"Wastewater Treatment Plant Effluent Pump Station Electrical Rehabilitation"

Invitation for Bids # PSUT-20-06

General Information		
Project Cost Estimate	$1,992,800	See Section 1.4
Project Timeline	560 Calendar Days from NTP	See Section 1.4
Evaluation of Proposals	Staff	See Section 1.7
Mandatory Pre-Bid Meeting	9:00 a.m. on July 7, 2020 at the Wastewater Treatment Facility located at 13955 Pembroke Road, Pembroke Pines, FL 33029	See Section 1.8
Question Due Date	July 14, 2020	See Section 1.8
Proposals will be accepted until	2:00 p.m. on July 28, 2020	See Section 1.8
5% Proposal Security / Bid Bond	Required in the event that the proposal exceeds $200,000	See Section 4.1
100% Payment and Performance Bonds	Required in the event that the proposal exceeds $200,000	See Section 4.2
Grant or Federal Funding Information	Not Applicable	Not Applicable

THE CITY OF PEMBROKE PINES
PURCHASING DIVISION
8300 SOUTH PALM DRIVE
PEMBROKE PINES, FLORIDA 33025
(954) 518-9020

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ATTACHMENTS

SECTION 1 - INSTRUCTIONS

1.1 NOTICE

Notice is hereby given that the City Commission of the City of Pembroke Pines is seeking sealed proposals for:

IFB # PSUT-20-06
"Wastewater Treatment Plant Effluent Pump Station Electrical Rehabilitation"

Solicitations may be obtained from the City of Pembroke Pines website at http://www.ppines.com/index.aspx?NID=667 and on the www.BidSync.com website.

If you have any problems downloading the solicitation, please contact the BidSync Support line at 1-800-990-9339.

If additional information help is needed with downloading the solicitation package please contact the Purchasing Office at (954) 518-9020 or by email at purchasing@ppines.com. The Purchasing Office hours are between 7:00 a.m. - 6:00 p.m. on Monday through Thursday and is located at 8300 South Palm Drive, Pembroke Pines, Florida 33025.

The City requires all questions relating to the solicitation be entered through the "Ask a Question" option tab available on the BidSync website. Responses to the questions will be provided online at www.bidsync.com. Such request must be received by the "Question Due Date" stated in the solicitation. The issuance of a response via BidSync is considered an Addendum and shall be the only official method whereby such an interpretation or clarification will be made.

Proposals will be accepted until 2:00 p.m., Tuesday, July 28, 2020. Proposals must be **submitted electronically at www.BidSync.com**. The sealed electronic proposals will be publicly opened at 2:30 p.m. by the City Clerk's Office, in the City Hall Administration Building, 4th Floor Conference Room located at 601 City Center Way, Pembroke Pines, Florida, 33025.

1.2 PURPOSE

The City of Pembroke Pines is seeking proposals from qualified firms, hereinafter referred to as the Contractor, to furnish all labor, materials, equipment, services and incidentals for the electrical rehabilitation of the effluent pump station located at the Wastewater Treatment Plant, 13955 Pembroke Road, Pembroke Pines, FL 33029, in accordance with the terms, conditions, and specifications contained in this solicitation.

1.3 SCOPE OF WORK

The work includes the furnishing of all labor, materials, equipment, services and incidentals for the Electrical Rehabilitation of the Effluent Pump Station. Refer to Attachment H: Contract Documents.

The demolition work includes the demolition of existing Switchboard EPS, VFDs, ATS, transformers, panelboards, lighting systems, disconnect switches, conduits and conductors as per specifications and plans. Refer to Attachment H: Contract Documents.

The temporary work during construction includes temporary generators, temporary VFDs, temporary conduits and temporary conductors as per specifications and plans. Refer to Attachment H: Contract Documents.

The new work includes a new main-tie-main switchboard, new VFDs, new disconnect switches, new medium voltage pad mounted transformers, new lighting systems, new grounding systems, new panelboard, new low voltage transformers, modifications to existing east and west switchboards, new cable tray, new concrete encased duct banks, new conduit and conductor systems, modifications to existing Effluent Pump Station PLC and new instrumentation and control systems as per Attachment H: Contract Documents.

1.4 PROJECT COST ESTIMATE & TIMELINE

Staff estimates this project to cost approximately $1,992,800, which does not include permit costs.

Please note the City will include a Permit Allowance for this project**, therefore proposers should not include permit costs in their total proposal price.**

The work shall be completed within 560 days from issuance of City's Notice to Proceed.

1.4.1 PERMITS

The City anticipates this project to require the following permits:

Permit	**Agency**	**Cost (or related method of calculation)**
Engineering	City of Pembroke Pines Engineering Department	4.9136% of construction costs
Building	City of Pembroke Pines Building Department (Calvin, Giordano & Associates, Inc.)	1. Construction costs up to $2,500 (Per structure per trade) = $97.17 2. Construction costs greater than $2,500 up to $1,000,000 = 2.96%

1.4.2 PERMIT ALLOWANCE

The City shall include a "Permit Allowance" for this project. The Contractor shall obtain all required permits to complete the work, however the City shall utilize the Permit Allowance to reimburse the contractor for the related permit, license, impact or inspection fees. Payments will be made to the contractor based on the actual cost of permits upon submission of paid permit receipts. The City shall not pay for other costs related to obtaining or securing permits.

The City shall determine the amount of the allowance at time of award. The allowance may be based on a specified percent of the proposed project amount and shall be established for the specific project being performed under the contract. This dollar amount shall be shown on the specific project purchase order as a distinct item from the vendor's overall offer to determine the total potential dollar value of the contract. Any Permit Allowance funds that have not been utilized at the end of the project will remain with the City, if the City Permit fees exceed the allowance indicated, the City will reimburse the contractor the actual amount of City Permit Fees required for project completion.

1.5 PROPOSAL REQUIREMENTS

The www.bidsync.com website allows for vendors to complete, scan and upload their documents as part of the bidder's submittal on the website. Prospective proposers interested in responding to this solicitation are requested to provide all of the information listed in this section. Submittals that do not respond completely to all of requirements specified herein may be considered non-responsive and eliminated from the process. Brevity and clarity are encouraged.

1.5.1 Attachment A: Contact Information Form

a. Attached is contact information form (Attachment A) where the vendor will enter their contact information and complete the proposal checklist. The Contact information form shall be electronically signed by the contact person authorized to represent the contractor. This form must be completed and submitted through www.bidsync.com as part of the bidder's submittal.

b. The vendor must provide their pricing through the designated lines items listed on the BidSync website.

c. Please note vendors should be registered on BidSync under the name of the organization that they are operating as and it should match the organization name on the documents that they are submitting and utilizing when responding to the solicitation.

d. The contact information form should contain an electronic signature of the authorized representative of the Proposer along with the address and telephone number for communications regarding the Proposal.

e. Proposals by corporations should be executed in the corporate name by the President or other corporate officer accompanied by evidence of authority to sign. The corporate address and state of incorporation must also be shown.

f. Proposals by partnerships should be executed in the partnership name and signed by a partner whose title and the official address of the partnership must be shown.

1.5.2 Attachment B: Non-Collusive Affidavit

1.5.3 Attachment C: Proposer's Qualifications Statement

1.5.4 Attachment F: References Form

a. Complete **Attachment F: References Form**, preferably where the team was the same. References should be from the last five years and should be capable of explaining and confirming your firm's capacity to successfully complete the scope of work outlined herein. As part of the proposal evaluation process, the City may conduct an investigation of references, including a record check or consumer affairs complaints. Proposers' submission of a proposal constitutes acknowledgment of the process and consent to investigate. The City is the sole judge in determining Proposers qualifications.

1.5.5 Proposal Security (Bid Bond Form or Cashier's Check)

a. Each Proposal should be accompanied by a certified or cashier's check or by a Bid Bond made payable to the City of Pembroke Pines on an approved form, duly executed by the Proposer as principal and having as surety thereon a surety company acceptable to CITY and authorized to write such Bond under the laws of the State of Florida, in an amount not less than five percent (5%) of the amount of the base Proposal price.

b. Contingency is not to be counted in the total amount the proposal security is based on.

c. Proposers must submit a scanned copy of their bid security (bid bond form or cashier's check) with their bid submittal through BidSync.

d. Proposers should also submit their original bid security (bid bond form or cashier's check) at time of the bid due date, or they may be deemed as non-responsive.

e. The original Bid Bond or Cashier's Check should be in a sealed envelope, plainly marked "**BID SECURITY - IFB # PSUT-20-06 Wastewater Treatment Plant Effluent Pump Station Electrical Rehabilitation**" and sent to the City of

Pembroke Pines, City Clerk's Office, 4th Floor, 601 City Center Way, Pembroke Pines, Florida, 33025.

f. Please see SECTION 4 - SPECIAL TERMS & CONDITIONS of this IFB for additional information.

1.6 VENDOR REGISTRATION AND QUALIFICATION DOCUMENTS

The City has implemented a new process that is intended to make the bidding process easier for vendors that bid on multiple City projects. This process will require vendors to complete and submit the following standard forms and documents at any time prior to bidding on a project. In addition, the vendors will be able to utilize these same forms without the need to re-fill and re-submit the forms each time they bid on a City project.

Furthermore, please make sure to update this information on an as-needed basis so that all pertinent information is accurate, such as local business tax receipts, and any other relevant information.

These forms will be found under the "Vendor Registration" group of "Qualifications" on the BidSync website for the City of Pembroke Pines. Please note that the BidSync website requires bidders to complete all of these qualifications prior to being able to submit questions on any bids, therefore, please make sure to complete this information as soon as possible.

The following documents can be completed prior to the bidding process through the BidSync website and do not need to be attached to your submittal as the BidSync website will automatically include it.

1.6.1 Vendor Information Form

1.6.2 Form W-9 (Rev. October 2018)

a. Previously dated versions of this form will delay the processing of any payments to the selected vendor.

1.6.3 Sworn Statement on Public Entity Crimes Form

1.6.4 Local Vendor Preference Certification

a. If claiming Local Pembroke Pines Vendor Preference, business must attach a current business tax receipt from the City of Pembroke Pines

b. If claiming Local Broward County Vendor Preference, business must attach a current business tax receipt from Broward County or the city within Broward County where the business resides.

c. The Local Vendor Preference Certification form must be completed by/for the proposer; the proposer **WILL NOT** qualify for Local Vendor Preference based on their sub-contractors' qualifications.

1.6.5 Local Business Tax Receipts

1.6.6 Veteran Owned Small Business Preference Certification

a. If claiming Veteran Owned Small Business Preference Certification, business must attach the "Determination Letter" from the United States Department of Veteran Affairs Center for Verification and Evaluation notifying the business that they have been approved as a Veteran Owned Small Business (VOSB).

b. The Veteran Owned Small Business Preference Certification form must be completed by/for the proposer; the proposer **WILL NOT** qualify for Veteran Owned Small Business Preference based on their sub-contractors' qualifications.

1.6.7 Equal Benefits Certification Form

1.6.8 Vendor Drug-Free Workplace Certification Form

1.6.9 Scrutinized Company Certification

1.7 EVALUATION OF PROPOSALS & PROCESS OF SELECTION

A. Staff will evaluate all responsive proposals received from proposers who meet or exceed the bid requirements contained in the solicitation. Evaluations shall be based upon the information contained in the proposals as submitted.

B. Staff will make a recommendation to the City Commission for award of contract.

1.8 TENTATIVE SCHEDULE OF EVENTS

Event	Time &/or Date
Issuance of Solicitation (Posting Date)	**June 23, 2020**
Mandatory Pre-Bid Meeting	**9:00 a.m. on July 7, 2020**
Question Due Date	**July 14, 2020**
Anticipated Date of Issuance for the Addenda with Questions and Answers	**July 20, 2020**
Proposals will be accepted until	**2:00 p.m. on July 28, 2020**
Proposals will be opened at	**2:30 p.m. on July 28, 2020**
Evaluation of Proposals by Staff	**July 28, 2020 – August 3, 2020**
Recommendation of Contractor to City Commission award	**August 19, 2020**
Issuance of Notice to Proceed	**August 20, 2020**

Project Commencement	**Not later than 10 days after NTP**
Project Completion	**June 23, 2020**

1.7.1 MANDATORY PRE-BID MEETING / SITE VISIT

There will be a mandatory scheduled pre-bid meeting on July 7, 2020 at 9:00 a.m. Meeting location will be at the Public Services Building, Large Conference Room, located at 8300 S. Palm Drive, Pembroke Pines, FL 33025.

All vendors will be required to sign in at the meeting to show proof of attendance to the mandatory meeting. It is the vendor's responsibility to make sure that they sign in at the meeting.

1.9 SUBMISSION REQUIREMENTS

Bids/proposals **must be submitted electronically** at www.bidsync.com **on or before 2:00 p.m. on July 28, 2020.**

Please note vendors should be registered on BidSync under the name of the organization that they are operating as and it should match the organization name on the documents that they are submitting and utilizing when responding to the solicitation.

The vendor must provide their pricing through the designated lines items listed on the BidSync website. In addition, the vendor must complete any webforms on the BidSync website and provide any additional information requested throughout this solicitation. Any additional information requested in the solicitation should be scanned and uploaded. **Unless otherwise specified, the City requests for vendors to upload their documents as one (1) PDF document in the order that is outline in the bid package.**

The City recommends for proposers to submit their proposals as soon as they are ready to do so. Please allow ample time to submit your proposals on the BidSync website. Proposals may be modified or withdrawn prior to the deadline for submitting Proposals. BidSync Support is happy to help you with submitting your proposal and to ensure that you are submitting your proposals correctly, but we ask that you contact their support line at 1-800-990-9339 with ample time before the bid closing date and time.

PLEASE DO NOT SUBMIT ANY PROPOSALS VIA MAIL, E-MAIL OR FAX.

However, please note that any required Bid Bond or Cashier's Check should be in a sealed envelope, plainly marked "**BID SECURITY - IFB # PSUT-20-06 Wastewater Treatment Plant Effluent Pump Station Electrical Rehabilitation**" and sent to the City of Pembroke Pines, City Clerk's Office, 4th Floor, 601 City Center Way, Pembroke Pines, Florida, 33025.

CONTACT INFORMATION FORM

IN ACCORDANCE WITH **PSUT-20-06** titled "**Wastewater Treatment Plant Effluent Pump Station Electrical Rehabilitation"** attached hereto as a part hereof, the undersigned submits the following:

A) Contact Information

The Contact information form shall be electronically signed by one duly authorized to do so, and in case signed by a deputy or subordinate, the principal's properly written authority to such deputy or subordinate must accompany the proposal. This form must be completed and submitted through www.bidsync.com as part of the bidder's submittal. The vendor must provide their pricing through the designated lines items listed on the BidSync website.

COMPANY INFORMATION:

COMPANY: _____

STREET ADDRESS: _____

CITY, STATE & ZIP CODE: _____

PRIMARY CONTACT FOR THE PROJECT:

NAME: _____TITLE: _____

E-MAIL: _____

TELEPHONE: _____ FAX: _____

AUTHORIZED APPROVER:

NAME: _____TITLE: _____

E-MAIL: _____

TELEPHONE: _____ FAX: _____

SIGNATURE: _____

B) Proposal Checklist

Did you make sure to submit the following items, as stated in section 1.5 "Proposal Requirements" of the bid package?

Attachment A - Contact Information Form	Yes_____

Attachment B - Non-Collusive Affidavit	Yes_____
Attachment C - Proposer's Completed Qualification Statement	Yes_____
Attachment F - References Form	Yes_____

Did you make sure to update the following documents found under the "Vendor Registration" group of "Qualifications" on the BidSync website for the City of Pembroke Pines?

Vendor Information Form	Yes_____
Form W-9 (Rev. October 2018)	Yes_____
Sworn Statement on Public Entity Crimes Form	Yes_____
Local Vendor Preference Certification	Yes_____
Local Business Tax Receipts	Yes_____
Veteran Owned Small Business Preference Certification	Yes_____
Equal Benefits Certification Form	Yes_____
Vendor Drug-Free Workplace Certification Form	Yes_____
Scrutinized Company Certification	Yes_____

C) Sample Proposal Form

The following sample price proposal is for information only. The vendor must provide their pricing through the designated lines items listed on the BidSync website.

Base Option:

Item #	Item Description	Total Cost
1)	Mobilization/Demobilization	**Price to be Submitted Via BidSync**
2)	All Work Associated with the Electrical Rehabilitation of the Effluent Pump Station including, but not limited to, all general appurtenances; electrical systems; equipment; modifications to existing electrical and instrumentation and control systems; temporary systems; testing; startup services; site investigations; site restoration; construction sequencing requirements; preparation and submittal of shop drawings;	**Price to be Submitted Via BidSync**

	and other related work required, but not necessarily defined, for a complete and operable system in accordance with the Contract Documents.	
3)	Cost to provide Insurance	**Price to be Submitted Via BidSync**
4)	Additional Cost to provide a Payment & Performance Bond in the form of a **Percent** of the total contract amount.	**Price to be Submitted Via BidSync**

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CITY OF PEMBROKE PINES WASTEWATER TREATMENT PLANT
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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 City of Pembroke Pines Waste Water Treatment Plant Effluent Pump Station Electrical Rehabilitation project as shown on plans and specified herein. Instrumentation drawings are as part of E-series Drawings in this project. Refer to appropriate electrical drawings for I&C scope of work.

1. Furnish and install new input/output (I/O) modules in the existing PLC-5 control panel located in the Effluent Pump Station Building – Electrical Room. Make all necessary connection, modification, etc. and furnish all necessary terminal block, relays, SPD, etc. for a complete and working PLC system in place.

2. Contractor shall use Hillers Electrical Engineering, Inc for the PLC and SCADA programming task for this project as describes in 1.01.D of this specification. Contractor shall assist Hillers Electrical Engineering, Inc for loop check and scaling verification as well as startup services.

3. Furnish and install all instruments shown on the contract drawings and specified herein. Furnish and install all necessary tubing, valves, connectors, manifolds, supports, stands, hoods and mounting hardware for a complete working system in place.

4. The contractor shall furnish all shop drawings to the instrumentation contractor for systems that interface with the station control system. The instrumentation contractor shall inform the general contractor in writing of the shop drawings necessary for instrumentation and control system coordination.

5. The contractor is responsible for providing a complete working station instrumentation and control system in place.

6. Power supplies, surge suppressors, terminal strips, etc. for all I/O that are to be connected to the new control system must be provided new. The instrument contractor is responsible to provide completed panels that are clean, functional and present a professional workman-like appearance.

7. All wires in control panels must be permanently tagged and shown on the as-built drawings. This includes all spare and abandoned wires and cables. Spare and abandoned cables are to be taped and left coiled in the panels for future use. Cable and wire numbers are to be assigned by the

contractor, documented and controlled to prevent duplicate numbers. The contractor shall turn over to the owner, at the project conclusion, a cable and wire list showing assigned numbers and their physical location in the plant.

8. See electrical drawings and specifications for additional work required of the instrument contractor as part of this project.

9. Furnish updated PLC loop diagram after modification of existing PLC system as required by this project.

10. Modify the existing filter local control panel as shown on drawings and as required by the control strategy implementation section of this specification. Field locate actual location to install selector switch, push buttons, indication light, etc. and install accordingly. Make all necessary wiring, terminations, etc. for a complete and functional filter local control panel in place.

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

1. Major elements are:

a. Field Instruments including elements and transmitters.

b. Modification of existing PLC-5 Control Panel

c. PLC programming as describes in 1.01, A.2.

d. SCADA programming as describes in 1.01, A.2.

e. Loop check.

f. Start-up and testing.

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

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

a. Completion of detailed design.

b. Required Submittals.

c. Equipment and ancillaries.

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

e. Coordination with package system shop drawings and other disciplines.

f. Loop checks.

g. Verify readiness for operation.

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

i. Adjusting and calibrating.

j. Starting up.

k. Testing and coordination of testing.

l. Training.

m. As-built documentation.

2. Verify 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 I&C System. Examples of items in this category, but not limited to the following:
1) Valve operators, position switches, and controls.
2) Chemical feed pump and feeder speed/stroke controls.
3) Automatic samplers.
4) Motor control centers.
5) Variable speed drive systems.

e. 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: Provided by I&C Supplier.

D. Software Engineering work scope:

1. Software engineering work shall be performed by the instrumentation and control contractor, unless otherwise noted. The instrumentation and control contractor shall have be responsible to coordinate loop-checks, start-up etc. for a complete working system in place. The following are part of the software engineering scope:

    a. Correct I/O mapping and scaling.

    b. Ladder logic implementation defined in control strategies.

    c. HMI interface graphic screens and mapping.

    d. Start-up support, including system testing and trouble shooting.

    e. System training.

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

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 and control systems. The Contractor shall have said supplier perform all engineering necessary in order to select, furnish, program, supervise the installation of, connection, calibrate, and 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/her 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, programming, panel assembly, instrumentation installation, documentation (including panel assembly), schematics and wiring diagrams, field testing, calibration and start-up, operator instruction and maintenance training. Provide references (including phone number and contact name) for at least three project s where software engineering (programming) tasks such as ladder logic programming, computer based SCADA system configuration, documentation, field testing, start-up, and operator instruction were performed.

C. The foregoing shall enable the Contractor and the Owner 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 treatment and distribution field and its associated 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. All control panels shall bear a UL 508A label. All control panels shall also meet the requirements of national electrical code article 419 for industrial control panels.

E. Instrumentation and Controls supplier shall be:

1. C.C. Control Corp.

2. Or Owner approved equal.

F. The single I&C Supplier shall use Hillers Electrical Engineering for the PLC and SCADA software engineering (PLC programming) task of this project. The task of providing an error-free communication configuration, both the hardware and software task, shall be the sole responsibility of the single I&C Supplier and not the PLC software engineer. There is an on-going SCADA upgrade project that may be in construction phase during this project construction period, the software engineer (Hillers Electrical Engineering) will coordinate with the SCADA upgrade project for all necessary modification of the SCADA screens relating to this project.

1.03 INSTALLATION WORK

A. The I&C contractor is not required to employ the services of the instrument or 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 Owner, 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 Owner's normal working days and hours.

4. To terminate and test all fiber optic cable and effected devices (if applicable).

1.06 GUARANTEE

A. The Contractor shall guarantee all equipment and installation, as specified herein, for a period of one 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 calendar days after notification by the Owner.

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 Owner.

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 that 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

B. Division 11 – Equipment

PART 2 - PRODUCTS

2.01 INSTRUMENTATION CRITERIA

A. Designation of Components

1. 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 Signal and Automation Society of America 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.

B. Signal Characteristics

1. Signals shall be electrical, as indicated herein, and shall vary in direct linear proportion to the measured variable, except as noted. Electrical signals outside control panel(s) shall be 4 to 20 milliamperes DC, except as noted. Signals within enclosures may be 1-5 volts DC.

C. Matching Style Appearance and Type

1. All instruments to be panel mounted at the control panels shall have matching style and general appearance. Instruments performing similar functions shall be of the same type, model, or class, and shall be of one manufacturer, where applicable.

D. Accuracy and Repeatability

1. The overall accuracy of each instrumentation system or loop shall be as described in the Specifications for that system or loop. Each system's accuracy shall be determined as a probable maximum error; this shall be the square-root of the sum of the squares of certified "accuracies" of certain designated components in each system, expressed as a percentage of the actual span or value of the measured variable. Each individual electronic instrument shall have a minimum accuracy of +0.7 percent of full scale and a minimum repeatability of +0.4 percent of full scale unless otherwise specified. Instruments that do not conform to or improve upon these criteria are not acceptable.

E. Signal Isolators, Converters, and Power Supplies

1. Signal isolators shall be furnished and installed in each measurement and control loop, wherever required, to insure adjacent component impedance match or where feedback paths may be generated. Signal converters shall be included where required to resolve any signal level incompatibilities. Signal power supplies shall be included, as required by the manufacturer's instrument load characteristics, to insure sufficient power to each loop component.

F. Alternative Equipment or Methods

1. Equipment or methods requiring redesign of any project details are not acceptable without prior approval of the Engineer. Any changes inherent to a proposal alternative shall be at no additional cost to the Owner. The required approval shall be obtained in writing by the I&C Subcontractor through the Contractor prior to submittal of Shop Drawings and data. Any proposal for approval of alternative equipment or methods shall include evidence of improved performance, operational advantage and maintenance enhancement over the equipment or method specified, or shall include evidence that a specified component is not available. Otherwise, alternative equipment (other than direct, equivalent substitutions) and alternative methods shall not be proposed.

