounted:

1. Provide precast concrete base.

2. Provide branch circuit in-line fuses in pole base handhole.

D. Swinging Type:

1. Provide, at each support, safety cable capable of supporting four times the vertical load from the structure to the luminaire.

E. Finished Areas:

1. Install symmetrically with tile pattern.

2. Locate with centerlines either on centerline of tile or on joint between adjacent tile runs.

3. Install recessed luminaires tight to finished surface such that no spill light will show between ceilings and sealing rings.

4. Combustible Low Density Cellulose Fiberboard: Provide spacers and mount luminaires 1-1/2 inches from ceiling surface, or use fixtures suitable for mounting on low density ceilings.

5. Junction Boxes:

a. Flush and Recessed Luminaires: Locate minimum 1 foot from luminaire.

b. In concealed locations, install junction boxes to be accessible by removing luminaire.

6. Wiring and Conduit:

a. Provide wiring of temperature rating required by luminaire.

b. Provide flexible steel conduit.

7. Provide plaster frames when required by ceiling construction.

8. Independent Supports:

a. Provide each recessed fluorescent luminaire with two safety chains or two No. 12 soft-annealed galvanized steel wires of length needed to secure luminaire to building structure independent of ceiling structure.

b. Tensile strength of chain or wire, and method of fastening to structure shall be adequate to support weight of luminaire.

c. Fasten chain or wire to each end of luminaire.

F. Unfinished Areas: Locate luminaires to avoid either conflict with other building systems or blockage of luminaire light output.

1. Fixture Suspension: Provide 1/4-inch threaded steel hanger rods. Scissor type hangers not permitted.

2. Attachment to Steel Beams: Provide flanged beam clips and straight or angled hangers.

3.02 LAMPS

A. Provide in each fixture, the number and type for which the fixture is designed, unless otherwise noted.

3.03 BALLASTS

A. Install in accordance with manufacturer's recommendations.

B. Utilize all ballast mounting holes to fasten securely within luminaire.

C. Replace noisy or defective ballasts.

3.04 LIGHTING CONTROL

A. Outdoor Luminaires: Photocells switch lights ON at dusk and OFF at dawn.

3.05 CLEANING FOLLOWING CONSTRUCTION

A. Remove all labels and other markings, except UL listing mark.

B. Wipe luminaires inside and out to remove construction dust.

C. Clean luminaire plastic lenses with antistatic cleaners only.

D. Touch up all painted surfaces of luminaires and poles with matching paint ordered from manufacturer.

E. Replace all defective lamps at time of Substantial Completion.

END OF SECTION