2.02 DETAILED SYSTEMS DRAWINGS AND DATA

A. Content

1. The Contractor shall submit detailed Shop Drawings and data prepared

and organized by the Single I&C supplier designated at the time of bidding. Six submittal sets shall be required. 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:

a. Drawings showing definite diagrams for every instrument 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.)

b. Data sheets for each component, together with a technical product brochure or bulletin. The data sheets shall show:
   1) Component function description used herein and on the Drawings;
   2) Manufacturer's model number or other product designation;
   3) Project tag number used herein and on the Drawings;
   4) Project system loop of which the component is a part;
   5) Project location or assembly at which the component is to be installed;
   6) Input and output characteristics;
   7) Scale range and units (if any) and multiplier (if any);
   8) Requirements for electric supply (if any);
   9) Requirements for air supply (if any);
   10) Materials of component parts to be in contact with, or otherwise exposed to, process media;
   11) Calibration curves as required.
   12) Special requirements or features.

c. 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.

d. 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.

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

f. 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.

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

h. 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.

i. 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. Five final sets of technical manuals shall be supplied for the Owner, and one final set shall be supplied to the Engineer, as a condition of acceptance of the project. Each set shall consist of one 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, two (2) sets of these manuals shall be submitted to the Engineer, and two sets submitted to the Owner, for review. Coordinate with front end documents for

quantity of submittal requirements and adjust accordingly. Following the Engineer's, and Owner's review, one (1) set shall be returned to the Contractor with comments. The sets shall be revised and/or amended as required and the requisite final sets shall be submitted to the Engineer fifteen (15) days prior to start-up of systems. The Engineer shall distribute the copies to the Owner.

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 Owner 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 MODIFICATION OF EXISTING PLC CONTROL PANELS

A. General:

1. Contractor shall modify the existing PLC control panel as shown on drawings and as described in this specification. Modify existing panel to add new signals as shown on drawings, including relays, surge arrestors, terminal block, wiring, etc. as necessary for a complete and function PLC system.

2. New control panels shall be furnished and installed under this Contract if shown on drawings. They shall house the instrumentation, control devices, indicating lights, PLC's, alarm chasses, displays, 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. 120 volt AC control voltage in a control panel shall be supplied with a line noise suppressing transformer 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

3. Construction:

   a. Control Room: Control room panels shall be Nema 12. The enclosures shall be manufactured of 14 gauge steel.
   b. Building interior, non air-conditioned area: Control panels inside a building (not in a control room) shall be Nema 12, 304 stainless steel 14 gauge construction with painted white. Control panels in corrosive areas shall be construed to be outdoors.
   c. Outdoor: All outdoor control panels shall be NEMA 4X with drip shield kit, 3 point latch mechanism and 316 stainless steel 14 gauge construction, unless otherwise noted on drawings.
   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 finished color of the outside surfaces shall be white, unless otherwise noted or requested by Owner. The inside surfaces shall have a white finish coat.

4. 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.

5. UPS: UPS: Control Panels shall be furnished with a UPS to provide power to the PLC microprocessor and all PLC support, interface, and communication equipment for 10 minutes. UPS shall be manufactured by Eaton or APC.

6. Power supply units for non-PLC modules: Provide power supply units for 120V to 24VDC and 12VDC as needed and sized accordingly to the load supplied. Power supply units for non-PLC modules shall be Puls or Owner approved equal.

B. Signal and Control Circuit Wiring

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:

a. 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.

b. 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.

c. 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.

d. 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.

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

f. Conformance to the above wiring installation requirements shall be reflected by details shown on the Shop Drawings for the Engineer's review.

g. Wires shall be terminated using pin connectors or spade lugs.

4. Wire Marking:

a. 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:

a. 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.

2.05 PLC REQUIREMENTS

A. Existing I/O points will be used and no new PLC or I/O modules are needed.

2.06 PROGRAMMABLE LOGIC CONTROLLER SOFTWARE

A. No new PLC software is needed.

2.07 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 with LED indication. Sockets for relays shall have screw type terminals. Relays shall be Potter and Brumfield, Square-D, or equal.

B. Time delay relays shall be solid-state on-delay or off-delay type with contacts rated for 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 exceeds the contact capacity of the specified relays and timers.

D. Switches and indicating lights shall be round, 30.5 mm 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 LED type, 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. Devices shall be Eaton Electrical Type E-30, General Electric Type CR104, Square D class 9001 Type SK, Allen-Bradley Bulletin 800 or equal.

G. Selector switches shall be of the rotary type with the number of positions as shown on the Drawings. Color, escutcheon engravings, contact configurations and the like shall be as shown. Devices shall be Eaton Electrical Type E-24, General Electric Type CR104, or equal.

H. 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.

I. 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.

J. Solenoid Valves, if not otherwise noted, shall be globe valve, directly actuated by solenoid and not requiring minimum pressure differential for operation. Materials shall be brass globe valve bodies and Buna-N valve seats. The size shall be 1/4" normally closed. The coil shall be 115 VAC coil, NEMA 4 solenoid enclosure. Manufacturer shall be ASCO Red Hat, or equal.

2.08 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS) PROTECTION

A. General

1. 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.

2. 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

1. 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

1. 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.

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

2.09 INSTRUMENTATION AND CONTROL EQUIPMENT SPECIFICATIONS

P1. FLOAT SWITCH (FLOAT)

1. Level switches of the direct acting float-operated design shall be comprised of a hermetically sealed, approximately 5 inch diameter plastic casing float, containing microswitches and flexibly supported by means of a heavy neoprene jacket, with three conductor cable a minimum of 20 feet in length. Level switches containing mercury shall be unacceptable. Unless otherwise specified, media specific gravity is 0.95 to 1.05. Microswitches shall be one normally open and one normally closed, 5A-115V AC capacity. Float hangers and supports shall be provided as shown on the installation detail drawings. Float switches shall be as manufactured by Flygt, Anchor Scientific, Zoeller or equal.

M1. MOTOR VIBRATION SWITCH AND PROBE

1. Electronic vibration switches to provide economical, self-contained, signle-channel vibration protection device. The switch shall be suitable for use in non-hazardous as well as Class I Div 2 hazardous areas.

2. Electronic vibration switches shall provide two independent alarm setpoints and corresponding discrete outputs, allowing implementation of ALERT (pre-shutdown) and DANGER (shutdown) levels. A separate 4-20mA proportional output shall be provided but will be for future use in this project.
3. Vibration on both switches is monitored in RMS velocity units. The standard configuration consists of an internal accelerometer mounted inside the switch housing, providing completely self-contained functionality. The switch can also be configured to use an external accelerometer as shown on drawings.
4. Manufacturer: Metrix Vibration Model 440 or Owner approved equal and SA6200 probe with manufactured supplied cable. Coordinate with manufacturer for the actual recommended probe model and provide accordingly. Vibration switch model 440 will be installed in the VFD unit. Contractor shall provide the unit to VFD supplier (specification 16485) to be installed with the VFD unit. Vibration switch and probes are only required for Effluent Pump No.5 and No.6.

2.10 CONTROL STRATEGY AND LOOP DESCRIPTIONS

A. No control strategy modification is needed.

B. The I&C supplier and software programmer shall perform the loop check after the

new signals and existing signals are reconnected to the existing PLC-5 panel. New signals will need I/O mapping in the PLC program. The I&C supplier and software programmer shall also perform the startup service after all signals are connected.

2.11 INSTRUMENT LIST

TAG NO.	COMPONENT CODE	COMPONENT TITLE	COMPONENT OPTIONS/RANGE	REMARKS
LSH-EFF01	L1	Effluent Electrical Room Trench High Level Alarm		Field determine mounting high approximately 3" above trench level.
VSH-EFF05A, VSH-EFF05B	M1	Effluent Pump No.5 Upper and Lower Vibration Switch and Probe		2 sets of vibration switch/probe are needed for each pump. Switches will be send to VFD supplier to be installed in the VFD unit.
VSH-EFF06A, VSH-EFF06B	M1	Effluent Pump No.6 Upper and Lower Vibration Switch and Probe		2 sets of vibration switch/probe are needed for each pump. Switches will be send to VFD supplier to be installed in the VFD unit.

PART 3 - EXECUTION

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

A. General:

1. 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 Owner, 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 all loops. Check data logging, alarm logging, and event logging.

3. 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 Division 16. 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 Owner. 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 Owner. 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 Owner, 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 Owner. 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 Owner 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 Owner's operating personnel can follow. When the owner has accepted the system, instruction shall be given by qualified persons who have been made familiar in advance with the systems in accordance with item 3.01.I. 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 Owner.

G. Modifications to Existing Facilities

1. The Contractor shall make all modifications to existing equipment and control devices that are required to successfully install and integrate all new instrumentation equipment. All costs for any required modification and rehabilitation effort shall be included in the Contractor's original bid amount and no additional payment shall be allowed.

H. 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.

I. Training

1. The cost of training programs to be conducted with City’s personnel shall be included in the Contract price. The training and instruction, insofar as practicable, shall be directly related to the systems being supplied.

2. The supplier shall provide detailed manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project.

3. The supplier shall make use of teaching aids, manuals, slide/video presentations, etc. as necessary to provide a complete and valuable training experience. After the training services, such materials shall be delivered to City.

4. The training program shall represent a comprehensive program covering all

aspects of the operation, maintenance, calibration and cleaning procedures for the system.

5. All training schedules shall be coordinated with, and at the convenience of the City. Shift training may be required to correspond to the City's working schedule.

6. Training shall be performed by qualified representatives of the Instrumentation Control and Monitoring System Integrator. Training shall be specifically tailored to this project and reflect the control system installation and configuration. All training shall be conducted at the job site, unless an alternate location is approved by the City. Training shall be for a minimum of 1 full days and may require multiple classes to accommodate different shifts of operations personnel. Submit training materials and resumes of the training personnel to the City a minimum of two weeks prior to the training session(s) for City approval.

2.13 SUPPLEMENTS

A. Supplements listed below; following "END OF SECTION" is 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

COMPONENT CODE: NAME:	MANUFACTURER: MODEL: SERIAL:	PROJECT NUMBER: NAME:
RANGE VALUE UNITS □INDIATE/ CHART _____ _____ RECORD SCALE _____ _____ □TRANS/ INPUT _____ _____ CONVERT OUTPUT _____ _____	□ COMPUTE FUNCTIONS	□ CONTROL ACTION (DIRECT/REVERSE) MODES (P/I/D) □ SWITCH UNIT RANGE (VALUE/UNITS) DIFFERENTIAL (FIXED/ADJUSTABLE) RESET (AUTOMATIC/MANUAL)

	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 six years that shall include installations of medium voltage pad mounted transformers, medium voltage conductors, medium voltage conductor terminations, low voltage switchboards and variable frequency drives.

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.

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 Contractor's 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 Broward 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. Perform demolition of electrical power equipment and electrical distribution systems as described in drawings and the specifications, complete.

2. Provide and install the complete electrical power distribution systems described in the drawings and specifications, complete in place.

3. Provide and install all electrical equipment as described in the drawings and the specifications including medium voltage transformers, medium voltage conductors, switchboards, panelboards, low voltage conductors, disconnect switches, raceway, variable frequency drives (VFDs), surge protective devices, etc. complete in place.

4. Provide and install new lighting and convenience power systems as described in the drawings and the specifications, complete in place.

5. Provide and install all new underground conduit duct banks and wiring described in drawings and the specifications, complete in place.

6. Provide and install new expansion coupling for each exposed conduit between Effluent Pump Station Electrical Building and Effluent Pump Building as required by NEC codes, indicated or not on drawings.

7. Provide all miscellaneous electrical including switches, terminations, fittings, wiring, conduit, junction boxes, etc. not expressly described or specified in the drawings and specifications but obviously necessary, for a complete working system in place.

8. Provide and install new grounding systems as described in the drawings and Specification 16450, complete in place.

9. Preform an Electrical Systems Analysis per Specification 16015.

10. Provide all modifications to the existing PLC-5 as described in drawings, for a complete working system in place. Refer to specification 13300 for additional requirements.

11. The Contractor shall provide a detailed proposed sequence of construction as a submittal and get approval in writing, by the Owner and Engineer. Proposed sequence of construction shall also include duration of each shutdown, temporary equipment locations, and duration of each phase, if any. Incorporate all comments by Engineer and Owner into the sequence of construction until the proposed sequence of construction is approved. Where temporary power is required, the Contractor shall provide and install all necessary temporary power distribution equipment, generators, noise abatement systems through critical silencers, wires, raceway supports, etc. for a complete and working temporary power system in place. All cost associated with temporary power system shall be included in the bid price. See construction constraints and suggested construction sequence.

B. Temporary Power:

1. Provide temporary power for all office trailers and for all construction areas. Coordinate with local power and telephone utility for temporary construction power and telephone service during construction.

2. Provide temporary power systems as described in the drawings and specifications to facilitate operations during construction. Temporary power systems shall include but not be limited to all temporary generators, cables/conductors, fuel, maintenance and temporary barricades. Provide the following generator sizes as part of the temporary power systems at each identified location during construction:

    a. Panel PDP at East Transfer Pump Station – 100KW, 480V, 3 phase
    b. Panel MDP-1 and MDP-2 at East Blower Room – 400KW, 480V, 3 phase
    c. MCC-2 at Old Control Building – 20KW, 480V, 3 phase
    d. MCC-5 at Sludge Building – 30KW, 480V, 3 phase
    e. MCC-7 at Headworks Building – 30KW, 480V, 3 phase
    f. Panel H at Control Building – 250KW, 480V, 3 phase
    g. Panel MDP-1 and MDP-2 at West Blower Room – 600KW, 480V, 3 phase
    h. Panel PP1 at West Main Electrical Building – 30KW, 277/480V, 3 phase
    i. Panel LP1 at West Main Electrical Building – 30KW, 120/208V, 3 phase
    j. Panel PP1 at West Transfer Pump Station – 150KW, 480V, 3 phase

C. Construction Constraints:

2. All shutdowns, including durations, shall be coordinated with the City a minimum of two week prior to any construction related activity. Contractor shall complete as much construction related activities as possible prior to any shutdowns to limit their durations to the greatest extent possible.

3. Shutdowns of West Main Switchboard and East Main Switchboard shall be approved by the City and be done during the Plant's normal working hours for a maximum duration of eight (8) hours or otherwise dictated by Plant Staff. Temporary power systems as described in 1.05(B) shall be provided during shutdowns to maintain the operation of the Plant.

4. Lighting systems, programmable logic controllers (PLCs) and instruments shall remain in operation at all times.

5. Effluent Pumps:

    a. Only one Effluent Pump, may be taken out of operation at any one time.

6. Site:

    a. Contractor shall maintain access for plant personnel and vehicular traffic throughout Plant.

b. When trenching for conduit installation, the Contractor shall be limited to a maximum of 500ft area at any one time that shall be restored and inspected by the Engineer and City before being allowed to proceed to the next work area.

c. The Contractor shall hand-dig all new underground routes to verify all existing utility crossings prior to utilizing mechanical digging equipment and shall be responsible for any damage to existing utilities.

D. Suggested Construction Sequence:

1. To facilitate the installation of the new electrical power distribution equipment in the Effluent Pump Station Electrical Building, the medium voltage power distribution conduit ductbank and medium voltage transformers from the existing West Main Electrical Building to the Effluent Pump Station Electrical Building is to be constructed first:

    a. Install the new medium voltage conduit ductbank, new medium voltage conductors and two medium voltage pad mount transformers.

    b. Install new low voltage conductors between new medium voltage pad mounted transformer and existing West Main Electrical Building Switchboard via new conduit ductbank and cable tray.

    c. Modify existing West Main Electrical Building Switchboard for addition of new fused switch. Provide all temporary power systems as required per 1.05(C).

2. Effluent Pump Station Electrical Building: This work assumes new medium voltage transformers are installed and operational.

    a. Install new VFDs No. 5 and 6 in temporary locations within Effluent Pump Station Electrical Building and install temporary conduit and conductor systems between new VFDs and existing switchboard/PLC. Install new pump No. 6 disconnect switch and pump No. 5 and 6 conduit and conductor systems between temporary VFD and pump.

    b. After new VFDs No.5 and 6 are operational, demolish the existing VFDs No. 5 and 6, existing pump No. 6 disconnect switch and existing No. 6 conduit and conductor systems between Effluent Pump Station Electrical Building and pump.

    c. Install new Switchboard EPS and new conductor systems between new switchboard and new pad mounted transformer MV-T-2.

    d. After new Switchboard EPS has been energized and is operational, install temporary conduit and power conductor systems to new VFDs No. 5 and 6 in temporary locations.

e. After new VFDs No.5 and 6 have been energized and are operational, demolish existing effluent pump No. 4 VFD, isolation transformer, pump disconnect switch and conduit and conductor systems between existing Switchboard EPS and pump. Install new pump No. 4 VFD, pump disconnect switch and conduit and conductor systems between new Switchboard EPS and pump.

f. After effluent pump No.4 has been energized and is operational, demolish existing effluent pump No. 3 VFD, isolation transformer, pump disconnect switch and conduit and conductor systems between existing Switchboard EPS and pump. Install new pump No. 3 VFD, pump disconnect switch and conduit and conductor systems between new Switchboard EPS and pump.

g. After effluent pump No.3 has been energized and is operational, demolish existing effluent pump No. 2 VFD, isolation transformer, pump disconnect switch and conduit and conductor systems between existing Switchboard EPS and pump. Install new pump No. 2 VFD, pump disconnect switch and conduit and conductor systems between new Switchboard EPS and pump.

h. After effluent pump No.2 has been energized and is operational, demolish existing effluent pump No. 1 VFD, isolation transformer, pump disconnect switch and conduit and conductor systems between existing Switchboard EPS and pump. Install new pump No. 1 VFD, pump disconnect switch and conduit and conductor systems between new Switchboard EPS and pump.

i. Install new Panel E2, and conduit and conductor systems between new Switchboard EPS and Panel E2. Install new conduit and conductor systems between new Panel E2 and existing transformer TR-E. Transition existing Panel E2 loads to new Panel E2. After all new and existing loads have been transitioned to the new Panel E2, demolish the existing Panel E2.

j. After all existing loads have been removed/transitioned to the new Switchboard EPS, demolish the existing Switchboard EPS.

k. After existing Switchboard EPS has been demolished, relocate the effluent pump No. 5 VFD and demolish the existing pump disconnect switch and conduit and conductor systems between Effluent Pump Station Electrical Building and pump. Install new pump No. 5 VFD, pump disconnect switch and conduit and conductor systems between new Switchboard EPS and pump.

l. After effluent pump No.5 has been energized and is operational, relocate the effluent pump No. 6 VFD. Install new pump No. 6 VFD and conduit and conductor systems between new Switchboard EPS and pump.

d. Install new low voltage conductors between new Switchboard EPS and existing East Main Electrical Building Switchboard via

new/existing conduit ductbank and new cable tray. Provide all temporary power systems as required per 1.05(C).

1.06 SUBMITTALS

A. 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. Quality Control Submittals:

1. Voltage Field Test Results.

2. Voltage Balance Report.

3. Equipment Line Current Report.

4. Factory test certification and reports for all major electrical equipment.

5. Site test certification and reports as specified in other Division 16, ELECTRICAL sections.

6. Provide a conduit plan for power, instrumentation and control conduits, both interior and exterior, showing routing, size and stub up locations for buried or in slab conduits, including on exterior process facilities.

7. As part of the electrical submittal, the contractor shall provide a minimum of ¼”=1’-0” scaled layout of the electrical equipment in each electrical room, or major electrical equipment in a mechanical room, showing sizes of all equipment and their spatial relationships to other equipment in the space. Non-electrical equipment shall be approved before finalizing the electrical layout in mechanical rooms. Layout shall demonstrate compliance with code requirements for working space about equipment. Layout shall depict actual sizes of existing equipment facilities as well as actual dimensions of equipment to be furnished by the contractor.

B. With each equipment submittal, the following information shall be provided for all electrical equipment:

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.

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 or areas 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. Submit a request for shut down to the Owner for 5 working days in advance and for review and approval. 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. All electrical equipment sizes and characteristics have been based on manufacturer EATON. 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.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide materials and equipment listed by UL wherever standards have been established by that agency.

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.

a. Submit Voltage Field Test Report within 5 days of test.

B. Equipment Line Current Tests:

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

2. Make line current check after equipment start up and is in service.

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 480V electrical equipment. Participate with other trades in all startup activities.

3.04 RUBBER MATS

A. A three foot wide rubber mat shall be furnished and installed on the floor and in front of each switchboard, MCC, VFD and control panel assembly. The mat shall be long enough to cover the full length of each line-up. The mat shall be 1/4 inch thick with beveled edges, canvas back, solid type with corrugations running the entire length of the mat. The mat shall be guaranteed extra quality, free from cracks, blow holes, or other defects detrimental to their mechanical or electrical strength. The mat shall meet OSHA requirements and the requirements of ANSI/ASTM D-178 J6-7 for Type 2, Class 2 insulating matting.

- END OF SECTION -

SECTION 16015

ELECTRICAL SYSTEMS ANALYSIS

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. The requirements of this specification shall apply to the modified and new electrical distribution system installed under this project. The end result shall be a fully protected, and properly coordinated, system with proper arc flash safety labels and personal protective equipment recommendations.

B. Contractor shall furnish short-circuit and protective device coordination studies as described herein. The study results shall be presented in a draft study that shall be submitted for review prior to submittal of power distribution equipment for this project. The final study document shall be submitted after start up and shall include all adjustments made during start-up.

C. The contractor shall furnish an Arc Flash Hazard Analysis Study with Arc Flash Labels per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D. Arc Flash labels shall be provided for all switchboards, VFDs and panelboards installed, modified or repowered under this project as shown on plans. Affix arc flash label on new and modified electrical equipment before start-up during construction.

D. Labels shall be constructed on UV resistance, wet rated and be suitable for the environment for which the label will reside in.

1.02 REFERENCES

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

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

a. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems

b. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings

c. IEEE 242: Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.

d. IEEE 399: Recommended Practice for Industrial and Commercial Power System Analysis.

e. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems

f. IEEE 1584-2018: Guide for Performing Arc Flash Hazard Calculations.

2. American National Standards Institute (ANSI):

a. C57.12.00, Standard General Requirements for Liquid-immersed Distribution, Power, and Regulating Transformers.

b. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures

c. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis

d. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories

e. ANSI C37.5 – Methods for Determining the RMS Value of a Sinusoidal Current Wave and Normal-Frequency Recovery Voltage, and for Simplified Calculation of Fault Currents

3. National Fire Protection Association:

a. NFPA 70E: Electrical Safety In The Workplace, Chapter 1.

b. NFPA 70: National Electrical Code.

4. Occupational Safety & Health Administration (OSHA):

a. 29-CFR, Part 1910, sub part S.

1.03 SUBMITTALS

A. Shop drawings: the results of the short circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a preliminary and final summary report. Submit an electronic copy of the complete preliminary and final study reports. The preliminary short circuit and device coordination study report shall be submitted within 30 days of notice to proceed and shall be a basis for approval of all other electrical equipment in the power distribution system. The contractor is expected to review the results of the preliminary short circuit and device coordination study report against all other applicable shop drawings, including industrial control panels, prior to shop drawing submittal to coordinate appropriate fault duty ratings of all electrical equipment. The final short circuit and device coordination study report shall incorporate all comments from shop drawing submittals, all adjustments made during start-up and include the arc-flash hazard analysis. The contractor shall ensure proper arc-flash warning labels are applied to all appropriate electrical equipment installed under this contract when the final study has been approved. The new arc-flash warning labels shall be similar format to the existing label as much as possible. Provide two electronic copies in CD, or DVD, media in additional to the hard copies in the final report. Provide in CD, or DVD, copies of the native study files used to perform the study analysis, including all applicable databases, one line diagrams, TCC curves and results files.

1.04 QUALITY ASSURANCE

A. Short circuit, protective device coordination, and arc flash studies shall be prepared by the manufacturer furnishing the electrical power distribution equipment or a professional electrical engineer registered in the State of Florida, hired by the manufacturer, in accordance with IEEE 242 and IEEE 399.

B. Manufacturer shall have unit responsibility for the equipment and protective device coordination.

1.05 SEQUENCING AND SCHEDULING

A. An initial, complete short circuit and arc flash study must be submitted and reviewed before Engineer will approve Shop Drawings for distribution panelboards, breakers, MCC'S, switchboard, VFD'S, SSRVS'S, manufactured industrial control panels and circuit breaker panelboard equipment. Failure to do so will delay the approval of major equipment submittals.

B. The short circuit, protective device coordination and arc flash studies shall be updated prior to Project Substantial Completion. Utilize characteristics of as-installed equipment actual wire run lengths and materials.

PART 2 – PRODUCTS

2.01 GENERAL

A. Contractor shall furnish all field data as required for the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future utility supplies, motors, and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner or Contractor.

D. Equipment and component titles used in the studies shall be identical to the equipment and component titles shown on the Drawings.

E. Perform studies using digital computer with a software package such as SKM Power*Tools for Windows™ DAPPER™, CAPTOR™ and ARC FLASH™, or approved equal.

F. Perform complete fault calculations for all busses on utility and generator power sources. Perform load flow and voltage drop studies for major feeders and loads with long feeder

runs. Analysis shall include expected fault currents at industrial control panels manufactured in accordance with UL 508A and NEC article 409.

G. Fault source combinations shall include large motors, large transformers, utility and generator.

H. Utilize proposed and existing load data for the study obtained from Contract Documents and field survey. Coordinate with local power utility for available fault currents from utility services.

I. Existing Equipment:

1. Include fault contribution of existing motors, services, generators and equipment, as appropriate, in the study.

2. Obtain required existing equipment data from the field and FPL.

J. Provide a comprehensive report document containing the short circuit, device coordination and arc flash studies. As a minimum the report structure shall contain the following:

1. Executive Summary.

2. Methodology.

3. One Line Diagram(s).

4. Short Circuit Analysis.

5. Short Circuit Analysis Results/Conclusions/Recommendations.

6. Device Coordination Analysis.

7. Recommended protective devices settings.

8. Arc Flash Analysis.

9. Arc Flash PPE recommendations.

2.02 SHORT CIRCUIT STUDY

A. General:

1. Use cable impedances based on copper conductors. Use actual conductor impedances if know. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition.

2. Use bus impedances based on copper bus bars.

3. Use cable and bus resistances calculated at 25 degrees C.

4. Use 600-volt cable reactances based on use of typical data of conductors to be used in this project.

5. Use transformer impedances 92.5 percent of "nominal" impedance based on tolerances specified in ANSI C57.12.00.

B. Provide:

1. Calculation methods and assumptions.

2. Selected base per unit quantities.

3. One-line diagrams annotated with results of short circuit analysis including:

a. Three phase, line-to-line and single line to ground faults.

b. Equipment Short Circuit Rating.

4. Source impedance data, including electric utility system and motor fault contribution characteristics.

5. DAPPER™ Short circuit report, demand load report, load flow report and input data reports.

6. Results, conclusions, and recommendations.

C. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed symmetrical three-phase bolted fault, bolted line-to-ground fault, and bolted line-to-line fault at each:

1. Electric utility's supply termination point.

2. Main breakers, generator breakers and feeder breakers.

3. Low voltage switchgear, switchboard and/or distribution panelboard.

4. Unit substations.

5. Motor control centers.

6. Standby generator.

7. Automatic Transfer Switch (if applicable).

8. All branch circuit panelboards.

9. Variable Frequency Drives and Solid State Reduced Voltage Starters.

10. Industrial control panels manufactured in accordance with UL 508A and NEC article 409.

11. Other significant locations throughout the system.

12. Future load contributions as shown on one-line diagram.

D. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short circuit ratings Verify all equipment, main breakers, ATS, and protective devices are applied within their ratings.

2. Adequacy of switchgear, switchboards, motor control centers, unit substations and panelboard bus bar bracing to withstand short-circuit stresses

3. Adequacy of transformer windings to withstand short-circuit stresses

4. Cable and busway sizes for ability to withstand short-circuit heating besides normal load currents.

5. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current

E. Through the General Contractor, furnish expected fault currents for industrial control panels, constructed and installed under other divisions and specifications of this contract, to the panel builder for his coordination with meeting the requirements of UL 508A and NEC article 409.

2.03 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves for distribution system, graphically displayed on log-log scale paper. Time Current Curve plots from SKM CAPTOR™ program are acceptable.

B. Each curve sheet to have title and one-line diagram with legend identifying the specific portion of system associated with time-current curves on that sheet.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Perform device coordination on time-current curves for low voltage distribution system(s).

F. Provide Individual protective device time-current characteristics on log-log paper or software generated graphs.

G. Plot Characteristics on Curve Sheets:

1. Electric utility's relays or protective device (if applicable).

2. Electric utility's fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands (if applicable).

3. Medium voltage equipment relays (if applicable).

4. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.

5. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands.

6. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters.

7. Transformer damage curves.

8. Conductor damage curves.

9. ANSI transformer with stand parameters.

10. Significant symmetrical and asymmetrical fault currents.

11. Ground fault protective devices and settings (if applicable).

12. Pertinent motor starting characteristics and motor damage points.

13. Pertinent generator short circuit decrement curve and generator damage point.

14. Circuit breaker panelboard main breakers, where appropriate.

15. Motor circuit protectors for major motors

H. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

I. Primary Protective Device Settings for Delta-Wye Connected Transformer:

1. Secondary Line-to-Ground Fault Protection: Primary protective device operating band within the transformer's characteristics curve, including a point equal to 58 percent of ANSI C57.12.00 withstand point.

2. Secondary Line-To-Line Faults: 16 percent current margin between primary protective device and associated secondary device characteristic curves.

J. Separate medium voltage relay characteristics curves from curves for other devices by at least 0.4-second time margin.

2.04 ARC FLASH ANALYSIS

A. Perform incident energy calculations in accordance with IEEE 1584-2018 Guide for Performing Arc Flash Hazard Calculations for all equipment analyzed in the short circuit

study. Tabular results and recommended labels from SKM ARC FLASH™ are acceptable.

B. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model.

C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, bussway and unit substations, variable frequency drives, and industrial control panels) where work could be performed on energized parts.

D. The Arc-Flash Hazard Analysis shall include all medium voltage and low voltage locations in 480 volt, 240 volt and 208 volt systems. Arc-Flash Hazard Analysis on low voltage systems 120V and below is not required.

E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering incident energy value of 1.2 cal/cm2.

F. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.

H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2018 section B.1.2.

I. Furnish recommendations for Personal Protective Equipment, in accordance with OSHA standards, and proper labels to be located on the electrical equipment in accordance with NEC Article 110.16.

J. Use manufacturer data for: enclosure type; gap between exposed conductors or buss way; grounding type; number of phases and connection; and working distance.

2.05 TABULATIONS

A. Input Data:

1. Utility three-phase and line-to-ground available contribution with associated X/R ratios.

2. Short circuit reactances of rotating machines and associated X/R ratios.

3. Cable type, construction, size, quantity per phase, length, impedance and conduit type.

4. Bus data, including impedance.

5. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio.

B. Short Circuit Data:

1. Source fault impedance and generator contributions.

2. X to R ratios.

3. Asymmetry factors.

4. Motor contributions.

5. Short circuit kVA.

6. Symmetrical and asymmetrical fault currents.

C. Recommended Protective Device Settings:

1. Phase and ground relays:

a. Relay name.

b. Device number.

c. Description.

d. TCC catalog number.

e. Short circuit ratings.

f. Current transformer ratio.

g. Current tap.

h. Time dial setting (as applicable).

i. Instantaneous pickup setting (as applicable).

j. Ground fault setting (as applicable).

k. Specialty, non-overcurrent device settings.

l. Recommendations on improved relaying systems, if applicable

2. Circuit Breakers:

a. Breaker name.

b. Breaker Description.

c. Model number.

d. TCC catalog number.

e. Short circuit rating.

f. Frame/Sensor rating.

g. Adjustable pickups and time delays (long time, short time, ground).

h. Adjustable time-current characteristic.

i. Adjustable instantaneous pickup.

j. Recommendations on improved trip systems, if applicable

3. Motor Circuit Protectors (MCP):

a. MCP name.

b. MCP Description.

c. Model number.

d. TCC catalog number.

e. Short circuit rating.

f. Frame/Sensor rating.

g. Instantaneous settings.

4. Fuses:

a. Fuse name.

b. Fuse Description.

c. Model number.

d. TCC catalog number.

e. Short circuit rating.

f. Fuse rating.

D. Incident energy and flash protection boundary calculations.

1. Arcing fault magnitude

2. Device clearing time

3. Duration of arc

4. Arc flash boundary

5. Working distance

6. Incident energy

7. Hazard Risk Category

8. Recommendations for arc flash energy reduction

2.06 STUDY ANALYSES

A. Written Summary:

1. Scope of studies performed.

2. Explanation of bus and branch numbering system.

3. Prevailing conditions.

4. Selected equipment deficiencies.

5. Results of short circuit and coordination studies.

6. Comments or suggestions.

B. Suggest changes and additions to equipment rating and/or characteristics.

C. Notify Engineer in writing of existing circuit protective devices improperly rated for new fault conditions.

PART 3 – EXECUTION

3.01 GENERAL

A. Adjust relay and protective device settings according to values established by coordination study.

B. Make minor modifications to equipment as required to accomplish conformance with the short circuit and protective device coordination studies.

C. Notify Engineer in writing of any required major equipment modifications.

END OF SECTION

SECTION 16050

BASIC ELECTRICAL MATERIALS 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. C62.11, Standard for Metal-Oxide Surge Arrestors for AC Circuits.
   b. Z55.1, Gray Finishes for Industrial Apparatus and Equipment.
   c. C57, Standard General Requirements for Dry Type Distribution and Power Transformers
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 Contractor's 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. ICS 2, Industrial Control Devices, Controllers, and Assemblies.
   d. KS 1, Enclosed Switches.
   e. LA I, Surge Arrestors.
   f. PB 1, Panelboards
   g. ST 20, Dry-Type Transformers for General Applications.
   h. WD I, General Requirements for Wiring Devices.
   i. NEMA Standard TP-1-2002.

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 used at, or below, grade.

3. Hardware.

4. Terminal junction boxes.

5. Panelboards and circuit breaker data.

6. Fuses.

7. Contactors.

8. Transformers.

9. All other miscellaneous material part of this project.

10. Wire pulling compound.

B. Quality Control Submittals:

1. Test Report: Sound test certification for dry type power transformers (0 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.

1.04 SPARE PARTS

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

1. Fuses, 0 to 600 Volts: Six (3) of each type and each current rating installed.

PART 2 – PRODUCTS

2.01 OUTLET AND DEVICE BOXES

A. 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.

B. 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.

C. 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 Sheet Steel Box: NEMA 250, Type 1.

1. Box: Code-gauge, galvanized steel.

2. Cover: Full access, screw type.

3. Machine Screws: Corrosion-resistant.

C. Large Cast Metal Box: NEMA 250, Type 4.

1. Box: Cast malleable iron, hot-dip galvanize finished, with drilled and tapped conduit entrances.

2. Cover: Hinged with screws.

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

4. Manufacturers, Surface Mounted Type:

a. Crouse-Hinds; Series W.

b. O.Z./Gedney; Series Y.

5. Manufacturers, Recessed Type:

a. Crouse-Hinds; Type WJBF.

b. O.Z./Gedney; Series YR.

D. 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 316 stainless steel.

4. Manufacturers:

a. Hoffman Engineering Co.

b. Robroy Industries.

E. Large Steel Box: NEMA 250, Type 4.

1. Box: 12-gauge steel, with white enamel painted interior and gray primed exterior, over phosphated surfaces, with final ANSI Z55.1, No. 61 gray enamel on exterior surfaces.
2. Cover: Hinged with screws.
3. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
4. Manufacturers:
    a. Hoffman Engineering Co.
    b. Robroy Industries.

F. Large Nonmetallic Box:
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.

G. Concrete Box:
1. Box: Rebar reinforced, cast concrete.
2. Cover: H20-44 traffic rated cast iron.
3. Cover Marking: ELECTRICAL, TELEPHONE, SIGNAL, CONTROL or as shown.
4. Manufacturers:
    a. Brooks Products Inc.; No. 36/36T.
    b. Qwikset; W 17.

2.03 WIRING DEVICES

A. Receptacle, Single and Duplex:
1. NEMA WD 1 and FS W-C-596.

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

3. High strength, thermoplastic base color.

4. Color:

   a. Office Areas: Ivory.

   b. 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.

B. 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.

C. 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.

2.04 DEVICE PLATES

A. General: Sectional type plates not permitted.

B. 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.

C. Cast Metal:

1. Material: Malleable ferrous metal, with gaskets.

2. Screw: Oval-head stainless steel.

D. Engraved:

1. Character Height: 3/16 inch.

2. Filler: Black.

E. 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:

1) Bryant

2) Hubbell

3) Pass and Seymour

4) Crouse-Hinds

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

a. Mounting Screw: Stainless steel.

b. Manufacturers:

1) Crouse-Hinds; DS-181 or DS-185.

2) Appleton; FSK-LVTS or FSK-IVS.

2.05 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: If not otherwise shown in plans. Applicable to a system with available short-circuit current of 25,000 amperes rms symmetrical at 208Y/120 or 120/240 volts and 65,000 amperes rms symmetrical at 480Y/277 volts.

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

F. Cabinet: As shown on plans.

G. 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 100 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. Sub-feed or through-feed lugs as shown.

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

H. 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. Non-interchangeable, in accordance with NFPA 70.

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

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

6. Multi-pole 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.

I. SPD

1. Provide external surge protective device (SPD). Provide breaker for SPD.

J. SURGE PROTECTIVE DEVICE (SPD)

1. This section describes the material and installation requirements for surge protective devices (SPD) for switchboards, panelboards, and motor control centers for the protection of all AC electrical circuits.

2. SPD shall be listed and component recognized in accordance with UL 1449 and UL 1283.

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

4. 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.

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

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

7. SPD shall meet or exceed the following criteria:

   a. Maximum surge current capability (single pulse rated) shall be:
      1. Switchboards 300kA
      2. Panelboards 150kA
      3. Motor control centers 80kA

   b. 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

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

9. SPD shall be provided with 1 set of NO/NC dry contacts.

10. SPD shall have a warranty for a period of five years, incorporating unlimited replacements of suppressor parts if transients destroy them during the warranty period. Warranty will be the responsibility of the electrical distribution equipment manufacturer.

K. Manufacturers:

1. Eaton.

2. Or approved equal

2.06 NONFUSED DISCONNECT SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA KS 1.

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

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

D. Enclosure: NEMA 250, Type 12, industrial use, 4X 316 stainless steel - outdoors, wet locations and corrosive areas, unless otherwise shown.

E. Interlock: Enclosure and switch to prevent opening cover with switch in the ON position and capable of being locked in the OPEN position.

F. Auxiliary contacts where indicated in the drawings.

G. Disconnect switches shall be furnished with a factory installed internal barrier kit that helps prevent accidental contact with live parts and provides “finger-safe” protection when the door of the enclosed switch is open.

H. Manufacturers:

1. Eaton.

2. Or approved equal

2.07 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.

2.08 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.

2.09 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.

2.10 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.

2.11 SUPPORT AND FRAMING CHANNELS

A. Material:
1. ASTM A167, Type 316 stainless steel. Use 316 stainless steel rods, nuts and bolts to attach or anchor to the concrete slab or wall.

B. Finish:
1. ASTM A167, Type 316 stainless steel.

C. Inserts: Continuous.

D. Beam Clamps: Gray cast iron for non-corrosive areas and FRP (fiberglass) for corrosive/ chemical areas.

E. Manufacturers:

1. B-Line.
2. Unistrut.
3. Or approved 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. 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 splash back, or 6 inches above countertops without splash back.

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 plaster covers to make edges of boxes flush with finished surface.

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

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. 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.

d. Concrete Encased Raceways: Cast metal.

e. Lighting Circuits, Ceiling: Cast metal.

f. 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: Cast metal.

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

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

P. Box Type (Nonmetallic Raceway System):

1. Corrosive Locations: Nonmetallic.

2. Exposed Raceways: Nonmetallic.

3. Concealed Raceways: Nonmetallic.

4. Concrete Encased Raceways: Nonmetallic.

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 boxes 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 conduits 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. All 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.

7. Corrosive Locations: Nonmetallic.

8. Receptacles: Install in accordance with manufacturer's instructions.

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.

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.

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

C. Do not install on finished outdoor surfaces.

D. 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 NONFUSED DISCONNECT SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. All disconnect switches shall be mounted five (5) feet above the floor, at the equipment height where appropriate, or where shown otherwise.

3.09 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.

3.10 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. Install securely, plumb, in-line and square with walls.

B. Install top of cabinet 6 feet above floor unless otherwise shown.

C. Provide typewritten circuit directory for each panelboard.

3.11 SUPPORT AND FRAMING CHANNEL

A. Furnish zinc-rich primer; paint cut ends prior to 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 which 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 Contractor's 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. PVC Schedule 40 conduit.
   b. Rigid Aluminum conduit.
   c. Flexible metal, liquid-tight conduit.
   d. Flexible, nonmetallic, liquid-tight conduit.
   e. Conduit fittings.
   f. Wireways.
2. 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.
3. Conduit Layout:
   a. Plan and section type, showing arrangement and location of conduit and duct bank required for:
      1) Low and medium voltage feeder and branch circuits.
      2) Instrumentation and control systems.
      3) Communications systems.
      4) Empty conduit for future use.
   b. Site plan scale not greater than 1 inch equals 20 feet.
      1) Equipment and machinery proposed for bending metal conduit.
      2) 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.

PART2 - PRODUCTS

2.01 CONDUIT AND TUBING

A. PVC Schedule 40 and 80 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.

3. Have smooth Interior and grey color.

B. Rigid Aluminum Conduit

1. Meets requirements of UL 514B

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

C. Flexible Metal, Liquid-Tight Conduit:

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

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

D. 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.

2.02 FITTINGS

A. PVC Conduit and Tubing:

1. Meet requirements of NEMA TC-3.

2. Type: PVC, slip-on.

B. Rigid Aluminum Conduit:

1. General:
   a. Meet requirements of UL 514B.
   b. Type: Threaded, galvanized. Set screw fittings not permitted.

2. Bushing:
   a. Material: Cast Aluminum with integral insulated throat, rated for 150 degrees C.
   b. Manufacturers:
      1) O.Z./Gedney; Type AB.

3. Grounding Bushing:
   a. Material: Cast Aluminum with integral insulated throat rated for 150 degrees C, with solderless lugs.
   b. Manufacturers:

1) Appleton; Series GIB.
2) O.Z. Gedney; Type ABLG.

3. Conduit Hub:
   a. Material: Cast Aluminum with insulated throat.
   b. Manufacturers:
      1) O.Z. Gedney; Series CHA.
      2) T & B; Series 370AL.

5. Conduit Bodies:
   a. Material: Cast Aluminum, sized as required by NFPA 70.
   b. Manufacturers:
      1) Appleton; Form 85 threaded Unilets.
      2) Crouse-Hinds; Mark 9 or Form 7-SA threaded condulets.
      3) Killark; Series O Electrolets.

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

11. Cable Sealing Fittings:
    a. To form watertight non-slip cord or cable connection to conduit.
    b. For Conductors with OD of 1/2 Inch or Less: Neoprene bushing at connector entry.
    c. Manufacturers:
       2) Appleton; CG-S.

C. Flexible Metal, Liquid-Tight Conduit:

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

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.

D. 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.

E. 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.

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

1. Manufacturer: Crouse-Hinds; Type ECGJH.

2.03 WIREWAYS

A. Meet requirements of UL 870.

B. Type: Stainless Steel, with hinged cover.

C. Rating: Outdoor raintight if outdoor, and indoor if indoor.

D. Finish: Don not paint stainless steel wireways.

E. Manufacturers:

1. Square D.

2. B-Line Systems, Inc.

2.04 CABLE TRAYS

A. Meet requirements of NEMA VE 1.

B. Type: Ladder of welded construction.

C. Material: Copper-free aluminum alloy 6063-T6 finish.

D. Cover: Louvered, minimum 0.40-inch thick aluminum.

E. Barrier Strip: Vertical, solid type, with horizontal fittings and strip clamps.

F. Fittings of same cross-sectional tray area, and hardware of same material as cable tray.

G. Tray Grounding: Conform to NFPA 70 and NEMA VE 1.

H. Provide next higher NEMA VE 1 class designation than required for support of designed span length.

I. Design Loads: Use working load adequate for actual cable installed plus 50 percent additional weight allowance for future cables plus 200-pound concentrated static load applied between side rails at midspan, with safety factor of 2 in accordance with NEMA VE 1, Table 3-1.

J. Expansion Joints: NEMA VE 1 for 50 degrees F maximum temperature variation.

K. Furnish Cable Tray with no sharp edges, burrs, or weld projections.

L. Manufacturers:
   1. B-Line Systems, Inc.
   2. Square-D.
   3. P. W. Industries.

2.05 PRECAST MANHOLES AND HANDHOLES

A. Concrete Strength: Minimum, 3,000 psi compressive, in 28 days.

B. Loading: AASHTO Division 1, H-20 in accordance with ASTM C857.

C. Access: Provide cast concrete 6- or 12-inch risers and access hole adapters between top of manhole and finished grade at required elevations.

D. Drainage:
   1. Slope floors toward drain points, leaving no pockets or other non-draining areas.
   2. Provide drainage outlet or sump at low point of floor constructed with a heavy, cast iron, slotted or perforated hinged cover, and 4-inch minimum outlet and outlet pipe.

E. Raceway Entrances:
   1. Provide on all four sides.
   2. For raceways to be installed under this Contract, provide knockout panels or precast individual raceway openings.
   3. At entrances where raceways are to be installed by others, provide minimum 12-inch high by 24-inch wide knockout panels for future raceway installation.

F. Embedded Pulling Iron:
   1. Material: 3/4-inch diameter stock, fastened to overall steel reinforcement before concrete is placed.
   2. Location:
      a. Wall: Opposite each raceway entrance and knockout panel for future raceway entrance.
      b. Floor: Centered below manhole or handhole cover.

G. Cable Racks:
   1. Arms and Insulators: Adjustable, of sufficient number to accommodate cables for each raceway entering or leaving manhole, including spares.
   2. Wall Attachment:
      a. Adjustable inserts in concrete walls. Bolts or embedded studs not permitted.
      b. Insert Spacing: Maximum 3-foot on center entire inside perimeter of manhole.
      c. Arrange so that spare raceway ends are clear for future cable installation.

H. Manhole Frames and Covers:
   1. Material: Machined cast iron.
   2. Cover Type: Indented, solid top design, with two drop handles each.
   3. Cover Loading: AASHTO Division I, H-20.
   4. Cover Designation: Cast, on upper side, in integral letters, minimum 2 inches in height, appropriate titles:
      a. Above 600 Volts: ELECTRIC HV.
      b. 600 Volts and Below: ELECTRIC LV.
      c. TELEPHONE.

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

J. Hardware: Steel, hot-dip galvanized.

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

L. Manufacturers:
   1. U.S. Precast.
   2. Brooks Products, Inc.
   3. Penn-Cast Products, Inc.
   4. Concrete Conduit Co.
   5. Associated Concrete Products, Inc.
   6. Utility Vault Co.
   7. Pipe,Inc.

2.06 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:
   a. Material: Permanent, nylon.
   b. Shape: Round.
   c. Raceway Designation: Pressure stamped, embossed, or engraved.
   d. Tags relying on adhesives or taped-on markers not permitted.

2. Warning Tape:
   a. Material: Polyethylene, 4-mil gauge.
   b. Color: Red.
   c. Width: Minimum 6-inch.
   d. Designation: Warning on tape that electric circuit is located below tape.
   e. Manufacturers:
      1) Blackburn, Type RT.
      2) Griffolyn Co.

3. Buried Raceway Marker:
   a. Material: Sheet bronze, consisting of double-ended arrows, straight for straight runs and bent at locations where runs change direction.
   b. Designation: Incise to depth of 3/32 inch, ELECTRIC CABLES. in letters 1/4-inch high.
   c. Minimum Dimension: 1/4-inch thick, 10 inches long, and 3/4-inch wide.

C. Raceway Coating:

1. Material: Bitumastic or plastic tape coating.

2. Manufacturers:
   a. Koppers bitumastic; No. 505.
   b. Scotchwrap; No. 51, plastic tape.

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 NECA 5055.

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. Aluminum Conduit: Do not install in direct contact with concrete.

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 with zinc-rich paint or liquid galvanizing compound.

P. All metal conduit to 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, unless otherwise noted.

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 Conduit all other areas.

C. Interior, Exposed:

1. Rigid Aluminum Conduit all other areas.

D. Direct Earth Burial: – Schedule 40 PVC

E. Direct Buried With Concrete Slab On Top – PVC Schedule 40.

F. Concrete-Encased Raceways – Schedule 40 PVC

G. Under Slabs-On-Grade – Schedule 40 PVC

3.04 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:

1. Conduit Size 4 Inches or Less: Flexible metal, liquid-tight conduit.

2. Conduit Size Over 4 Inches: Nonflexible.

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

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

B. Lighting Fixtures in Dry Areas: Flexible metal, liquid-tight conduit.

C. Outdoor Areas, Process Areas Exposed to Moisture, and Areas Required to be Oiltight and Dust-Tight: Flexible metal, liquid-tight conduit.

D. Transition from Underground or Concrete Embedded to Exposed: Rigid Aluminum Conduit.

E. Under Equipment Mounting Pads – Schedule 40 PVC

F. Exterior Light Pole Foundations – Schedule 40 PVC

3.05 PENETRATIONS

A. Make at right angles, unless otherwise shown.

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

C. Fire-Rated Walls, Floors, or Ceilings: 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 nonshrink grout dry-pack, or use watertight seal device.

F. Entering Structures:

1. 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.

2. Concrete Roof or Membrane Waterproofed Wall or Floor:

a. Provide a watertight seal.
b. Without Concrete Encasement: Install watertight entrance seal device on each side.
c. With Concrete Encasement: Install watertight entrance seal device on the accessible side.
d. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.
e. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.

3. 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.

4. Corrosive-Sensitive Areas:

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

b. Seal all conduit entering equipment panel boards and field panels containing electronic equipment.
c. Seal penetration with silicone type sealant as specified.

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

6. Nonwaterproofed Wall or Floor (Underground, without Concrete Encasement):

a. Provide Schedule 40 galvanized pipe sleeve, or watertight entrance seal device.
b. Fill space between raceway and sleeve with an expandable plastic compound on each side.

7. Manholes and Handholes:

a. Metallic Raceways: Provide insulated grounding bushings.
b. Nonmetallic Raceways: Provide bell ends flush with wall.
c. Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

3.06 SUPPORT

A. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 10 feet. Do not support from piping, pipe supports, or other 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:

1. Wood: Wood screws.

2. Hollow Masonry Units: Toggle bolts.

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

4. Steelwork: Machine screws.

D. 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.

3.07 BENDS

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

B. Make bends and offsets of longest practical radius.

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:

1. Bends 30-Degree and Larger: Provide factory-made elbows.

2. 90-Degree Bends: Provide rigid aluminum elbows.

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

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

3.08 EXPANSION/DEFLECTION FITTINGS

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

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

C. Install in accordance with manufacturer's instructions.

3.09 PVC CONDUIT

A. Solvent Welding:

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

2. Install such that joint is watertight.

B. Adapters:

1. PVC to Metallic Fittings: PVC terminal type.

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

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

3.10 WIREWAYS

A. Install in accordance with manufacturer's instructions.

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

3.11 CABLE TRAYS

A. Install in accordance with Application Information Section of NEMA VE 1.

B. Provide accessories as necessary for a complete system.

C. Install such that joints are not made at support brackets.

D. Install horizontal section support brackets between support point and quarter point of tray span.

E. Provide ceiling trapeze for all horizontal cable tray.

F. Install support within 2 feet on each side of expansion joints and within 2 feet of fitting extremity.

G. Provide expansion joints in accordance with NEMA VE 1 for 50 degrees F maximum temperature variation.

H. Install horizontal tray level, plumb, straight, and true to line or grade within a tolerance of 1/8 inch in 10 feet and within a cumulative maximum of 1/2 inch.

I. Install vertical tray plumb within a tolerance of 1/8 inch in 10 feet.

J. Install without exposed raw edges.

K. Maintain 9-inch vertical separation between multi-tiered trays having a common support, and at all crossover locations.

L. Provide bonding jumper at each expansion joint and adjustable connection.

M. Ground Conductor: Provide properly sized clamps for each section, elbow, tee, cross, and reducer.

3.12 TERMINATION AT ENCLOSURES

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

B. Sheet Metal Boxes, Cabinets, and Enclosures:

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

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

3. 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.

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

C. 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.

3.13 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 10 feet.

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

H. Installation with Other Piping Systems:

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

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

3. Installation over valves or couplings not permitted.

I. 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.

J. Concrete Encasement:

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

K. Backfill:

1. Do not backfill until inspected by Engineer.

3.14 MANHOLES AND HANDHOLES

A. Excavate, shore, brace, backfill, and final grade back to original state.

B. Do not install until final raceway grading has been determined.

C. Install such that raceways enter at nearly right angles and as near as possible to one end of wall, unless otherwise shown.

D. Grounding: As specified in Section 16450, GROUNDING.

E. Identification: Field stamp covers with manhole or handhole number as shown. Stamped numbers to be i-inch minimum height.

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:

1. Identify origin and destination.

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

3. Provide nylon strap for attachment.

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

C. Buried Raceway Markers:

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

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

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

3.17 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-P1ated 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, Cross-linked 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-insulated 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 descriptive product information.

B. Quality Control Submittals:

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

2. Certified Factory Test Report per AEIC CS6, including AEIC qualification report for conductors above 600 volts.

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 for No.6 AWG and smaller. XHHW for No.4 AWG and larger or installations in wet location.

D. Direct Burial and Aerial Conductors and Cables:

1. Type USE/RHH/RHW insulation, UL 54 listed, Type RHW-2/USE-2.

2. Conform to physical and minimum thickness requirements of NEMA WC3.

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.

2.02 600-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. Wire and Connectors:

1. Cable shall be rated for 600 volts and shall meet the requirements below:

a. Conductors shall be stranded

b. All wire shall be brought to the job in unbroken packages and shall bear the data of manufacturing; not older than 12 months.

c. Type of wire shall be XHHW or THWN, rated 75 degrees C suitable for wet locations except where required otherwise by the drawings.

d. No wire smaller than No. 12 gauge shall be used unless specifically indicated.

e. Conductor metal shall be copper.

f. All conductors shall be megger tested after installation and insulation must be in compliance with the Insulated Power Cable Engineers Association Minimum Values of Insulation Resistance.

C. Type I-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: Provide in accordance with NEMA WC 5, Method 1, and 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	Max. Outside Diameter (inches)	Jacket Thickness (mils)
3	0.41	45
5	0.48	45
7	0.52	45

12	0.72	60
19	00.83	60
25	1.00	60
37	1.15	80

4. Manufacturers:

   a. Okonite Co.

   b. Rome Cable.

   c. Southwire.

D. Type 2-Multiconductor Power Cable:

1. Conductors:

   a. Class B stranded, coated copper.

   b. Insulation: Chemically crosslinked 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 pass 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	Max. 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	1.01	80

		4	1.11	
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.

   c. Southwire

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.

   d. Jacket: 4-mil nominal nylon.

   e. Color Code: Pair conductors black and red.

5. Manufacturers:

   a. Okonite Co.

   b. Rome Wire Corp.

   c. Belden.

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. Individual Pair 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. Rome Wire Corp.

c. Belden.

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. Rome Wire Corp.

c. Belden.

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. Rome Wire Corp.

   c. Belden.

I. Ethernet Cat. 6e UTP Cable (Copper):

1. Section applies to all Ethernet Cable (Copper) except for Fiber Optic cable.

2. Conductor Physical Characteristics: 4 twisted pairs (8 conductors), 23 AWG solid bare Copper with Polyolefin Insulation. Overall Nominal Diameter: 0.235 inch. Operating Temperature Range: -20'C to +75'C. Model Number – 7881A, Belden Inc. Provide green color to match the City's standard Ethernet Cables.

3. NEC/UL specification CMR, UL444, UL verified category 6.

4. Manufacturer:

   a. Belden Inc.

   b. Or approved equal.

J. Flexible Variable Frequency Drive (VFD) Output Power Unarmored Cable:

1. Section applies to power cables routed between the output of VFD's and motor terminals.

2. Cable shall be rated for 2kV/1000 volts type MC-HL and shall meet the requirements below:

   a. Conductors shall be soft annealed tinned copper flexible strand.

   b. All wire shall be brought to the job in unbroken packages and shall bear the data of manufacturing; not older than 12 months.

c. Type of wire shall be XHHW or RHW rated 75 degrees C suitable for wet locations. Insulation shall be Polyrad XT-125 Irradiated Cross-linked Polyolefin (XLPO).

d. No wire smaller than No. 12 gauge shall be used unless specifically indicated.

e. Cable construction shall consist of three insulated current-carrying phase conductors and three bare ground conductors or insulated ground conductors, symmetrically placed between the phase conductors, and beneath a tinned copper braid with aluminum/polyester tape with overall Polyethylene Sheath/jacket.

f. Cable shall be UL listed and shall have UL mark.

3. Each ground conductor size (circular mil area) shall be one-third (1/3) of the NEC required size (circular mil area) for a single ground conductor. If one third of the required circular mil area does not correspond to a standard size (circular mil area) of construction, the next largest size of standard construction shall be us All conductors shall be megger tested after installation and insulation must be in compliance with the Insulated Power Cable Engineers Association Minimum Values of Insulation Resistance. Continuous aluminum sheath shall meet the grounding requirements of NEC 250.122.

4. Manufacturers:

a. Southwire.

b. Belden.

c. General Cable.

e. Or Approved Equal.

2.03 CONDUCTORS ABOVE 600 VOLTS

A. EPR Insulated Cable:

1. Extrusion: Single-pass, triple-tandem, of conductor screen, insulation, and insulation screen.

2. Type: 5 kV, shielded, UL 1072, Type MV-105.

3. Conductors: Copper, concentric lay Class B round stranded in accordance with ASTM B3, ASTM B8, and ASTM B263.

4. Conductor Screen: Extruded, semiconducting ethylene-propylene rubber in accordance with NEMA WC 8 and AEIC CS 6.

5. Insulation: 133 percent insulation level, ethylene-propylene-rubber (EPR) containing no polyethylene in accordance with NEMA WC 8, and AEIC CS 6.

6. Insulation Thickness: 115 mils, 5 kV, nominal.

7. Insulation Screen: Thermosetting, semiconducting ethylene-propylene rubber (EPR), extruded directly over insulation in accordance with NEMA WC 8, and AEIC CS 6.

8. Metallic Shield: Uncoated, copper shielding tape helically applied with 17-1/2 percent minimum overlap.

9. Jacket: Extruded polyvinyl chloride (PVC) compound applied over the metallic shield in accordance with NEMA WC 8.

10. Operating Temperature: 105 degrees C continuous normal operations, 140 degrees C emergency operating conditions, and 250 degrees C short-circuit conditions.

11. Cable Tray Applications: Rated for use in cable trays.

12. Manufacturers:

    a. Okonite Co.

    b. Pirelli Wire and Cable.

    c. Southwire.

2.04 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

B. Direct Buried: Bare tinned stranded 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. Arcs and Fireproofing:

    a. 30-mil, elastomer

    b. Manufacturers and Products:

        1) Scotch; Brand 77, with Scotch Brand 69 glass cloth tape binder.

2) Plytnount; 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.

4. 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.

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. Manufacturers and Product: Thomas & Betts; TY-RAP.

F. Heat Shrinkable Insulation: Thermally stabilized, cross-linked polyofin.

1. Manufacturers and Product: Thomas & Betts; SHRINK-KON.

2.06 ACCESSORIES FOR CONDUCTORS ABOVE 600 VOLTS

A. Molded Splice Kits:

1. Components necessary to provide insulation, metallic shielding and grounding systems, and overall jacket.

2. Capable of making splices that has a current rating equal to, or greater than the cable ampacity, conforming to IEEE 404.

3. 25 kV class, with compression connector, EPDM molded semiconductive insert, peroxide-cured EPDM insulation, and EPDM molded semiconductive outer shield.

4. Pre-molded splice shall be re-jacketed with a heat shrinkable adhesive-lined sleeve to provide a waterproof seal.

5. Manufacturers:

   a. Elastimold.

   b. Cooper industries.

B. Heat Shrinkable Splice Kits:

1. Components necessary to provide insulation, metallic shielding and grounding systems, and overall jacket.

2. Capable of making splices that has a current rating equal to, or greater than the cable ampacity, conforming to IEEE 404.

3. 25 kV class, with compression connector, splice insulating and conducting sleeves, stress-relief materials, shielding braid and mesh, and abrasion-resistant heat shrinkable adhesive-lined re-jacketing sleeve to provide a waterproof seal.

4. Manufacturers:

   a. Raychem.

   b. 3M Co.

C. Termination Kits:

1. Capable of terminating a 25 kV, single-conductor, polymeric-insulated shielded cables plus a shield ground clamp.

2. Capable of producing a termination with a current rating equal to, or greater than, the cable ampacity, meeting Class 1 requirements of IEEE 48.

3. Capable of accommodating any form of cable shielding or construction without the need for special adapters and/or accessories.

4. Manufacturers:

   a. Raychem.

   b. 3M Co.

D. Bus Connection Insulation:

1. Heat shrinkable tubing, tape, and sheets of flexible crosslinked polymeric material formulated for high dielectric strength.

2. Tape and sheet products to have coating to prevent adhesion to metal surfaces.

3. Insulating materials to be removable and reusable.

4. Manufacturer: Raychem.

E. Cable Lugs:

1. In accordance with NEMA CCI.

2. Rated 25 kV of same material as conductor metal.

3. Manufacturers and Products, Uninsulated Crimp Connectors and Terminators:

a. Square D; Versitide.

b. Thomas & Betts; Color-Keyed.

c. ILSCO.

4. Manufacturers and Products, Uninsulated, Bolted, Two-Way Connectors and Terminators:

a. Thomas & Betts; Locktite.

b. Burndy; Quiklug.

c. JLSCO

2.07 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.

2.08 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 NECA 5055.

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, hand holes, 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 18 inches on center.

G. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

H. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4-inch smaller than raceway inside diameter.

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: (Unless local Authority Having Jurisdiction has different requirements)

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	Grounded Neutral	White

Three-Phase, Four-Wire	Phase A Phase B Phase C	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, hand holes, 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.

D. 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 contractor as-built 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.

3.04 CONDUCTORS 600 VOLTS AND BELOW

A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.

B. Do not splice incoming service conductors and branch power distribution conductors No. 6 AWG and larger unless specifically indicated or approved by ENGINEER.

C. Connections and Terminations:

1. Install wire nuts only on solid conductors.

2. Install nylon self-insulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 6 AWG and smaller.

3. Install un-insulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 4 AWG through No. 2/0 AWG.

4. Install un-insulated, bolted, two-way connectors and terminators for power circuit conductors No. 4/0 AWG and larger.

5. Install un-insulated bolted two-way connectors for motor circuit conductors No. 12 and larger.

6. Tape insulates all un-insulated connections.

7. Place no more than one conductor in any single-barrel pressure connection.

8. Install crimp connectors with tools approved by connector manufacturer.

9. Install terminals and connectors acceptable for type of material used.

10. Compression Lugs

a. Attach with a tool specifically designed for purpose.

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: Use general purpose, flame retardant tape.

2. Outdoors: Use flame retardant, cold- and weather-resistant tape.

F. Cap spare conductors and conductors with UL listed end caps.

G. Cabinets, Panels, and Motor Control Centers:

1. Remove surplus wire, bridle and secure.

2. Where conductors pass through openings or over edges in sheet metal, remove 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. Locate splices in readily accessible cabinets or junction boxes using terminal strips.

4. Where connections of cables installed under this section are to be made under Division 13, 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.

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 +2 ohms from the calculated average loop resistance valve.

b. Insulation resistance tests shall be performed by using a 500-volt megohmeter to measure the insulation resistance 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.

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. Variable Frequency Drive (VFD) Output Power Cable:

1. Furnish and install VFD rated cable as describes in 2.02.I of this specification for all VFD applications.

2. Install cables in raceway.

3. Terminate the three ground conductors together at the motor and at the ground bus of the VFD.

3.05 CONDUCTORS ABOVE 600 VOLTS

A. Do not splice unless specifically indicated or approved by the ENGINEER.

B. Make joints and terminations with splice and termination kits, in accordance with kit manufacturer's instructions

C. Install splices or terminations as continuous operation in accessible locations under clean, dry conditions.

D. Single Conductor Cable Terminations: Provide heat shrinkable stress control and outer non-tracking insulation tubing, high relative permittivity stress relief mastic for insulation shield cutback treatment, and a heat-activated sealant for environmental sealing, plus a ground braid and clamp.

E. Install terminals or connectors acceptable for type of conductor material used.

F. Provide outdoor rain skirts for all riser pole and outdoor switchgear terminations.

G. Provide shield termination and grounding for all terminations.

H. Provide necessary mounting hardware, covers, and connectors.

I. Where elbow connectors are specified, install in accordance with manufacturer's instructions.

J. Connections and Terminations:

1. Install un-insulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 4 AWG through No. 2/0 AWG.

2. Install un-insulated, bolted, two-way connectors and terminators for power circuit conductors No. 4/0 AWG and larger.

3. Install un-insulated, bolted, two-way connectors for motor circuit conductors No. 12 and larger.

4. Insulate bus connections with heat shrinking tubing, tape, and sheets.

5. Make all bus connections removable and reusable in accordance with manufacturer's instructions.

K. Give 2 working days' notice to ENGINEER prior to making splices or terminations.

3.06 CONDUCTOR ARC AND FIREPROOFING

A. Install arc and fireproofing tape on 5 kV cables throughout their entire exposed length in manholes, hand holes, vaults, cable trays, junction boxes, and other indicated locations.

B. Wrap conductors of same circuit entering from separate conduit together as a single cable.

C. Follow tape manufacturer's installation instructions.

D. Secure tape at intervals of 5 feet with bands of tape binder. Each tape band shall consist of a minimum of two wraps directly over each other.

3.07 UNDERGROUND DIRECT BURIAL CABLE

A. Install in trench as required.

B. Warning Tape: Install approximately 12 inches above cable, aligned parallel to, and within 12 inches of centerline of the run.

3.08 FIELD QUALTTY CONTROL

A. In accordance Section 16950, ELECTRICAL TESTING.

END OF SECTION

SECTION 16322

MEDIUM VOLTAGE TRANSFORMERS - LIQUID FILLED PAD-MOUNT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, and test liquid filled, pad-mount transformers for power distribution systems as specified herein, as indicated on the Drawings, and as required to complete the electrical installations.

B. All equipment specified in this Section shall be furnished by the transformer manufacturer who shall be responsible for the suitability and compatibility of all included equipment.

C. Transformers shall be feed-through type with LBOR (Load Break Oil Rotary) switch or radial feed with LB (Load Break) switch only as shown on one line diagrams in contract documents for electrical system configuration.

1.02 CODES AND STANDARDS

A. The liquid filled pad-mount transformer shall comply with the following codes and standards:

1. American National Standards Institute (ANSI):
   a. ANSI C57.12.00-Latest Revision, General Requirements for Liquid Immersed Distribution, Power, and Regulating Transformers.
   b. ANSI C57.12.28-Latest Revision, Switchgear and Transformers, Pad mounted Equipment -Enclosure Integrity.
   c. ANSI C57.12.26-Latest Revision, Standard for Transformers, Pad mounted, Compartmental Type, Self Cooled Three Phase Distribution Transformer for Use with Separable Insulated High Voltage Connectors, High Voltage 34,500 Grd./y 19,920 Volts and Below: 2500 kVA and Smaller.
   d. ANSI C57.12.90-Latest Revision, Test Code for Liquid-Immersed Distribution Power, and Regulating Transformers and Guide for Short Circuit Testing of Distribution and Power Transformers.
   e. ANSI/IEEE 386-1985, Separable Insulated Connectors for Power Distribution Systems Above 600 Volts.
2. Institute of Electrical and Electronic Engineers (IEEE)
3. National Electrical Code (NEC)
4. National Electrical Manufacturers Association (NEMA)
   a. NEMA 210

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings
2. Operation and Maintenance Manuals
3. Spare Parts List
4. Special Tools List
5. Reports of Certified Shop Tests

B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:
1. Product data sheets.
2. Sample equipment nameplate diagram.
3. Drawings showing clearly marked overall dimensions for each transformer. Drawings shall show conduit stub-up area locations.
4. Weight of each transformer.
5. Proof of ISO 9001 registration

D. The submittal information shall reflect the specific equipment identification name/number as indicated on the Drawings.

E. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items that the Contractor intends to provide are acceptable and shall be submitted.

1.05 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions.

1.06 TOOLS, SUPPLIES AND SPARE PARTS

A. The transformers shall be furnished with all special tools necessary to disassemble, service, repair and adjust the equipment. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.

The Contractor shall furnish the following minimum spare parts for each transformer.

No. Required	Description
1 set	Primary fuses of each size provided.

B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.

D. Spare parts lists, included with the Shop Drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

E. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size shall have the same parts number.

1.07 IDENTIFICATION

A. Each transformer shall be identified with the identification name/number indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on each transformer. Nameplates shall be as specified in Specification 16050, “Basic Electrical Materials and Methods”.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. All transformer manufacturers shall be registered as an ISO 9001 quality manufacturer. The manufacturer shall supply documentation to attest to this registration.

C. Transformers shall be by
1. Eaton (Cooper Power).
2. Schneider Electric (Square D).
3. General Electric Company.
4. ABB.

2.02 PAD-MOUNT TRANSFORMERS

A. Pad-mount transformers shall be of a compact design. The transformer kVA rating shall be as indicated on the Drawings. All units shall be a pad mounted compartmental type, which when assembled shall be an integral unit for mounting on a pad. All units shall be designed to comply with the short circuit capability requirements of ANSI C57.12.00.

B. The average temperature rise of the windings, measured by the resistance method, shall be 55°/65° C when the transformer is operated at rated kVA output in a 40°C ambient. The transformers shall be capable of being operated at rated load in a 30°C average, 40°C maximum ambient, as defined by ANSI C57.12.00 without loss of service life expectancy. Primary bushings shall be rated 200 or 600 amperes as required for each specific transformer capacity.

C. Coolant and insulating fluid shall be less flammable/high fire point, Envirotemp FR3, as defined per the NEC. The transformer shall be furnished and installed in accordance with the latest edition of Article 450 of the NEC and in accordance with the requirements of the testing and listing agency of the liquid. All transformer liquid shall be bulk tested for polychlorinated biphenyls (PCBs) per ASTM D 4059 and certified, upon request, as having no detectable level of PCB.

D. The high voltage windings shall be rated 4.16kV and 60 kV BIL unless indicated otherwise on the Drawings for use on a solidly grounded system and shall have two (2) 2-1/2% full capacity taps above and below rated voltage. Nominal impedance shall be 5.75%, or as required to comply with United States Department of Energy (DOE) 2016 Energy Efficiency Standards.

E. The low voltage windings shall be rated 480/277 VAC and 30 kV BIL unless indicated otherwise on the Drawings. Transformers shall be designed for either step up or step-down use.

F. Low voltage neutrals shall be connected internally to the secondary neutral lugs and brought out to an insulated low voltage neutral spade type bushing with an externally removable ground strap. The low voltage neutral shall be a fully insulating bushing. A ground pad shall be provided on the outer surface of the tank with one or more removable ground straps suitably sized for the short circuit rating of the transformer provided and connected between the neutral bushing and the ground pad.

G. High voltage and low voltage windings shall be aluminum.

H. The transformer and associated terminal compartments shall be so designed and constructed as to be tamper resistant. There shall be no screws, bolts, or other fastening devices which are externally removable. Transformers shall be suitable for outdoor installation without a fence or other area enclosure. Full height, air filled incoming and outgoing terminal compartments with hinged doors shall be located side by side separated by a steel barrier, with the incoming (primary) compartment on the left. The lift-off doors shall be equipped with stainless steel hinges to allow the doors to be removed and door stops to hold the doors open if not removed while working in the compartments. The incoming compartment shall be accessible only after the door to the outgoing (secondary) compartment has been opened. To facilitate making connections and permit cable pulling, the doors shall be removable. Removable door sill on compartments shall be provided to permit rolling or skidding of unit into place over conduit "stub-ups" in foundation.

I. Locking provisions shall be provided in accordance with Paragraph 7 of ANSI C57.12.26-Latest Revision utilizing a captive penta-head bolt. Enclosure security shall conform with Paragraph 4 of ANSI C57.12.20-Latest Revision.

J. The high voltage incoming line compartment shall be dead-front, shall enclose the high voltage bushings, and provide for cabling from below. Externally clamped dead-front primary bushings shall be universal bushing wells with dead front, "feed thru" inserts. The compartment shall have a hinged door with a fastening device which is accessible only through the low voltage compartment and makes possible the use of a single padlock.

K. The Contractor shall furnish dead front elbow cable terminators. Elbow terminators shall be load-break at sizes less than 600A.

L. Furnish a load break, gang operated, liquid immersed switch that is externally operable from the high voltage compartment through the use of a distribution hot-stick. Switch shall be the 2-position sectionalizing type for use on a loop feed system. Switch shall be capable of feeding transformer from one set of bushings, second set of bushings, isolating transformer, or feed-through. Liquid-immersed switch shall carry ampere rating as required for the application.

M. Primary fusing for transformers under 1000kVA shall be provided with an oil immersed drawout expulsion BAY-O-NET Dual Sensing type Fuse in series with an ELSP type current limiting backup fuse designed to protect the transformer in the event of secondary or internal faults, or overload conditions. The BAY-O-NET fuse shall be replaceable and hook stick operable. Primary fusing for transformers equal to or greater than 1000kVA shall be provided with an oil immersed, current sensing cartridge type weak link fuse designed to protect the transformer in the event of secondary or internal faults, or overload conditions.

N. 5 kV distribution class lightning arresters for surge protection shall be provided. For radial feed systems, three (3) arresters shall be provided. For loop feed systems, six (6) arresters shall be provided. Arresters shall be mounted in the high voltage compartment. Surge arrester rating shall be per the IEEE C62.22.

O. The low voltage incoming line compartment shall be live-front, shall be arranged for cabling from below, and shall contain 3-spade type externally clamped bushings for phase connections and 1-spade type bushing for neutral and/or ground connection. Low voltage bushings shall be supported with an insulating material in a manner designed to counteract any downward forces resulting from the connection of multiple cables to the bushings. Any manufacturer not supplying these supports will have the transformer returned to them at their expense for reworking. Spades shall be of appropriate length with standard NEMA hole spacing or as required. The low voltage door shall have a 3-point latch (top, bottom, middle) to discourage unauthorized entry.

P. The transformer shall be designed to be capable of withstanding short circuits without damage on any winding, at a magnitude of fault current equal to the full rated voltage divided by the per unit impedance with full voltage maintained on all windings connected to the external source of power.

Q. The internal high-voltage leads of the transformer shall be adequately insulated and mechanically secured. Connection to the coil conductors shall be made by a process ensuring avoidance of damage to the coil insulation.

R. All high-voltage phase leads shall be installed rigidly and spaced to provide dielectric and mechanical strength and ensure absolute phase isolation.

S. All high and low voltage windings shall be secured in place by use of B-stage epoxy pattern paper. The epoxy shall be thermally cured under pressure to ensure the bonding of conductor and paper.

T. Core laminations shall be annealed, free of burrs, and furnished with a heat-resistant insulating coating. All core sections shall be grounded to the core clamp.

U. Bolted connections will be acceptable only from lead to bushing connection. All other connections shall be welded or adequately crimped.

V. The transformer shall be of all welded sealed-tank construction or sufficient strength to withstand a pressure of 7 psi without permanent distortion. The domed cover to aid water run-off shall be welded and the fastenings tamperproof. The transformer shall remain effectively sealed for a top liquid temperature range of -30°C to 105°C. When required, cooling panels will be provided on the back and sides of the tank.

W. Lifting provisions shall be permanently attached and arranged on the tank to provide a distributed, balanced lift in a vertical direction for the completely assembled transformer.

X. Terminal designations shall be as defined by ANSI C57.12.70. The high and low voltage terminal designations shall be indicated on the tank wall with oil resistant yellow paint or decals. A permanently marked diagrammatic instruction nameplate shall be located inside the low voltage compartment and be in accordance with all provisions contained in ANSI C57.12.26, Paragraph 7.4.

Y. The inside base of the transformer sill shall have a flange for anchoring the cabinet to the pad.

Z. Tank grounding provisions shall be as stated in ANSI standards. The grounding provisions shall be capped before painting the unit. The unit shall be shipped with the caps in place.

AA. The transformer shall be equipped with an externally operated, padlockable tap changer. The tap changer shall be designed for de-energized operation. The operating handle shall give permanent visual indication of the voltage position and have a provision for securing it at the desired position. The tap changer shall be marked for de-energized operation and the handle shall be easily accessible and located inside the high-voltage compartment. By operating the handle, all three phases shall be operated simultaneously. Tap position shall be clearly marked and a locking mechanism provided to prevent accidental operation.

AB. Furnish each transformer with the following accessories:

1. A liquid level indicator.
2. A dial type liquid temperature gauge.
3. An oil drain valve located in the primary compartment with a built-in sampling device.

4. A 1-inch NPT upper plug (or cap) for filling and pressure testing.
5. A pressure vacuum gauge.
6. A pressure relief valve.
7. An automatic pressure relief device (self-resealing w/indicator).
8. A key-interlock to high voltage door.
9. Alarm contacts for accessory gauges.
10. Hot stick for operating the internal switches and pulling fuses.

AC. All transformers shall be coated with a primer and finish coat to provide a tough, non-chalking weather resistant finish. The finish coat shall be ANSI green. The paint thickness shall be a minimum of 2.5 mils.

AD. The transformers shall be provided with the following labels, designed for outdoor application, permanently affixed to the front of each unit.
1. kVA Rating label
(Shall be centered 4-6 inches above the Secondary Voltage decal).
2. Secondary Voltage label
(Shall be centered 4-6 inches above the Danger Hazardous Voltage decal)

PART 3 -- EXECUTION

3.01 INSTALLATION

A. The transformers shall be furnished and installed as shown on the Drawings and as recommended by the equipment manufacturer.

B. Prior to final completion of the work, all metal surfaces of the transformer shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same lacquer as used for shop finishing coats.

C. Adjust primary taps such that the secondary voltage is within two (2) percent of rated voltage.

3.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:
1. Witnessed Shop Tests
a. None required.
2. Certified Shop Tests and Reports
a. Submit description of proposed testing methods, procedures, and apparatus.
b. Submit notarized and certified copies of all test reports.
c. The transformers shall be given routine factory tests in accordance with the requirements of the ANSI and NEMA standards. Temperature rises may be certified from basic design. The tests shall be:
i. Resistance measurements of all windings on the rated voltage connection of each unit and at the tap extremes of one unit only of a given rating.
ii. Ratio tests on the rated voltage connection and on all tap connections.

iii. Polarity and phase-relation tests on the rated voltage connections.
iv. No-load loss at rated voltage on the rated voltage connection.
v. Exciting current at rated voltage on the rated voltage connection.
vi. Impedance and load loss at rated current on the rated voltage connection of each unit and on the tap extremes of one unit only of a given rating.
vii. Applied potential test.
viii. Induced potential tests.

3. Field Tests
   a. Field tests shall be performed in accordance with the requirements specified in the General Conditions, Division 1, and NETA Acceptance Testing Standard, latest edition.

END OF SECTION

SECTION 16425

SWITCHBOARDS

PART 1 -GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, and test a UL 891 indoor switchboard configured in a main-tie-main arrangement with group mounted distribution sections associated with each main breaker. The switchboard shall be as shown on the drawings and shall allow for top and bottom entry connection of feeder conductors to each main breaker and top and bottom exit for feeder circuits from the group mounted distribution sections. The tie breaker shall be between the two main breakers.

1.02 REFERENCES

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

1. American National Standards Institute (ANSI): Z55.1, Gray Finishes for Industrial Apparatus and Equipment.

2. American Society for Testing and Materials (ASTM): A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel-Plated Steel Plate, Sheet, and Strip.

3. National Electrical Manufacturers Association (NEMA):

   a. AB 1, Molded-Case Circuit Breakers and Molded-Case Switches.

   b. PB 2, Deadfront Distribution Switchboards.

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

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

5. Underwriters Laboratories (UL):

   a. 489, Standard for Safety Molded-Case Circuit Breakers and Circuit Breaker Enclosures.

   b. 891, Standard for Safety Dead-front Switchboards.

   c. 1025, Standard for Safety Electric Air Heaters.

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

6. Uniform Building Code (UBC): Section 2312, Earthquake Requirements.

1.03 SUBMITTALS

A. Shop Drawings:

B. Descriptive product information.

1. Itemized Bill-of-Material,

2. Dimensional drawings.

3. Operational description.

4. Anchoring instructions and details.

5. One-line, three-line, and control schematic drawings.

6. Connection and interconnection drawings.

7. Circuit Breakers: Copies of time-current characteristics.

8. Ground Fault Protection: Relay time-current characteristics.

9. Bus data.

10. Incoming line section equipment data.

11. Transformer section equipment data.

12. Conduit entrance locations.

C. Quality Control Submittals:

1. Manufacturer's installation instructions.

2. Certified Factory Test Report.

3. Operation and Maintenance Manual.

4. Manufacturer's Certification of Proper Installation.

1.04 UL COMPLIANCE

A. Products manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL Listing Mark.

1.05 SPARE PARTS

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

1. Fuses: One complete set of spare fuses of each current rating, both power and control.

2. Lights: One complete set of spare indicating lights.

3. Paint: One pint, to match enclosure exterior finish in color and quality.

4. Indicating Lamp Pullers: Two each.

5. Indicating Lamp Resistors and Sockets: Two each.

1.06 WARRANTY

A. All equipment furnished under this section shall be warranted for on site parts and labor by the contractor and the equipment manufacturers for a period of two (2) years after completion of startup.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Eaton.

B. Schneider Electric (Square D).

C. General Electric.

D. No approved equal.

2.02 GENERAL

A. Equipment suitable for 480-volt, three-phase, three-wire, solid grounded-wye electrical system having an available short-circuit current at line terminals as shown on the Drawings.

B. Switchboard shall be service entrance rated where indicated on the drawings.

C. Comply with NEMA PB 2 and UL 891.

D. Switchboard and all it's major components to be manufactured and assembled by a single manufacturer in order to achieve standardization for appearance, operation and maintenance, spare parts replacement, and manufacturer's services. No assembler of electrical components manufactured by others shall be allowed.

E. Lifting lugs on all equipment and devices weighing over 100 pounds.

F. Operating Conditions:

1. Ambient Temperature: Maximum 40 degrees C.

2. Equipment shall be fully rated without derating for the above operating conditions.

2.03 STATIONARY STRUCTURE

A. Type: NEMA PB 2 construction, dead front, completely metal enclosed, self-supporting.

B. Sections bolted together to form one rigid assembly capable of being moved into position and bolted directly to the floor without use of floor sills.

2.04 ENCLOSURE

A. Equipment Finish: Baked enamel applied over a rust-inhibiting phosphate base coating.

1. Color:

a. Exterior: ANSI Z55.1, manufacturer's standard.

b. Interior: White.

c. Unpainted Parts: Plated for corrosion resistance.

B. Indoor Enclosure: NEMA 250, Type 1:

1. Rear, full-height, bolt on panels for each enclosure section.

2. Cable Termination Access: Padlock provision.

3. Front Accesses:

a. Service line and load terminations, internal devices, device and bolted bus connections, and protective device removal, serviceable from the front only.

b. Sections aligned across the back to permit placement flush against wall.

c. Working Space: As required by NFPA 70.

4. Transition sections as required or shown.

5. Side and Top Covers: Removable, captive, screw-on plates with formed edges on each side.

6. Front Cover: Hinged door with formed edges.

2.05 BUSWORK

A. Material: Phase non-insulated silver-plated copper throughout entire length of sufficient cross section to limit temperature rise at rated current to 65 degrees C over 40 degrees C ambient.

B. Bus Arrangement: A-B-C, left-to-right, top-to-bottom, and front-to-rear, as viewed from front.

C. Brace for short-circuit currents 65,000 amperes rms symmetrical, minimum.

D. Main Horizontal Bus: Non-tapered, continuous current rating as shown.

E. Neutral Bus: Where specified on plans shall be continuous current rating as shown.

F. Ground Bus: A copper ground bus (minimum 1/4 x 2 inches) shall be furnished firmly secured to each vertical section structure.

G. Bus Connections and Joints: Bolted with Belleville washers.

H. Extend each bus entire length of switchboard.

2.06 PROTECTIVE DEVICES

A. Molded-Case Circuit Breakers:

1. Branch Feeder Protective Devices unless noted otherwise: Group mounted, suitable for use with 75 degree C wire at full 75 degree C ampacity when mounted in switchboard.

2. Arrangement: Fully rated branch feeder with selectivity and coordination with main breaker(s).

3. Breakers 225-Ampere Frame and Above: Continuously adjustable magnetic pickups five to ten times trip rating.

4. Interrupting Rating: As shown.

5. Breakers 2,000- through 4,000-Ampere Frame: UL 489 listed and labeled 100 percent application in accordance with NFPA 70.

B. Insulated Case Breakers:

1. Feeder breakers as noted on plans and main/tie/transfer breakers shall be insulated case, 600-volt, 3-phase, and 60-HZ, as described in this section. All breakers shall be supplied with, but not be limited to, a minimum of the following features:

a. All breakers shall be UL listed for application in their intended enclosure.

b. Breakers shall be two-step stored energy type and be fully capable of operation at 100% of the maximum continuous ampere rating.

c. Breakers shall be equipped with anti-pump devices.

d. Breakers shall have a minimum symmetrical interrupting capacity at rated voltage as shown on the drawings.

e. Each breaker shall include the following dry contact outputs for connection to the SCADA system:

i. Open Status.

ii. Closed Status.

iii. Tripped Status.

2. All breakers shall be “trip-free” when removed from their housing and interlocked to prevent removal when in the closed position.

3. Circuit breaker(s) shall have power terminals to accommodate either cable or bolted bus connections.

4. Provide a fixed instantaneous (High Level Selective Override) Circuit on breaker(s). The circuit shall have a defeatable instantaneous adjustment to allow the breaker to remain closed for up to 30 cycles during overcurrent below the rms symmetrical short time withstand ratings. The circuit shall instantaneously trip when current levels exceed applicable withstand ratings.

5. Circuit breaker(s) shall utilize a glass reinforced insulating material providing high electric strength. Current carrying components shall be completely isolated from the handle and the accessory mounting area. Breaker(s) shall have common tripping of all poles and shall be trip free. The circuit breaker shall be UL Listed for reverse connection without requiring special construction or labeling. The breaker(s) shall have quick-make, quick-break contacts with a maximum 5-cycle closing time. All circuit breakers shall be equipped with electrical accessories as noted on the drawings.

6. Circuit breaker(s) shall be factory sealed and shall have a date code on the face of the circuit breaker. Poles shall be labeled with respective phase designations.

7. Breaker faceplate shall indicate rated ampacity. Breaker faceplate shall indicate UL and IEC certification standards with applicable voltage systems and corresponding AIC ratings.

8. Each circuit breaker shall be equipped with a push-to-trip button to mechanically operate the circuit breaker tripping mechanism.

9. All circuit breakers shall be equipped with electrical accessories as noted on the drawings.

10. Breakers shall be manually operated unless electrically operated is indicated on the drawings. The breaker control faceplate shall include color-coded visual indicators to indicate contact OPEN and CLOSED positions as well as mechanism CHARGED and DISCHARGED positions. Manual control pushbuttons on the breaker’s face shall be provided for “opening” and “closing” the breaker.

11. All breakers shall be provided with a two-step stored energy mechanism providing a maximum of 5 cycle closing and have multiple charge-close provisions, providing the following sequence: charge-close-recharge-open-close-open. At all times the breakers shall be capable of opening after closure without a recharging operation. A charge/discharge indicator shall be visible at all times. All energy required for closing the breakers shall be completely stored and held in readiness pending a release to close action. Manually

operated breakers shall be convertible to electrical operation by insertion of an internally mounted motor operator without voiding the UL Label.

12. Electrically operated breakers shall be complete with OPEN/CLOSE pushbuttons on the breaker face plus red and green indicating lights to indicate breaker contact position.

13. Each circuit breaker shall be electrically operated to permit remote CHARGE, CLOSE, and OPEN capabilities. Electrically operated circuit breaker shall be equipped with charge contact switch for remote indication of mechanism charge status.

14. A selective override circuit shall be provided on breakers having short time adjustments but without instantaneous adjustments that will allow selectively up to its RMS symmetrical short-time rating.

15. Lockout provision shall be provided for opening and closing the breakers.

16. The insulated case breakers shall have high-endurance characteristics being capable of no-load full-interruptions at rated current equal to or exceeding UL endurance ratings for molded case breakers without maintenance.

    a. Long-time pickup.

    b. Long-time delay.

    c. Instantaneous pickup with short time for feeders.

    d. Short-time pickup for main and feeders.

    e. Short-time delay for main and feeders with I2T function, and IN-OUT switch.

    f. Ground fault pickup.

    g. Ground fault delay with I2T function.

C. Phase Current Sensors:

    1. Single-ratio type.

    2. Fixed, mounted on breaker frame.

    3. Molded epoxy construction.

    4. One toroidal type for each phase.

D. Portable Test Set: AC/DC static, full function unit for checking programmer's time-current characteristics of programmer.

E. Where indicated on the drawings, furnish integral alternate maintenance switch that, when selected, will override the instantaneous setting of the associated breaker and

force the setting to minimum (fastest acting). The setting shall remain until the normal mode is selected on the switch where the original instantaneous settings shall be restored.

2.08 CONTROL WIRING

A. Control, Instrumentation, and Power/Current Circuits: NFPA 70, Type SIS, single-conductor, Class B, stranded copper, rated 600 volts.

B. Transducer Output/Analog Circuits: Shielded cable rated 600 volts, 90 degrees C minimum.

C. Conductor Lugs: Pre-insulated, self-locking, spade-type, with reinforced sleeves.

D. Identification: Individually, with permanent wire markers at each end.

E. Enclose in top and vertical steel wiring troughs, and front-to-rear in nonmetallic wiring troughs.

F. Splices: Not permitted in switchboard wiring.

2.09 TERMINAL BLOCKS

A. Enclosed in steel wiring troughs.

B. Rated 600 volts, 30 amperes minimum, one-piece barrier type with strap screws.

C. Shorting type for current transformer leads.

D. Provide terminal blocks for:

1. Conductors connecting to circuits external to switchboard.

2. Internal circuits crossing shipping splits.

3. Equipment parts requiring replacement and maintenance.

E. Spare Terminals: Not less than 20 percent.

F. Group terminal blocks for external circuit wiring leads.

G. Maintain 6-inch minimum space between columns of terminal blocks.

H. Identification: Permanent, for each terminal and columns of terminal blocks.

I. Manufacturer: General Electric; Type EB-5.

2.10 IDENTIFICATION

A. Nameplates:

1. Master:

a. Deep-etched aluminum, with manufacturer's name and model number.

b. Riveted to main vertical section.

2. Circuit Breaker Cubicles and Door-Mounted Device:

a. Engraved, acrylic.

b. Color: White with black.

c. Characters: Block-type, 1/4-inch high.

d. Size: Manufacturer's standard.

e. Inscription: As shown on one-line diagram.

f. Blank plates for future spaces.

g. Attachment Screws: Self-tapping.

B. Section Identification:

1. Stamped metallic, riveted to each vertical section.

2. Furnish master nameplate giving switchboard designation, voltage, ampere rating, short-circuit rating, manufacturer’s name, general order number, and item number.

3. Size: Manufacturer's standard.

C. Cubicle Labels:

1. Nonmetallic, applied inside each cubicle compartment.

2. Device serial number, rating, and description.

D. Metering Instruments: Meter type identified on meter face below pointer or dial.

E. Control Switches: Deep etched, aluminum escutcheon plate.

F. Relays and Devices:

1. Stamped metallic, riveted to instrument case.

2. Manufacturer's name, model number, relay type, and rating data.

G. Switchboard Sign:

1. One sign on front of switchboard.

2. Engraved, acrylic.

3. Size: Manufacturer's standard.

4. Color: Red with white.

5. Characters: Gothic-type, I-inch high.

6. Inscription: DANGER/HIGH VOLTAGE/KEEP OUT.

7. Attachment: Four rivets each sign.

2.11 POWER METER/ POWER MONITORING SYSTEM

A. Power meter shall be multi-function 3 phase solid state unit with ability to connect to either a 3-phase, 4-wire wye or 3-phase, 3-wire delta circuits. Solid-state device with LED displays.

B. Direct voltage input up to 600 volts ac.

C. Current input via current transformer with 5-ampere secondary.

D. Programmable current and potential transformer ratios.

E. Programmable limits to activate up to four alarms.

F. Selectable voltage measurements; line-to-line or line-to-neutral, and wye or delta.

G. Simultaneous Display:
1. Volts, three-phase.
2. Amperes, three-phase.
3. Kilowatts.
4. Kilowatt-hours.
5. Power factor.
6. Frequency.
7. kW demand, with programmable period intervals.
8. kVA, kVAR, kVARh.
9. Ground leakage mA.
10. THD.
11. K-factor.

H. Voltage Rating: 95 to 135 volts, ac.

I. Individual voltage, current, and kW 4-20 mA output. KYZ pulse output representing units of energy.

J. Power meter shall have memory storage capacity minimum of 512MB. Display shall be minimum 3.77” x 3.77” or larger.

K. Power meter shall communicate over Ethernet TCP/IP communications protocol for future connection to the plant SCADA system.

L. Manufacturers:

1. Cutler-Hammer.
2. Square D.
3. GE.
3. Or Owner approved equal.

2.12 SURGE PROTECTION DEVICE

A. Refer to Section 16050, “Basic Electrical Materials and Methods”.

2.13 FACTORY TESTING

A. Perform performance tests in accordance with UL 891 and production tests in accordance with NEMA PB-2.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions and recommendations.

B. Secure to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.

C. Install plumb and in longitudinal alignment with pad or wall.

D. Coordinate terminal connections with installation of secondary feeders.

3.02 FIELD QUALITY CONTROL

A. In accordance with Section 16950, “Electrical Testing.”

3.03 MANUFACTURERS' SERVICES

A. Furnish manufacturer's representative for the following services at jobsite, for minimum person-days listed below, travel time excluded:

1. 2 person-days for installation assistance, final adjustment, and initial energization of equipment.

2. 1 person-day for functional and performance testing.

3. 1 person-day for adjustment of relay settings.

B. Furnish startup services and training of OWNER's personnel at such times as requested by OWNER.

1. The manufacturer’s qualified representative shall conduct the training.

2. The cost of training programs to be conducted with Owner's personnel shall be included in the Contract price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied.

3. The supplier shall provide detailed manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project.

4. The supplier shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, such materials shall be delivered to Owner.

5. The training program shall represent a comprehensive program covering all aspects of the operation, maintenance and cleaning procedures for the system.

6. All training schedules shall be coordinated with, and at the convenience of the Owner. Shift training may be required to correspond to the Owner's working schedule.

7. Training shall be a minimum of two (2) session four (4) hours in length.

3.04 RUBBER MATS

A. A three foot wide rubber mat shall be furnished and installed on the floor and in front of each switchboard, MCC, VFD and control panel assembly. The mat shall be long enough to cover the full length of each line-up. The mat shall be 1/4 inch thick with beveled edges, canvas back, solid type with corrugations running the entire length of the mat. The mat shall be guaranteed extra quality, free from cracks, blow holes, or other defects detrimental to their mechanical or electrical strength. The mat shall meet OSHA requirements and the requirements of ANSI/ASTM D-178 J6-7 for Type 2, Class 2 insulating matting.

END OF SECTION

SECTION 16450

GROUNDING

PART 1 - GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI): 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: 3/4 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: Utilize low-smoke, low-emission process.

3. Manufacturers:

a. Erico Products, Inc.; Cadweld and Cadweld Exolon.

b. Thermoweld.

c. Approved equal.

B. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.

1. Manufacturers:

a. Burndy Corp.

b. Thomas and Betts Co.

c. Approved equal.

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

3. Approved equal.

PART 3 - EXECUTION

3.01 GENERAL

A. Grounding shall be in compliance 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.

F. All existing VFD motors shall have an AEGIS SCR motor shaft ground ring installed.

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 either exothermic weld or mechanical-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 prior to backfilling ground connections.

B. Exothermic Weld Type:

1. Wire brush or file contact point to bare metal surface.

2. Use welding cartridges and molds in accordance with manufacturer's recommendations.

3. Avoid using badly worn molds.

4. Mold to be completely filled with metal when making welds.

5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

C. 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 ground wire (in conduit where above grade) to closest plant ground system

3.12 BONDING

A. Bond to Main Conductor System:

1. All roof mounted ventilators, fans, air handlers, masts, flues, cooling towers, handrails, and other sizeable metal objects.

2. 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.

3. Provide air terminals as required.

B. Bond steel columns or major framing members to grounding system per National Electrical Code.

C. Bond each main down conductor to grounding system.

3.13 GROUNDING SYSTEM

A. Grounding Conductor:

1. Completely encircle well and building structure.

2. Bury minimum 30” below finished grade.

3. Minimum 2 feet distance from foundation walls.

B. Interconnect ground rods by direct-buried copper cables.

C. Connections:

1. Install ground cables continuous between connections.

2. Exothermic welded connections to ground rods, cable trays, structural steel, handrails, and buried and non-accessible connections.

3. Provide bolted clamp type mechanical connectors for all exposed secondary connections.

4. Use bolded offset parapet bases or through-roof concealed base assemblies for air terminal connections.

5. Provide interconnections with electrical and telephone systems and all underground water and metal pipes.

6. Provide electric service arrestor ground wire to building water main.

3.14 FIELD QUALITY CONTROL

A. As specified in Section 16950, ELECTRICAL TESTING.

END OF SECTION

SECTION 16485

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment and incidentals required, and install, place in operation and field test variable frequency drive(s) (VFD's).

B. The variable frequency drive shall be a space vector Pulse-Width Modulated (PWM) design. Modulation methods which incorporate "gear-changing" techniques are not acceptable. The final responsibility of distributor or packager modifications to a third-party standard product will reside with the VFD manufacturer. The VFD manufacturer shall have overall responsibility for the drives. All drives shall be supplied by one manufacturer. The VFD shall be manufactured within the United States of America to alleviate concerns of future serviceability and parts availability.

C. VFD below 100HP shall be six (6) pulse units with 5% input line reactor and output reactor/output filter. VFD 100HP and above shall be eighteen (18) pulse with output reactor/output filter.

D. VFD for 100HP Pump No.1 shall be sized for future 200HP motor and set overloads for a 100HP motor.

E. Provide upper and lower vibration monitors in VFDs No. 5 and 6 as described in drawings, complete in place.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Division 16 – Electrical

1.03 QUALITY ASSURANCE

A. The entire VFD system as described in section 2.01B shall be factory assembled and system tested by the VFD manufacturer to assure a properly coordinated system.

B. Codes: Provide equipment in full accordance with the latest applicable rules, regulations, and standards of:

1. Local Laws and Ordinances.
2. State and Federal Laws.
3. National Electric Code (NEC).
4. Underwriters Laboratories (UL).
5. American National Standards Institute (ANSI).
6. National Electrical Manufacturers Association (NEMA).
7. Institute of Electrical and Electronics Engineers (IEEE).

C. The complete drive system shall be UL listed.

D. Acceptable Manufacturers:

1. Eaton.
3. Square D.
3. Allen-Bradley.
4. Danfoss.
5. No approved equal.

1.04 SUBMITTALS

A. Submittals shall be custom prepared by the VFD manufacturer for this specific application.

B. Submittal information shall include, but not be limited to:

1. Equipment dimensions, including stub-up locations, shipping splits and shipping weights.
2. Catalog cuts of major components.
3. Spare parts list, per Paragraph 3.03.
4. Certifications, including:
   a. Warranty, per section 1.05.
   b. Efficiencies, per section 2.02.A.1.

1.05 WARRANTY

A. All equipment furnished under this section shall be warranted for on site parts and labor by the contractor and the equipment manufacturers for a period of five (5) years after completion of startup.

PART 2 - PRODUCTS

2.01 Material and Equipment

A. Any modifications to a standard product required to meet this specification shall be performed by the VFD manufacturer only. Distributor or system integrator changes to the VFD manufacturer's product are specifically disallowed.

B. The VFD system shall consist of a power factor correction / harmonic filter unit, input rectifier-grade phase-shifting transformer, 6 or 18 pulse converter section as appriopriate per 1.01C, output inverter and control logic section, harmonic filtering unit, input line reactor, and output filter. All components listed including power factor correction / harmonic filter shall be integral to the VFD lineup, factory wired and tested as a complete system. The entire VFD system shall meet the requirements of NEC article 409, IEEE 519 and UL 508A for fault current withstand ratings as indicated on the project electrical drawings.

C. Input circuit breaker, interlocked with the enclosure door, with through-the-door handle to provide positive disconnect of incoming AC power and shall be capable of being locked in the open position.

D. VFD system shall maintain a 0.95 minimum true power factor throughout the entire speed range.

2.02 VARIABLE FREQUENCY DRIVES

A. Ratings

1. The drive system shall be 96% efficient at full load and full speed and 95.5% efficient at 51% load and 80% speed. Losses to be utilized in drive system efficiency calculation shall include input transformer, harmonic filter and power factor correction if applicable, VFD converter and output filter if applicable. Auxiliary controls, such as internal VFD control boards, cooling fans or pumps, shall be included in all loss calculations. The VFD rating shall be 110% rated for the actual full load current of the motor.
2. Rated Input Power: 480 Volts 60 Hz, +10%, -5% at rated load, 3-phase.
   a. Voltage Dip Ride-Through: VFD shall be capable of sustaining continued operation with a 40% dip in nominal line voltage. Output speed may decline only if current limit rating of VFD is exceeded.
   b. Power Loss Ride-through: VFD shall be capable of a minimum 3 cycle power loss ride-through without fault activation.
3. Output Power: As required by motors supplied.
4. Ambient Temperature Range: 0 to 40°C.
5. Elevation: Up to 3300 feet (1000 meters) above MSL without derating.
6. Atmosphere: Non-condensing relative humidity to 95%.
7. AC Line Frequency Variation: +/- 3 Hertz.
8. Power Unit Rating Basis: 110% rated current continuous, 150% rated current for one minute, at rated temperature.

B. Construction

1. The controller shall produce an adjustable AC voltage/frequency output. It shall have an output voltage regulator to maintain correct output V/Hz ratio despite incoming voltage variations.
2. The controller shall have a continuous output current rating of 100% of motor nameplate current.
3. The converter section shall be 6 or 18 pulse minimum utilizing diodes.
4. The inverter output shall be generated by IGBTs. Pulse Width Modulation strategy will be of the space vector type implemented to generate a sine-coded output voltage. The VFD shall not induce excessive power losses in the motor. The worst-case RMS motor line current measured at rated speed, torque and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation. The inverters shall be able to sustain 1600 volt surges.
5. The controller(s) shall be suitable for use with any standard NEMA-B squirrel-cage induction motor(s) having a 1.0 Service Factor or with existing standard NEMA-B squirrel-cage induction motor(s) with nameplate data as shown on the plans. Provide drives with dV/dT output filters manufactured by Trans-Coil type KLC. At any time in the future, it shall be possible to substitute any standard motor (equivalent horsepower, voltage and RPM) in the field.
6. The control logic section shall be fully digital and not require analog adjustment pots or fixed selector resistors. A power failure will not necessitate a reload of any drive parameter or configuration.
7. Minimum Starting Speed: When called to operate, the VFD shall immediately ramp to a minimum speed. The minimum speed shall be adjustable but initially set at

60% of maximum speed. The 4-20 MA speed signal from the PLC and potentiometer on the front of the drive shall modulate the signal between the minimum speed setpoint and the maximum output speed of the drive; i.e., at the 4 MA signal, the VFD shall run at the minimum speed. At the 20 MA signal, the VFD shall run at full speed. The potentiometer shall also adjust speed between the minimum speed setpoint and the maximum running speed. Below the minimum speed setpoint, the potentiometer shall have no effect.

8. All 6-pulse VFD's shall be provided with 5% input line reactors.

C. Basic Features

1 The door of each power unit shall include: a keypad with a manual speed device, "CONTROL POWER ON" light, "AVAILABLE" light, "VFD RUNNING" light, "MOTOR OVER TEMPERATURE" light, "VFD FAIL" light, and "RESET" pushbutton. All lights shall be LED type. See electrical drawings for VFD control wiring diagrams and adjust VFD indication lights, switches, etc. accordingly.

2. The VFD shall include a customer selectable automatic restart feature. When enabled, the VFD shall automatically attempt to restart after a trip condition resulting from instantaneous overcurrent, overvoltage, out of saturation or overload. For safety, the drive shall shut down and require manual reset and restart if the automatic reset/restart function (programmable for up to 3 attempts) is not successful within a customer programmable time period. Auto-Restart shall be programmable to allow for individual fault selection.

3. A door-mounted membrane keypad with integral 2-line minimum, 24-character LCD display shall be furnished, capable of controlling the VFD and setting drive parameters. The keypad shall include the following features:
   a. The digital display must present all diagnostic message and parameter values in English engineering units when accessed, without the use of codes.
   b. The digital keypad shall allow the operator to enter exact numerical settings in English engineering units. A user menu written in plain English (rather than codes) shall be provided in software in nonvolatile memory as a guide to parameter setting and resettable in the field through the keypad. Multiple levels of password security shall be available to protect drive parameters from unauthorized personnel. The drive set up parameters must be able to be transferred to new boards to reprogram spare boards.
   c. The following digital door-mounted keypad indications may be selectively displayed:
      1) Speed demand in percent.
      2) Output current in amperes.
      3) Output Frequency in hertz.
      4) Input voltage.
      5) Output voltage.
      6) Total 3-phase KW.
      7) Kilowatt hour meter
      8) Elapsed time running meter.
      9) RPM.
      10) DC bus voltage.

d. VFD shall have Ethernet TCP/IP communication port in addition to the hard-wired signals shown on drawings. Ethernet TCP/IP communication port is for future use.
e. VFD parameters, fault log and diagnostic log shall be downloadable via the RS-232, RS-422, or RS-485 port.

4. Refer to the VFD wiring diagram in the drawings for remote signals and alarms.

D. Enclosure

1. All VFD components shall be factory mounted and wired on a dead front, grounded, NEMA-1 enclosure. If a free-standing enclosure is provided, it shall be suitable for mounting on a concrete housekeeping pad. Maximum enclosure dimensions for various VFD sizes shall be as follows:
   a. 200 HP (18-pulse): 48”W x 32”D x 90”H
   b. 300 HP (18-pulse): 60”W x 32”D x 90”H

E. Protective Features and Circuits: The controller shall include the following alarms and protective features:

1. Instantaneous overcurrent and overvoltage trip.
2. Undervoltage and power loss protection.
3. Power unit overtemperature alarm and protection. Upon sensing an overtemperature condition, the VFD is to automatically trip.
4. Electronic motor inverse time overload protection.
5. Responsive action to motor winding temperature detectors or thermostatic switches. A dry contact (NC) input to the VFD is required.
6. When power is restored after a complete power outage, the VFD shall be capable of catching the motor while it is still spinning and restoring it to proper operating speed without the use of an encoder.
7. The VFD shall be protected from damage due to the following, without requiring an output contactor:
   a. Three-phase short circuit on VFD output terminals.
   b. Loss of input power due to opening of VFD input disconnecting device or utility power failure during VFD operation.
   c. Loss of one (1) phase of input power.
8. The VFD shall continue to operate at a reduced capacity under a single-phase fault condition.
9. The VFD shall be able to withstand the following fault conditions without damage to the power circuit components:
   a. Failure to connect a motor to the VFD output.
   b. VFD output open circuit that may occur during operation.
   c. VFD output short circuit that may occur during operation.
10. Provide input line reactors (5% impedance) when no 12 or 18 pulse transformers are supplied or required.
11. Three phase lightning and surge protection across the line input at each VFD.
12. Provide 120V motor heater power that is active when the motor is off and is off when the motor is active.
13. Provide 120V power for future that is inactive when the motor is off and is on when the motor is active.

F. Parameter Settings

1. The following system configuring settings shall be provided and field adjustable, without exception, through the keypad/display unit. Except for Motor Nameplate Data, all parameters must be adjustable while the processor is on-line and the drive is running.
   a. Motor Nameplate Data.
      1) Motor frequency.
      2) Number of poles.
      3) Full load speed.
      4) Motor volts.
      5) Motor full load amps.
      6) Motor HP.
      7) Current limit, max.
   b. VFD Configuration Parameters.
      1) Independent accelerate/decelerate rates.
      2) Max/Min speed (frequency).
      3) Catch-a spinning load selection.
      4) No load boost.
      5) Full load boost.
      6) Volts/Hertz ratio.
      7) Overspeed trip.
      8) Overload trip curve selection.
      9) Overload trip time selection.
   c. Automatic VFD Control.
      1) PID utilizing an internal or external setpoint.
      2) Three selectable critical speed avoidance bands with programmable bandwidths.
      3) Auto start functions: On/Off, Delay On/Off. Operable from a 4-20mA signal or from the PID output, command, or feedback signal.
      4) Speed Profile: Programmable entry and exit points.
      5) Programmable loss of signal control: Stop, maintain last speed, or default to preselected setpoint.
2. All drive setting adjustments and operation parameters shall be stored in a parameter log which lists allowable maximum and minimum points as well as the present set values. This parameter log shall be accessible via a RS-232, RS-422, or RS-485 serial port as well as on the keypad display.

G. Input/Output Features

1. Two programmable analog inputs: VFD speed in, spare.
2. Three programmable analog outputs: VFD speed output, Drive (output) current in Amps, spare.
3. Two programmable digital inputs: Run, Reset.
4. Ten programmable digital outputs: VFD fault, VFD running, VFD in hand, 6 spare.
5. System Program providing built-in drive control or application specific configuration capability.
6. Four fixed outputs: Fail, Running, Available, In Hand.
7. One fixed input: Start/Stop.

H. Diagnostic Features and Fault Handling

1. The VFD shall include a comprehensive microprocessor based digital diagnostic system that monitors its own control functions and displays faults and operating conditions.

2. A “Fault Log” shall be accessible via a RS-232, RS-422, or RS-485 serial link as well as line-by-line on the keypad display. The "FAULT LOG" shall record, store, display and output to a serial port upon demand, the following for the 64 most recent events:
   a. Date and time of day.
   b. Type of fault.
   c. All faults and events shall be stored and displayed in English, not fault codes.
3. A "HISTORIC LOG" shall record, store, and output to a RS-232, RS-422, or RS-485 serial link port upon demand, the following selectable control variables at 1 msec. intervals for the 58 intervals immediately preceding and the 20 intervals immediately following a fault trip:
   a. Torque demand.
   b. Torque command.
   c. Torque feedback.
   d. Torque error.
   e. Torque maximum.
   f. Current demand.
   g. Peak current.
   h. Motor current.
   i. DC bus voltage.
   j. Line voltage.
   k. Velocity demand.
   l. Velocity reference.
   m. PI min/max limit.
   n. Boost.
   o. VFD mode (Auto/Manual).

PART 3 - EXECUTION

3.01 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.

1. All printed circuit boards shall be functionally tested via automatic test equipment prior to unit installation.
2. After all tests have been performed, each VFD shall undergo a burn-in test. The drive shall be burned in at 100% inductive or motor load without an unscheduled shutdown.
3. After the burn-in cycle is complete, each VFD shall be put through a motor load test before inspection and shipping.

B. The manufacturer shall provide three (3) certified copies of factory test reports.

3.02 START-UP FIELD SERVICE

A. Provide the services of a qualified manufacturer's employed Field Service Engineer to assist the Contractor in installation and start-up of the equipment specified under this section. Field Service personnel shall be factory trained

with periodic updates and have experience with the same model of VFD on the job site. Sales representatives will not be acceptable to perform this work. The manufacturer's service representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, installation as specified in manufacturer's installation instructions, wiring, application dependent adjustments, and verification of proper VFD operation.

B. The Contractor under the technical direction of the manufacturer's service representative shall perform the following minimum work.

1. Inspection and final adjustments.
2. Operational and functional checks of VFD and spare parts.
3. The contractor shall certify that he has read the drive manufacturer's installation instructions and has installed the VFD in accordance with those instructions.

C. The Contractor shall provide three (3) copies of the manufacturer's field start-up report before final payment is made.

3.03 TRAINING

A. The manufacturer's qualified representative shall conduct the training.

B. The cost of training programs to be conducted with Owner's personnel shall be included in the Contract price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied.

C. The supplier shall provide detailed manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project.

D. The supplier shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, such materials shall be delivered to Owner.

E. The training program shall represent a comprehensive program covering all aspects of the operation, maintenance and cleaning procedures for the system.

F. All training schedules shall be coordinated with, and at the convenience of the Owner. Shift training may be required to correspond to the Owner's working schedule.

G. Training shall be a minimum of two (2) session four (4) hours in length.

3.04 SPARE PARTS

A. The following spare parts shall be furnished:

1. Three of each type of fuse rated 460V or less.
2. One keypad assembly.

3.05 RUBBER MATS

A. A three foot wide rubber mat shall be furnished and installed on the floor and in front of each switchboard, MCC, VFD and control panel assembly. The mat shall be long enough to cover the full length of each line-up. The mat shall be 1/4 inch thick with beveled edges, canvas back, solid type with corrugations running the entire length of the mat. The mat shall be guaranteed extra quality, free from cracks, blow holes, or other defects detrimental to their mechanical or electrical strength. The mat shall meet OSHA requirements and the requirements of ANSI/ASTM D-178 J6-7 for Type 2, Class 2 insulating matting.

END OF SECTION

SECTION 16500

LIGHTING

PART 1--GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install lighting fixtures, and accessories for all lighting systems, complete and operable, all in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Electrical General Provisions.

1.03 REFERENCES

A. Without limiting the generality of other requirements of these specifications, all work hereunder shall conform to the applicable requirements of the referenced portions of the following documents, to the extent that the requirements therein are not in conflict with the provisions of 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. Underwriters Laboratories, Inc. (UL):

4. 595, Standard for Safety Marine-Type Electric Lighting Fixtures.

5. 844, Standard for Safety Electric Lighting Fixtures for Use in Hazardous (Classified) Locations.

6. 924, Standard for Safety Emergency Lighting and Power Equipment.

1.04 SUBMITTALS

A. The Contractor shall submit the following in accordance with the requirements of the Section entitled "Submittals."

1. Shop drawings and catalog data:

a. Interior Luminaires:

1) Catalog data sheets and pictures.

2) Luminaire finish and metal gauge.

3) Lens material, pattern, and thickness.

4) Candle power distribution curves in two or more planes.

5) Candle power chart 0 to 90 degrees.

6) Lumen output chart.

7) Average maximum brightness data in foot-lamberts.

8) Coefficients of utilization for zonal cavity calculations.

9) Mounting or suspension details.

10) Heat exchange and air handling data.

b. Exterior Luminaires:

1) Catalog data sheets and pictures.

2) Luminaire finish and metal gauge.

3) Lens material, pattern, and thickness.

4) IES lighting classification and isolux diagram.

5) Fastening details to wall or pole.

6) For light poles, submit wind loading, complete dimensions, and finish.

c. Photocells:

1) Voltage, and power consumption.

2) Capacity.

3) Contacts and time delay.

4) Operating levels.

5) Enclosure type and dimensions.

6) Temperature range.

2. Complete literature for each fixture substitution. Photoelectric data shall include coefficients of utilization, average brightness, candle power distribution curves, and lumen output chart. Substitutions for specified fixtures shall be based upon quality of construction, light distribution, appearance, and maintenance. Other makes of fixtures than those specified will be approved by the Engineer provided they are judged equal in all respects to the type specified

3. For exterior pole mounted applications, submit calculations signed and

sealed by a professional structural engineer registered in the State of Florida, certifying that the outdoor pole and fixture installation, including pole, fixture, base and installation method will meet the appropriate wind loading criteria given by the Florida Building Code for the wind zone in which the assembly will be installed.

1.05 UL COMPLIANCE

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

1.06 QUALITY ASSURANCE

A. Exterior lighting system operation shall be demonstrated during the hours of darkness to indicate that fixtures are properly focused, photo cell operation is correct, and that fixture switching functions as intended. Similar requirements shall apply to interior lighting. Through demonstration, the Contractor shall also verify that panel schedules properly indicate the lighting systems connected to each circuit.

B. Lighting demonstration shall occur within 2 weeks prior to project acceptance.

C. Lighting fixtures shall be stored in their original cartons from the manufacturers until the time of installation. Fixtures poles shall be stored on blocks above grade until the time of installation.

1.07 CLEANUP

A. Fixture lenses, diffusers and reflects shall be cleaned just prior to the time specified for the system demonstrations.

B. Fixture trim, including poles and support brackets, where finish has been damaged, shall be refinished.

PART 2--PRODUCTS

2.01 FIXTURES - GENERAL

A. All fixtures shall be pre wired with leads for connection to building circuits.

2.02 EXTERIOR FIXTURES

A. Exterior fixtures and pole assemblies, in combination with their method of installation, shall be capable of meeting the wind loading criteria for the wind zone of installation as defined in the Florida Building Code. The wind loading requirement shall apply to the entire assembly including foundation (or base) and earthen materials used to secure the foundation or base. The calculation required under section 1.04.A.3 shall include this analysis.

B. Exterior fixtures shall have corrosion resistant hardware and hinged doors or lens retainer. Fixtures specified to be furnished with integral photo electrical control

shall be of the fixture manufacturer's standard design.

2.03 LUMINAIRES

A. Specific requirements relative to execution of Work of this section are located in the Luminaire Schedule on Drawings.

B. Soffit Installations:

1. UL Labeled: SUITABLE FOR DAMP LOCATIONS.

C. Exterior Installations:

1. UL Labeled: SUITABLE FOR WET LOCATIONS.

2. When factory-installed photocells are provided, entire assembly shall have UL label.

D. 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.

E. LED Driver

a. Voltage Range (120-277) +/- 10%

b. Current .35 Add (+/-5%)

c. Frequency 50/60Hz

d. Power Factor >90% at full load

e. THD < 20% at full load

f. Load regulation: +/- 1% from no load to full load

g. Output ripple < 10%

h. Output should be isolated

i. Case temperature: rated for -40 degrees through +80 degrees

j. Overheat protection, self-limited short circuit protection and overload protected

k. Primary fused

l. Life rating not less than 50,000 hours

m. 0-10V dimming where indicated on drawings

n. Internal surge arrester

F. Lighting Control

1. Photocell:

a. Automatic ON/OFF switching photo control.

b. Housing: Self-contained, die-cast aluminum, unaffected by moisture, vibration, or temperature changes.

c. Setting: ON at dusk and OFF at dawn.

d. Time delay feature to prevent false switching.

e. Field adjustable to control operating levels.

f. Manufacturers:

1) Tork.

2) Paragon.

G. Poles

1. Rating (with Luminaire): Shall meet Florida Building Code and ASCE 7-98 requirements for wind zone of installation.

2. Material: As shown on drawings.

PART 3--EXECUTION

3.01 LIGHTING FIXTURES

A. Lighting fixtures shall be furnished in accordance with the Fixture Schedule.

B. Lighting fixtures shall be installed plumb and square with building and wall intersections. Pendant mounted fixtures which are mounted from sloping ceilings shall be suspended by ball hangers. Fixtures installed in machinery rooms shall be located after machines have been installed. In all cases, fixture locations shall be coordinated with work of other trades to prevent obstruction of light from the fixtures. Fixtures shall be installed in accordance with the architectural reflected ceiling drawings. Unless otherwise indicated, fixtures shall be centered

on ceiling tiles. All fixtures and outlets shall be rigidly supported from the building structure or rigid conduit.

C. Recessed fixtures shall be installed tight to the ceiling and shall be provided with auxiliary safety supports attached directly to the building structure. Said safety supports shall consist of #10 AWG soft drawn galvanized wires.

3.02 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 luminaires nominally 48 inches apart.

3. Provide twin-stem hangers on single luminaires.

C. Pole Mounted:

1. Provide precast concrete base or pre-cast concrete pole as described in the drawings.

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.

   c. Provide plaster frames when required by ceiling construction.

7. Independent Supports:

   a. Provide each recessed 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.

G. Lighting Control

1. Outdoor Luminaires: Photocells will switch lights ON and OFF.

H. Cleaning Following Construction

1. Remove all labels and other markings, except UL listing mark.

2. Wipe luminaires inside and out to remove construction dust.

3. Clean luminaire plastic lenses with anti-static cleaners only.

4. Touch up all painted surfaces of luminaires and poles with matching paint ordered from manufacturer.

3.03 COORDINATION

A. The Contractor shall coordinate lighting fixture locations with all other disciplines. In case light fixtures are covered by pipe or other equipment, fixtures shall be moved with no cost to the Owner to provide for lighting level on the floor as indicated.

END OF SECTION

SECTION 16950

ELECTRICAL TESTING

PART1 – GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI):

a. C2, National Electrical Safety Code.

b. C37.20.1, Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear.

c. C37.20.2, Metal-Clad and Station-Type Cubicle Switchgear.

d. C37.20.3, Metal-Enclosed Interrupter Switchgear.

e. C62.33, Standard Test Specifications for Varistor Surge-Protective Devices.

2. Institute of Electrical and Electronics Engineers (IEEE):

a. 43, Recommended Practice for Testing Insulating Resistance of Rotating Machinery.

b. 48, Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminators.

c. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

d. 95, Recommended Practice for Insulation Testing of Large AC Rotating Machinery with High Direct Voltage.

e. 118, Standard Test Code for Resistance Measurement.

f. 400, Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field.

3. National Electrical Manufacturers Association (NEMA):

a. AB 4, Guideline for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.

b. PB 2, Deadfront Distribution Switchboards.

c. WC 7, Cross-Linked-Thermosetting-Polyethylene- Wire and Cable for the Transmission and Distribution of Electrical Energy.

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

4. International Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

5. National Fire Protection Association (NFPA):

a. 70, National Electrical Code (NEC).

b. 70E, Standard for Electrical Safety Requirements for Employee Workplaces.

1.02 SUBMITTALS

A. Administrative Submittals: Submit 30 days prior to performing inspections or tests:

1. Schedule for performing inspection and tests.

2. List of references to be used for each test.

3. Sample copy of equipment and materials inspection form(s).

4. Sample copy of individual device test form.

5. Sample copy of individual system test form.

B. Quality Control Submittals: Submit within 30 days after completion of test:

1. Test or inspection reports and certificates for each electrical item tested.

C. Contract Closeout Submittals:

1. Operation and Maintenance Data:

a. After test or inspection reports and certificates have been reviewed by ENGINEER and returned, insert a copy of each in operation and maintenance manual.

1.03. QUALITY ASSURANCE

A. Testing Firm Qualifications:

1. Corporately and financially independent organization functioning as an unbiased testing authority.

2. Professionally independent of manufacturers, suppliers, and installers, of electrical equipment and systems being tested.

3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.

4. Supervising engineer accredited as Certified Electrical Test Technologist by National Institute for Certification of Engineering Technologists (NICET), or International Electrical Testing Association and having a minimum of 5 years testing experience on similar projects.

5. Technicians certified by NICET or NETA.

6. Assistants and apprentices assigned to project at ratio not to exceed two certified to one noncertified assistant or apprentice.

7. Registered Professional Engineer to provide comprehensive project report outlining services performed, results of such services, recommendations, actions taken, and opinions.

8. In compliance with OSHA Title 29, Part 1907 criteria for accreditation of testing laboratories or a full Member Company of International Electrical Testing Association.

B. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.

C. Test instrument calibration shall be in accordance with NETA ATS.

1.04 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment has been installed.

B. Perform inspection and electrical tests on existing cryogenic compressor motors.

C. Perform tests with apparatus de-energized whenever feasible.

D. Inspection and electrical tests on energized equipment are to be:

1. Scheduled with ENGINEER prior to de-energization.

2. Minimized to avoid extended period of interruption to the operating plant equipment.

E. Notify ENGINEER at least 24 hours prior to performing tests on energized electrical equipment.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.01 GENERAL

A. Tests and inspection shall establish that:

1. Electrical equipment is operational within industry and manufacturer's tolerances.

2. Installation operates properly.

3. Equipment is suitable for energization.

4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, and ANSI C2.

B. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

C. Adjust mechanisms and moving parts for free mechanical movement.

D. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

E. Verify nameplate data for conformance to Contract Documents.

F. Realign equipment not properly aligned and correct unlevelness.

G. Properly anchor electrical equipment found to be inadequately anchored.

H. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.

I. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

J. Provide proper lubrication of applicable moving parts.

K. Inform ENGINEER of working clearances not in accordance with NFPA 70.

L. Investigate and repair or replace:

1. Electrical items that fail tests.

2. Active components not operating in accordance with manufacturer's instructions.

3. Damaged electrical equipment.

M. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.

2. Vacuum and wipe clean enclosure interior.

3. Remove corrosion found on metal surfaces.

4. Repair or replace, as determined by ENGINEER, door and panel sections having dented surfaces.

5. Repair or replace, as determined by ENGINEER, poor fitting doors and panel sections.

6. Repair or replace improperly operating latching, locking, or interlocking devices.

7. Replace missing or damaged hardware.

8. Finish:

a. Provide matching paint and touch up scratches and mars.

b. If required due to extensive damage, as determined by ENGINEER, refinish the entire assembly.

N. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents.

O. Replace transformer insulating oil not in compliance with ASTM D923.

3.02 SWITCHGEAR AND SWITCHBOARD ASSEMBLIES

A. Visual and Mechanical Inspection:

1. Insulator damage and contaminated surfaces.

2. Proper barrier and shutter installation and operation.

3. Proper operation of indicating devices.

4. Improper blockage of air-cooling passages.

5. Proper operation of drawout elements.

6. Integrity and contamination of bus insulation system.

7. Check Door and Device Interlocking System By:

a. Closure attempt of device when door is in OFF or OPEN position.

b. Opening attempt of door when device is in ON or CLOSED position.

8. Check Key Interlocking Systems For:

a. Key captivity when device is in ON or CLOSED position.

b. Key removal when device is in ON or CLOSED position.

c. Closure attempt of device when key has been removed.

d. Correct number of keys in relationship to number of lock cylinders.

e. Existence of other keys capable of operating lock cylinders.

1) Destroy duplicate sets of keys.

9. Check Nameplates for Proper Identification Of:

a. Equipment title and tag number with latest one-line diagram.

b. Pushbutton.

c. Control switch.

d. Pilot light.

e. Control relay.

f. Circuit breaker.

g. Indicating meter.

10. Verify that fuse and circuit breaker ratings, sizes, and types conform to those specified.

11. Check bus and cable connections for high resistance by low resistance ohmmeter and calibrated torque wrench thermographic survey applied to bolted joints.

a. Ohmic value to be zero.

b. Bolt torque level in accordance with NETA ATS, Table 10. 1, unless otherwise specified by manufacturer.

c. Thermographic survey temperature gradient of 2 degrees C, or less.

12. Check Operation and Sequencing of Electrical and Mechanical Interlock Systems By:

a. Closure attempt for locked open devices.

b. Opening attempt for locked closed devices.

c. Key exchange to operate devices in OFF-NORMAL positions.

13. Verify performance of each control device and feature.

14. Control Wiring:

a. Compare wiring to local and remote control and protective devices with elementary diagrams.

b. Proper conductor lacing and bundling.

c. Proper conductor identification.

d. Proper conductor logs and connections.

15. Exercise active components.

16. Perform phasing check on double-ended equipment to ensure proper bus phasing from each source.

B. Electrical Tests:

1. Insulation Resistance Tests:

a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 7.1.1.

b. Each phase of each bus section.

c. Phase-to-phase and phase-to-ground for 1 minute.

d. With switches and breakers open.

e. With switches and breakers closed.

f. Control wiring except that connected to solid state components.

g. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.

2. Overpotential Tests:

a. Applied ac or dc voltage and test procedure in accordance with ANSI C37.20.3 and NEMA PB 2.

b. Each phase of each bus section.

c. Phase-to-phase and phase-to-ground for 1 minute.

d. Test results evaluated on a pass/fail basis.

3. Current Injection Tests:

a. For entire current circuit in each section.

b. Secondary injection for current flow of 1 ampere.

c. Test current at each device.

4. Control Wiring:

a. Apply secondary voltage to control power and potential circuits.

b. Check voltage levels at each point on terminal boards and each device terminal.

5. Operational Test:

a. Initiate control devices.

b. Check proper operation of control system in each section.

3.03 DRY TYPE TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Physical and insulator damage.

2. Proper winding connections.

3. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.

4. Defective wiring.

5. Proper operation of fans, indicators, and auxiliary devices.

6. Removal of shipping brackets, fixtures, or bracing.

7. Free and properly installed resilient mounts.

8. Cleanliness and improper blockage of ventilation passages.

9. Verify that tap-changer is set at correct ratio for rated output voltage under normal operating conditions.

10. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

B. Electrical Tests:

1. Insulation Resistance Tests:

a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 7.2.3 for each:

1) Winding-to-winding.
2) Winding-to-ground.

b. Ten minute test duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.

c. Results temperature corrected in accordance with NETA ATS, Table 7.2.4.

d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.

e. Insulation resistance test results to compare within 1 percent of adjacent windings.

2. Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.

3.04 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect Each Individual Exposed Power Cable No. 6 and Larger For:

a. Physical damage.

b. Proper connections in accordance with single-line diagram.

c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.

d. Color coding conformance with specifications.

e. Proper circuit identification.

2. Mechanical Connections For:

a. Proper lug type for conductor material.

b. Proper lug installation.

c. Bolt torque level in accordance with NETA ATS, Table 10. 1, unless otherwise specified by manufacturer.

3. Shielded Instrumentation Cables For:

a. Proper shield grounding.

b. Proper terminations.

c. Proper circuit identification.

4. Control Cables For:

a. Proper termination.

b. Proper circuit identification.

5. Cables Terminated Through Window Type CT's: Verify that neutrals and grounds are terminated for correct operation of protective devices.

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

1. Insulation Resistance Tests:

a. Test each conductor with respect to ground and to adjacent conductors per IEEE 118 procedures for 1 minute.

b. Evaluate ohmic values by comparison with conductors of same length and type.

c. Investigate values less than 50 megohms.

d. Utilize 1,000VDC megohmmeter for 600V insulated conductors.

2. Continuity test by ohmmeter method to ensure proper cable connections.

3.05 MEDIUM VOLTAGE CABLES, 25KV MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect Each Individual Exposed Cable For:

a. Physical damage plus jacket and insulation condition.

b. Proper connections in accordance with single-line diagram.

c. Proper shield grounding.

d. Proper cable support.

e. Proper cable termination.

f. Cable bends not in conformance with manufacturer's minimum allowable bending radius.

g. Proper are and fireproofing in common cable areas.

h. Proper circuit and phase identification.

2. Mechanical Connections For:

a. Proper lug type for conductor material.

b. Proper lug installation.

c. Bolt torque level in accordance with NETA ATS, Table 10. 1, unless otherwise specified by manufacturers.

3. Conductors Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests:

1. Insulation Resistance Tests:

a. Utilize 5,000-volt megohmmeter for 5kV and a 10,000-volt megohmmeter for 25 kV conductors.

b. Test each cable individually with remaining cables and shields grounded.

c. Test each conductor with respect to ground and to adjacent conductors in accordance with IEEE 118 procedures for 1 minute.

d. Evaluate ohmic values by comparison with conductors of same length and type.

e. Investigate values less than 50 megohms.

2. Shield Continuity Tests:

a. By ohmmeter method on each section of conductor.

b. Investigate values in excess of 10 ohms per 1,000 feet of conductors.

3. High Potential dc Tests:

a. In accordance with NEMA WC 8 for EPR insulated conductors.

b. Each conductor section tested with:

1) Splices and terminations in-place but disconnected from equipment.

2) Remaining conductors and shields grounded in accordance with IEEE 400.

c. Apply maximum dc test voltage as per manufacturer's recommendation.

d. Measure only the leakage current associated with conductor.

e. Utilize guard ring or field reduction sphere to suppress corona at disconnected terminations.

f. Maximum test voltage shall not exceed limits for terminators specified in IEEE 48 or manufacturer's specifications.

g. Apply test voltage in a minimum of five equal increments until maximum acceptable test voltage is reached.

1) Increments not to exceed ac voltage rating of conductor.

2) Record dc leakage current at each step after a constant stabilization time consistent with system charging current.

h. Raise conductor to specified maximum test voltage and hold for 15 minutes, or as specified by conductor manufacturer. Record dc leakage current at 30 seconds and 1 minute and at 1-minute intervals, thereafter.

i. Immediately following test, ground conductor for adequate time period to drain insulation stored charge.

j. Test results evaluated on a pass/fail basis.

3.06 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 70 amperes and larger and to motor circuit protector breakers rated 50 amperes and larger.

B. Visual and Mechanical Inspection:

1. Proper mounting.

2. Proper conductor size.

3. Feeder designation according to nameplate and one-line diagram.
4. Cracked casings.

5. Connection bolt torque level in accordance with NETA ATS, Table 10.1.

6. Operate breaker to verify smooth operation.

7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.

8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.

C. Electrical Tests:

1. Insulation Resistance Tests:

a. Utilize 1,000-volt dc megohmmeter for 480- and 600-volt circuit breakers and 500-volt dc megohmmeter for 240-volt circuit breakers.

b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.

c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.

d. Test values to comply with NETA ATS, Table 10.2.

2. Contact Resistance Tests:

a. Contact resistance in microhms across each pole.

b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.

3. Primary Current Injection Test to Verify:

a. Long-time minimum pickup and delay.

b. Short-time pickup and delay.

c. Ground fault pickup and delay.

d. Instantaneous pickup by run-up or pulse method.

e. Trip characteristics of adjustable trip breakers shall be within manufacturer's published time-current characteristic tolerance band, including adjustment factors.

f. Trip times shall be within limits established by NEMA AB 4, Table 5-3.

g. Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4.

3.07 INSTRUMENT TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Visually Check Current, Potential, and Control Transformers For:

a. Cracked insulation.

b. Broken leads or defective wiring.

c. Proper connections.

d. Adequate clearances between primary and secondary circuit wiring.

2. Verify Mechanically That:

a. Grounding and shorting connections have good contact.

b. Withdrawal mechanism and grounding operation, when applicable, operate properly.

3. Verify proper primary and secondary fuse sizes for potential transformers.

B. Electrical Tests:

1. Current Transformer Tests:

a. Insulation resistance test of transformer and wiring-to-ground at 1,000 volts dc for 30 seconds.

b. Polarity test.

2. Potential Transformer Tests:

a. Insulation resistance test at test voltages in accordance with NETA ATS, Table 7.1.1 for 1 minute on:

1) Winding-to-winding.

2) Winding-to-ground.

b. Polarity test to verify polarity marks or H1-X1 relationship as applicable.

3. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 7.1.1.

3.08 METERING

A. Visual and Mechanical Inspection:

1. Verify meter connections in accordance with appropriate diagrams.

2. Verify meter multipliers.

3. Verify that meter types and scales conform to Contract Documents.

4. Check calibration of meters at cardinal points.

5. Check calibration of electrical transducers.

3.09 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in motor control centers, panelboards, switchboards, and switchgear assemblies for proper connection and tightness.

2. Ground bus connections in motor control centers, panelboards, switchboards, and switchgear assemblies for proper termination and tightness.

3. Effective transformer core and equipment grounding.

4. Accessible connections to grounding electrodes for proper fit and tightness.

5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

B. Electrical Tests:

1. Fall-Of-Potential Test:

a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.

b. Main ground electrode system resistance to ground to be no greater than 5 ohms.

2. Two-Point Direct Method Test:

a. In accordance with IEEE 81, Section 8.2. 1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.

b. Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.

3.10 THERMOGRAPHIC SURVEY

A. Provide a thermographic survey of connections associated with incoming service conductors, bus work, and branch feeder conductors No. 2 and larger at each:

1. Medium voltage switchgear and transformer.
2. Switchboard.
3. Low voltage motor control center.
4. Panelboard.

B. Provide a thermographic survey of feeder conductors No. 2 and larger terminating at:

1. Motors rated 30 horsepower and larger.
2. Medium and low voltage disconnect switches.
3. Transfer switches.
4. Engine-generators.

C. Remove necessary enclosure metal panels and covers prior to performing survey.

D. Perform with equipment energized during periods of maximum possible loading.

E. Do not perform survey on equipment operating at less than 20 percent of rated connected operating load.

F. Utilize Thermographic Equipment Capable Of:

1. Detecting emitted radiation.
2. Converting detected radiation to visual signal.
3. Detecting 1 degree C temperature difference between subject area and reference point of 30 degrees C.

G. Temperature Gradients Of:

1. 3 degrees C to 7 degrees C indicates possible deficiency that warrants investigation.
2. 7 degrees C to 15 degrees C indicates deficiency that is to be corrected as time permits.
3. 16 degrees C and above indicates deficiency that is to be corrected immediately.

H. Provide Written Report Of:

1. Areas surveyed and the resultant temperature gradients.

2. Locations of areas having temperature gradients of 3 degrees C or greater.

3. Cause of heat rise and actions taken to correct the cause of heat rise.

4. Detected phase unbalance.

END OF SECTION

Appendix 2

SYMBOL	DESCRIPTION
	CONNECTION POINT TO EQUIPMENT SPECIFIED, FURNISHED AND INSTALLED UNDER OTHER DIVISIONS. RACEWAY, CONDUCTOR AND CONNECTION IN DIVISION 16. COORDINATE FINAL CONNECTION WITH EQUIPMENT SUPPLIER.
1"C,2#12,1#12G 1"C,1–25/C TYPE 1	INDICATES RACEWAY AND CIRCUIT CONDUCTORS. FIRST NUMBER IS RACEWAY SIZE. THE FOLLOWING NUMBERS ARE THE CONDUCTOR QUANTITIES,SIZES, AND TYPES
25MCC1	MAJOR ELECTRICAL COMPONENT OR DEVICE – NAME OR IDENTIFYING SYMBOL AS SHOWN.
	PANELBOARD
UH1 5KW	UNIT HEATER NO.1 SEE SCHEDULE
TTC	TELEPHONE TERMINAL CABINET
	TERMINAL JUNCTION BOX
10	WOUND–ROTOR MOTOR, HORSEPOWER INDICATED
5	MOTOR, SQUIRREL CAGE INDUCTION – HORSEPOWER INDICATED
1/2	DC MOTOR, HORSEPOWER INDICATED
1	LUMINAIRE – SEE SCHEDULE
2	LUMINAIRE – SEE SCHEDULE
3	LUMINAIRE AND POLE – SEE SCHEDULE
4	WALL MOUNTED LUMINAIRE – SEE SCHEDULE
5	FLOOD LIGHTS – AIM IN THE DIRECTION SHOWN
	EXIT LIGHTS – SEE SCHEDULE
	EMERGENCY LIGHTING FIXTURE
S_d or O_S 17 a	SMALL LETTER SUBSCRIPT AT SWITCH AND LUMINAIRE INDICATES SWITCHING. SUBSCRIPT NUMBER AT LUMINAIRE INDICATES CIRCUIT IN PANELBOARD.
5LP1–3	HOME RUN – DESTINATION SHOWN
or #/G	EXPOSED CONDUIT AND CONDUCTORS*
or #/G	CONCEALED CONDUIT AND CONDUCTORS*
	NOTE: * ALL UNMARKED CONDUIT RUNS CONSIST OF TWO NO.12 CONDUCTORS W/GROUND IN CONDUIT. RUNS MARKED WITH CROSSHATCHES INDICATE NUMBER OF NO.12 CONDUCTORS. CROSSHATCH WITH SUBSCRIPT "G" INDICATES GREEN GROUND WIRE. SIZE CONDUIT ACCORDING TO SPECIFICATIONS AND APPLICABLE CODE.
YCX	YCX=YARD CONDUIT NO.
	CONDUIT DOWN, X IS CONDUIT NO.
	CONDUIT UP
	CONDUIT, STUBBED AND CAPPED AS SHOWN
	UNDERGROUND CONDUIT
	EXPOSED CONDUIT
FPL	FP&L SERVICE DUCTBANK
TE	TELEPHONE DUCTBANK
G	GROUND WIRE, 4/0 UNLESS OTHERWISE NOTED
	METERING FACILITIES
CO	CARBON MONOXIDE DETECTOR
VFD	18–PULSE VARIABLE FREQUENCY DRIVE
VFD	6–PULSE VARIABLE FREQUENCY DRIVE
	FIRE ALARM SMOKE DETECTOR
#	CONCRETE MANHOLE

SYMBOL	DESCRIPTION
	GROUND ROD
S	WALL SWITCH: 2– DOUBLE POLE P– PILOT LIGHT 3– THREE WAY K– KEY OPERATED 4– FOUR WAY D– DIMMER WP–WEATHERPROOF CRE–CORROSION RESISTANT EP– NEMA 7, EXPLOSION PROOF
S M	MANUAL MOTOR STARTER SWITCH
	CONVENIENCE RECEPTACLE – DUPLEX UNLESS SPECIFIED OTHERWISE WP–WEATHERPROOF C– CLOCK HANGER TL–TWIST LOCK CRE–CORROSION RESISTANT
	CONVENIENCE RECEPTACLE – QUADRUPLEX UNLESS SPECIFIED OTHERWISE WP–WEATHERPROOF C– CLOCK HANGER TL–TWIST LOCK CRE–CORROSION RESISTANT
	CONVENIENCE RECEPTACLE – DUPLEX UNLESS SPECIFIED OTHERWISE – FLUSH IN FLOOR
	CONVENIENCE RECEPTACLE, PEDESTAL OR ABOVE COUNTER DUPLEX, UNLESS INDICATED OTHERWISE
	MULTI–OUTLET ASSEMBLY RECEPTACLES
30	RECEPTACLE, SPECIAL PURPOSE – AMPERAGE AS INDICATED
	TELEPHONE/DATA RECEPTACLE (OUTLET BOX ONLY) WITH 1" CONDUIT TO TELEPHONE TERMINAL CABINET (TTC)
	TELEPHONE/DATA RECEPTACLE (FLUSH IN FLOOR OUTLET BOX ONLY) WITH 1" CONDUIT TO TELEPHONE TERMINAL CABINET (TTC)
	TELEPHONE RECEPTACLE (OUTLET BOX 48" AFF ONLY) WITH 3/4" CONDUIT TO TELEPHONE TERMINAL CABINET (TTC)
TV	COAXIAL CABLE RECEPTACLE (OUTLET BOX INSTALLED 18" AFF ONLY) WITH 1" CONDUIT TO TELEPHONE TERMINAL CABINET (TTC)
J	GENERAL CONTROL OR WIRING DEVICE. NEMA 4X ENCLOSURE UNLESS INDICATED OTHERWISE. LETTER SYMBOLS OR ABBREVIATIONS INDICATE TYPE OF DEVICE.
30	NONFUSED DISCONNECT SWITCH, SIZE INDICATED, 3 POLE UNLESS INDICATED OTHERWISE, NEMA 1 ENCLOSURE, 4X = WEATHERPROOF (NEMA 4X)
60/40 F	FUSED DISCONNECT SWITCH, SIZE INDICATED (60/40, 60 = SWITCH RATING: 40 = FUSE RATING) 3 POLE UNLESS INDICATED OTHERWISE, NEMA 1 ENCLOSURE, 4X = WEATHERPROOF (NEMA 4X)
2	STARTER MAGNETIC NEMA SIZE INDICATED, NEMA 1 ENCLOSURE, UNLESS INDICATED OTHERWISE. SEE CONTROL DIAGRAM.
2	COMBINATION (FUSE OR CIRCUIT BREAKER AS INDICATED). MAGNETIC STARTER, NEMA SIZE INDICATED, NEMA 1 ENCLOSURE UNLESS INDICATED OTHERWISE. SEE CONTROL SCHEMATIC DIAGRAM.
1	CONTACT – NORMALLY OPEN WITH NEMA SIZE INDICATED OR COIL IDENTIFICATION AS APPLICABLE
1	CONTACT – NORMALLY CLOSED WITH NEMA SIZE INDICATED OR COIL IDENTIFICATION AS APPLICABLE
	OVERLOAD RELAY HEATER
1	MAGNETIC STARTER WITH NEMA SIZE INDICATED
100/M	CIRCUIT BREAKER, MAGNETIC, TRIP SHOWN, 3 POLE UNLESS INDICATED OTHERWISE
400	CIRCUIT BREAKER, THERMAL MAGNETIC TRIP SHOWN, 3 POLE UNLESS INDICATED OTHERWISE.
400 400	CIRCUIT BREAKER WITH CURRENT LIMITING FUSES, TRIP AND FUSE RATING INDICATED, 3 POLE UNLESS INDICATED OTHERWISE.
400 225	FUSED SWITCH, SWITCH AND FUSE CURRENT RATING INDICATED, 3 POLE UNLESS INDICATED OTHERWISE.
100	SWITCH – CURRENT RATING INDICATED, 3 POLE UNLESS INDICATED OTHERWISE. 4X = WEATHERPROOF (NEMA 4X)
XXX YYY	DRAWOUT CIRCUIT BREAKER, LOW VOLTAGE, XXX = TRIP RATING RATING, YYY = FRAME
	DRAWOUT CIRCUIT BREAKER, MEDIUM VOLTAGE
	DRAWOUT FUSED SWITCH, MEDIUM VOLTAGE
	LIGHTNING ARRESTER

NOTE:

THIS IS A STANDARD LEGEND SHEET. SOME SYMBOLS OR ABBREVIATIONS MAY APPEAR ON THIS SHEET AND NOT BE UTILIZED ON PROJECT.

SYMBOL	DESCRIPTION
	FUSE
	CAPACITOR OR SURGE CAPACITOR
SW V 0–600V	METER WITH SWITCH – SCALE RANGE SHOWN
	GROUND
120V or	TRANSFORMER, VOLTAGES, PHASE AND RATING INDICATED AS APPLICABLE 120/240V 15 KVA 1 PH
GFR	GROUND FAULT RELAY WITH C.T.
	PUSH–BUTTON SWITCH, MOMENTARY CONTACT, NORMALLY OPEN
	PUSH–BUTTON SWITCH, MOMENTARY CONTACT, NORMALLY CLOSED
	PUSH BUTTON SWITCH, MAINTAINED CONTACTS WITH MECHANICAL INTERLOCK
	REMOTE DEVICE
H O A 1 XOO 2 OOX	SELECTOR SWITCH: MAINTAINED CONTACT WITH CONTACT POSITION INDICATED, CHART IDENTIFIES OPERATION

	POSITION		
CKT.	HAND	OFF	AUTO
1	X	O	O
2	O	O	X

X – CLOSED CONTACT
O – OPEN CONTACT

200/5 (3)	CURRENT TRANSFORMER, NUMBER AND RATIO INDICATED
A	PUSH–TO–TEST AND CONNECT, INDICATING LIGHT A – AMBER G – GREEN B – BLUE R – RED C – CLEAR W – WHITE LETTER INDICATES COLOR
XX	PROTECTIVE RELAY XX = 47 PHASE FAILURE/PHASE REVERSE 50 INSTANTANEOUS 51 TIME OVERCURRENT 51GS GROUND FAULT/GROUND SENSOR
KK	KIRK KEY INTERLOCK
SOL	SOLENOID
	ELECTRIC RESISTANCE HEATER
DCR	CONTROL RELAY, 24V DC COIL
L LR U	LATCHING RELAY
CR	120V CONTROL RELAY

TIME DELAY CONTACTS

	NORMALLY OPEN, TIMED OPEN
	NORMALLY OPEN, TIMED CLOSED
	NORMALLY CLOSED, TIMED OPEN
	NORMALLY CLOSED, TIMED CLOSED

LIQUID LEVEL

	OPENS ON RISING LEVEL, CLOSES ON FALLING LEVEL
	CLOSES ON RISING LEVEL, OPENS ON FALLING LEVEL

PRESSURE

	OPENS ON RISING PRESSURE, CLOSES ON FALLING PRESSURE
	CLOSES ON RISING PRESSURE, OPENS ON FALLING PRESSURE

FLOW

	OPENS ON RISING FLOW, CLOSES ON FALLING FLOW

SYMBOL	DESCRIPTION
	CLOSES ON RISING FLOW, OPENS ON FALLING FLOW

TEMPERATURE

	OPENS ON RISING TEMPERATURE, CLOSES ON FALLING TEMPERATURE
	CLOSES ON RISING TEMPERATURE, OPENS ON FALLING TEMPERATURE

LIMIT SWITCH

	HELD OPEN, NORMALLY CLOSED
	NORMALLY CLOSED
	NORMALLY OPEN
	HELD CLOSED, NORMALLY OPEN

LINE WEIGHTS

	PROPOSED
	EXISTING
	DEMOLITION

ABBREVIATIONS

ABBREVIATIONS	DESCRIPTION
4XSS	NEMA 4X 316 STAINLESS STEEL
A	AMMETER, AMPERE, AMBER
AC	ALTERNATING CURRENT
AFF	ABOVE FINISHED FLOOR
AL	ALUMINUM
ALT	ALTERNATE
AM	AUTO–MANUAL
AMS	ALTERNATE MAINTENANCE SWITCH
AS	AMMETER SWITCH,
ATS	AUTOMATIC TRANSFER SWITCH
BRKR	BREAKER
C	CONDUIT, CONTACTOR
CB	CIRCUIT BREAKER
CKT	CIRCUIT
CMP	CENTRAL MONITORING PNL
CPT	CONTROL POWER TRANSFORMER
CR	CONTROL RELAY
CT	CURRENT TRANSFORMER
EHD	ELECTRIC HAND DRYER
EF	EXHAUST FAN
EG	EQUIPMENT GROUND
EMH	ELECTRICAL MAHHOLE
EPB	ELECTRICAL PULL BOX
ETM	ELAPSED TIME METER
DISC	DISCONNECT
DODE	DELAY UPON DE–ENERGIZATION
DOE	DELAY UPON ENERGIZATION
FC	FULLY CLOSED
FDR	FEEDER
FM	FLOW METER
FS	FLOAT SWITCH
FT	FLOW TRANSMITTER
FUT	FUTURE
FVNR	FULL VOLTAGE NON–REVERSING STARTER
G	GREEN, GROUND
GALV	GALVANIZED
GFI	GROUND FAULT INTERRUPTER
GEN	GENERATOR
GFR	GROUND FAULT RELAY
GND	GROUND
GRS	GALVANIZED RIGID STEEL
HH	HANDHOLE
HID	HIGH INTENSITY DISCHARGE
HOA	HAND–OFF–AUTO
HOR	HAND–OFF–REMOTE
IC	INSTANTANEOUS CLOSE
I & C	INSTRUMENTATION AND CONTROL
JB	JUNCTION BOX
K	KEY INTERLOCK
KW	KILOWATT
LA	LIGHTNING ARRESTER
LC	LIGHTING CONTACTOR
LLS	LIQUID LEVEL SWITCH
LS	LIMIT SWITCH
LT FLEX	LIQUID TIGHT FLEX CONDUIT
LTG	LIGHTING
LP	LIGHTING PANEL
LR	LOCAL–REMOTE, LATCHING RELAY
M	MAGNETIC CONTACTOR COIL
MA	MANUAL–AUTO
MANUF	MANUFACTURER
MCC	MOTOR CONTROL CENTER
MCP	MOTOR CIRCUIT PROTECTOR

ABBREVIATIONS	DESCRIPTION
MDS	MAIN SERVICE DISCONNECT SWITCH
MDP	MAIN DISTRIBUTION PANEL
MH	MANHOLE
MIN	MINIMUM
MS	MOTOR STARTER
MTS	MANUAL TRANSFER SWITCH
N	NEUTRAL
NC	NORMALLY CLOSED
NEMA	NATIONAL ELECTRIC MANUFACTURERS ASSOCIATION
NO	NORMALLY OPEN
NP	NAMEPLATE
NTS	NOT TO SCALE
OC	OPEN–CLOSE (D)
OCA	OPEN–CLOSE–AUTO
OCR	OPEN–CLOSE–REMOTE
OL	OVERLOAD RELAY
OO	ON–OFF
OOA	ON–OFF–AUTO
OOR	ON–OFF–REMOTE
OSC	OPEN–STOP–CLOSE
P	POLE
PB	PULL BOX
PE	PHOTOCELL
PH	PHASE
PLC	PROGRAMMABLE LOGIC CONTROLLER
PM	PHASE MONITOR
PNL	PANELBOARD
PR	PAIR
PT	POTENTIAL TRANSFORMER
PVC	POLYVINYL CHLORIDE CONDUIT
QNTY	QUANTITY
RPC	REMOTE POWER CENTER
R	RED
RCPT	RECEPTACLE
R/I	RESISTANCE TO CURRENT CONVERTER
RMS	ROOT MEAN SQUARE
RS	RIGID STEEL CONDUIT
RTU	REMOTE TELEMETRY UNIT
SC	SURGE CAPACITOR
SF	SUPPLY FAN
SMH	SIGNAL MAINTENANCE ACCESS HOLE
SPB	SIGNAL PULL BOX
SS	STAINLESS STEEL, SELECTOR SWITCH
SSRVS	SOLID STATE REDUCED VOLTAGE STARTER
S	SWITCH
SYM	SYMMETRICAL
TC	TIMED CLOSE
TDR	TIME DELAY RELAY
TDAD	TIME DELAY AFTER DE–ENERGIZATION
TDAE	TIME DELAY AFTER ENERGIZATION
TJB	TERMINAL JUNCTION BOX
TO	TIMED OPEN
TR	TRIPLE, TIMING RELAY
TS	THERMAL SWITCH
TSP	TWISTED SHIELDED PAIR
TURB	TURBIDITY
TYP	TYPICAL
UVR	UNDER VOLTAGE RELAY
V	VOLTMETER, VOLT
VFD	VARIABLE FREQUENCY DRIVE
VS	VOLTMETER SWITCH
VSD	VARIABLE SPEED DRIVE
WP	WEATHERPROOF
XFMR	TRANSFORMER

NO	DATE	REVISION	BY	NO	DATE	REVISION	BY

HILLERS ELECTRICAL ENGINEERING, INC.
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WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

ELECTRICAL LEGEND

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022

DATE: JUNE 2020

BID SET

SCALE: NONE

PROJECT No: PP14

SHEET: **E-1**

GENERAL NOTES AND SPECIFICATIONS:

1. THE SCOPE OF WORK SHALL BE AS DESCRIBED IN SPECIFICATIONS AND SHOWN ON THE DRAWINGS.
2. THE CONTRACTOR SHALL PROVIDE ALL MATERIALS AND LABOR TO INSTALL THE ELECTRICAL SYSTEMS AS DESCRIBED IN THE DRAWINGS AND SPECIFICATIONS. ITEMS NOT SHOWN BUT OBVIOUSLY NECESSARY FOR COMPLETION OF THE WORK SHALL BE INCLUDED.
3. THE INSTALLATION SHALL BE IN ACCORDANCE WITH THE 2014 NATIONAL ELECTRICAL CODE (NFPA 70), 2018 NATIONAL ELECTRICAL SAFETY CODE (NFPA 70E), 2018 LIFE SAFETY CODE (NFPA 101), CITY OF PEMBROKE PINES CODES AND 2017 FLORIDA BUILDING CODE WITH BROWARD COUNTY AMENDMENTS.
4. THE CONTRACTOR SHALL OBTAIN ALL NECESSARY PERMITS, INSPECTIONS AND APPROVALS AND TO INCLUDE ALL FEES AS PART OF THE BID IF NOT OTHERWISE NOTED.
5. THE CONTRACTOR SHALL COORDINATE ALL WORK WITH THE ENGINEER AND OWNER AS PER SPECIFICATION 16010.
6. THE CONTRACTOR SHALL VISIT THE SITE OF THE PROJECT AND BECOME FAMILIAR WITH THE EXISTING CONDITIONS. NO ALLOWANCE WILL BE MADE FOR EXISTING CONDITIONS OR FAILURE OF THE CONTRACTOR TO OBSERVE THEM.
7. ALL EQUIPMENT AND MATERIAL SHALL BE UNUSED AND U.L. LISTED. ALL REFERENCES TO A PARTICULAR MANUFACTURER ARE GIVEN ON AN "APPROVED EQUAL" BASIS.
8. THE CONTRACTOR IS RESPONSIBLE TO TEST ALL SYSTEMS INSTALLED OR MODIFIED UNDER THIS PROJECT AND REPAIR OR REPLACE ALL DEFECTIVE WORK TO THE SATISFACTION OF THE ENGINEER AND OWNER.
9. ALL EQUIPMENT FURNISHED AND INSTALLED BY THE CONTRACTOR SHALL BE GUARANTEED AGAINST DEFECTS IN MATERIAL AND QUALITY FOR A PERIOD OF ONE YEAR FROM DATE OF ACCEPTANCE.
10. ALL CONDUCTORS SHALL BE COPPER. NO ALUMINUM ALLOWED UNLESS SPECIFICALLY INDICATED ON DRAWINGS.
11. SHOP DRAWINGS SHALL BE SUBMITTED FOR ALL ELECTRICAL & CONTROL EQUIPMENT AND MATERIAL.
12. ALL CONTROL PANELS SHALL BE CONSTRUCTED BY A UL 508A APPROVED PANEL VENDOR AND SHALL BEAR A UL 508A LABEL ON THE PANEL.
13. THE DRAWINGS ARE NOT INTENDED TO SHOW THE EXACT LOCATION OF CONDUIT RUNS. THESE ARE TO BE COORDINATED WITH THE OTHER TRADES AND EXISTING CONDITIONS SO THAT CONFLICTS ARE AVOIDED PRIOR TO INSTALLATIONS.
14. ALL LOCATIONS OF EQUIPMENT, PANELS ETC. ARE SHOWN FOR ILLUSTRATION PURPOSES. CONTRACTOR SHALL VERIFY AND COORDINATE EXACT LOCATION AND SIZE WITH ALL SUBCONTRACTORS, EQUIPMENT SUPPLIERS AND EXISTING CONDITIONS PRIOR TO ANY INSTALLATION AND THEN INSTALL AS SUCH WITH CORRESPONDING CONDUIT STUB-UPS.
15. REFER TO OTHER DISCIPLINE DRAWINGS FOR COORDINATION OF ALL DRAWINGS. ANY CONFLICTS SHALL BE BROUGHT TO THE ENGINEER'S ATTENTION AND MOVEMENT OF CONDUITS OR OTHER ELECTRICAL EQUIPMENT SHALL BE ACCOMPLISHED WITHOUT ANY ADDITIONAL COST FOR THE OWNER.
16. LOCATIONS OF HANDHOLES AND IN-GROUND PULL BOXES ARE APPROXIMATE. CONTRACTOR SHALL COORDINATE EXACT LOCATION WITH EXISTING AND/OR NEW PIPING AND/OR NEW AND EXISTING CONDUIT AND ADJUST ACCORDINGLY.
17. NOT ALL CONDUITS SHOWN ON RISER AND ONE-LINE DIAGRAMS ARE SHOWN ON BUILDING LAYOUT. CONTRACTOR SHALL SUPPLY ALL CONDUITS AND WIRE AS SHOWN ON RISER AND ONE-LINE DIAGRAMS IN ADDITION TO THOSE ON PLAN VIEWS.
18. ALL CIRCUITS SHALL BE IDENTIFIED IN JUNCTION BOXES, PULL BOXES, CONTROL PANELS, PANELBOARDS, LIGHTING POLES, CONTROLLERS AND SERVICE POINTS. IDENTIFICATION SHALL MATCH PANELBOARD SCHEDULES.
19. EXPOSED RUNS OF CONDUITS SHALL BE INSTALLED WITH RUNS PARALLEL OR PERPENDICULAR TO WALLS, STRUCTURAL MEMBERS OR INTERSECTIONS OF VERTICAL PLANES AND CEILINGS, WITH RIGHT ANGLE TURNS CONSISTING OF SYMMETRICAL BENDS OR PULL BOXES AS INDICATED ON THE DRAWINGS. BENDS AND OFFSETS SHALL BE AVOIDED WHERE POSSIBLE.
20. INSTRUMENTATION IS LOW VOLTAGE SIGNALS SUCH AS 4-20MA, TELEPHONE COMMUNICATION, FIRE ALARM COMMUNICATION. POWER CONDUIT SHALL ONLY CROSS INSTRUMENTATION CONDUIT PERPENDICULARLY AT RIGHT ANGLES WITH 6" SEPARATION.
21. CONDUCTOR PULLING TENSIONS SHALL NOT EXCEED MANUFACTURER'S RECOMMENDATION. CONTRACTOR SHALL INSTALL PULL BOXES TO MEET MANUFACTURER'S REQUIREMENTS.
22. MINIMUM DISTANCE ALLOWED BETWEEN POWER CONDUITS AND INSTRUMENTATION CONDUITS SHALL BE:

VOLTAGE	DISTANCE
4160V	3 FT
480V	2 FT
120V	1 FT

23. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL CONDUIT AND WIRING INSTALLATION FOR ALL VENDOR PROVIDED EQUIPMENT (PACKAGE SYSTEMS). IF THE SHOP DRAWINGS DIFFER FROM THE DESIGNED FACILITIES, THE CONTRACTOR SHALL REDESIGN THE FACILITIES AND SUBMIT THE REVISED DESIGN FOR THE ENGINEER'S APPROVAL ALONG WITH THE SHOP DRAWINGS. THERE SHALL BE NO ADDITIONAL COST TO THE OWNER FOR THE REDESIGN NOR FOR ANY ADDITIONAL CONDUITS AND WIRING. DURING SUBMITTAL THE CONTRACTOR SHALL VERIFY ALL SUPPLIED BREAKER SIZES FOR ALL PACKAGED SYSTEMS SUCH AS HVAC, EXHAUST FANS, MIXERS, CHEMICAL PUMPS ETC. AND MODIFY ALL BREAKERS IN MCC'S AND PANELBOARDS ACCORDINGLY WITHOUT ANY ADDITIONAL COST TO THE OWNER.
24. ALL EXCAVATIONS FOR CONDUITS, HANDHOLES, AND IN-GROUND PULLBOXES NEAR EXISTING PIPING, CONDUIT AND EQUIPMENT SHALL BE HAND EXCAVATED AND COORDINATED WITH ENGINEER AND OWNER.
25. MINIMUM DEPTH FROM TOP OF DUCTBANKS OR CONDUITS TO FINISHED GRADE SHALL BE 24" UNLESS OTHERWISE NOTED.
26. COLORED WARNING TAPE 6" WIDE SHALL BE INSTALLED 8" BELOW FINISHED GRADE DIRECTLY ABOVE ALL UNDERGROUND YARD CONDUITS ACCORDING TO THE FOLLOWING SCHEDULE:

    POWER: RED
    ALL OTHER CONDUITS: GREEN

27. CONTRACTOR SHALL RESTORE SIDEWALKS, ROADWAYS, SOD AND SPRINKLER SYSTEM PIPING TO MATCH EXISTING, AFTER THE COMPLETION OF THE CONDUIT AND PULLBOX INSTALLATION.
28. GROUNDING SHALL BE INSTALLED IN ACCORDANCE WITH NEC, ARTICLE 250. THE GROUNDING SYSTEM TEST SHALL NOT EXCEED A 48 HOUR SPAN DRY RESISTANCE OF 10 OHMS. ADDITIONAL GROUNDING TO MEET THIS REQUIREMENT SHALL BE INSTALLED AT NO EXTRA COST TO THE OWNER. GROUNDING AND BONDING CONNECTIONS SHALL NOT BE PAINTED. ALL GROUNDING CONNECTIONS SHALL BE EXOTHERMIC UNLESS SPECIFICALLY INDICATED OTHERWISE.
29. AN EQUIPMENT GROUND WIRE SIZED PER NEC SHALL BE PULLED IN ALL ELECTRICAL CONDUITS, POWER AND CONTROL, WHETHER OR NOT INDICATED ON THE PLANS.
30. ALL ENCLOSURES, TJB, WIREWAY, PULL BOXES ETC. SHALL CONTAIN A GROUNDING BUS. CONNECT ALL RACEWAY BONDS TO THIS BUS VIA GROUNDING BUSHING AND EXTEND BONDING JUMPER FROM THIS BUS TO THE ENCLOSURE.
31. PRIMARY BUILDING GROUNDING SHALL BE AN EMBEDDED GRID OF MINIMUM #4/0 AWG BARE TINNED COPPER WIRE INSTALLED IN THE FOUNDATION AND AROUND THE BUILDING PERIMETER TO FORM A COMPLETE LOOP. SECONDARY GROUND CONNECTIONS TO ALL METAL EQUIPMENT, HAND RAILS, STRUCTURAL STEEL, CONCRETE PADS, REBAR ETC. SHALL HAVE A MINIMUM #4 STRANDED BARE TINNED COPPER CONDUCTOR BONDED USING APPROVED LUGS OR EXOTHERMIC CONNECTIONS. ALL EQUIPMENT GROUNDING CONDUCTORS PENETRATING CONCRETE SLABS OR FINISHED GRADE SHALL HAVE A 72" CONDUCTOR PIGTAIL AT EACH LOCATION FOR CONNECTION TO EQUIPMENT.
32. GROUND SURROUNDING YARD FENCE AND ALL YARD LIGHTING FIXTURES WITH MINIMUM #4 STRANDED BARE TINNED COPPER CONDUCTORS BELOW GRADE TO SITE GROUNDING GRID PER NFPA 54/70.
33. ALL CONCRETE ENCASED DUCTBANKS SHALL CARRY A MINIMUM #4/0 AWG BARE TINNED COPPER GROUND WIRE, OVER THE ENTIRE LENGTH, WHICH SHALL BE CONNECTED TO THE SITE GROUNDING GRID AND GROUND RODS LOCATED CONNECTING HANDHOLES OR IN-GROUND PULL BOXES.
34. CONTRACTOR SHALL CORE DRILL EXISTING CONCRETE WALLS, FLOORS, HANDHOLES AND IN-GROUND PULL BOXES FOR CONDUIT PENETRATIONS. SEAL PENETRATIONS WITH NON-SHRINK GROUT OR APPROPRIATE FIRE RATED DEVICES WHERE APPLICABLE.
35. ALL CONDUITS PENETRATING RATED FIRE WALLS OR RATED FIRE FLOORS SHALL BE INSTALLED WITH U.L. APPROVED DEVICES TO MAINTAIN THE FIRE RATING OF THE WALL OR FLOOR PENETRATED.
36. PROVIDE CONDUIT DUCT SEAL AT ALL CONDUIT ENDS.
37. ALL SPARE CONDUITS SHALL BE SEALED WITH A CAP AT BOTH ENDS AND A PULL STRING INSTALLED WITH IDENTIFICATION ON BOTH ENDS.
38. ALL RECEPTACLES SHALL BE INSTALLED 18" AFF UNLESS OTHERWISE NOTED. LIGHT SWITCHES SHALL BE MOUNTED 48" AFF UNLESS OTHERWISE NOTED.
39. ALL RECEPTACLES WITHIN 6' OF A SINK SHALL BE GFI.
40. FLEXIBLE CONDUITS SHALL BE USED TO TERMINATE ALL MOTORS AND OTHER VIBRATING EQUIPMENT AND SHALL BE BETWEEN 18" AND 3' IN LENGTH.
41. ELECTRICAL PULL BOXES SHALL BE SUPPLIED WITH TRAFFIC-RATED COVER MARKED "ELECTRICAL" OR "SIGNAL", UNLESS OTHERWISE NOTED.
42. TYPEWRITTEN PANEL SCHEDULES SHALL BE INSTALLED IN EACH PANELBOARD, AND TYPEWRITTEN TERMINAL BLOCK SCHEDULES IN EACH CONTROL CABINET.
43. ALL SPD'S SHALL BE INTEGRAL TO THE EQUIPMENT SHOWN AND SUPPLIED AS ONE UNIT AND ONE U.L. ENTITY.
44. AS PART OF THE ELECTRICAL SUBMITTAL, CONTRACTOR SHALL PROVIDE A LAYOUT OF THE ELECTRICAL ROOM SHOWING SIZES OF ALL EQUIPMENT AND THEIR SPATIAL RELATIONSHIPS.
45. ALL MATERIAL IN DESIGNATED CORROSIVE AREAS SHALL BE NEMA 4X STAINLESS STEEL OR NON-METALLIC.
46. CONTRACTOR SHALL BALANCE PANELBOARD LOADS AT THE END OF THE PROJECT AND ADJUST PANELBOARD SCHEDULE ACCORDINGLY.
47. ALL CONDUITS INSTALLED IN CONCRETE SLABS, WALLS, ETC. SHALL HAVE A MINIMUM OF 2" CONCRETE COVER ON ALL SIDES.
48. ALL ENCLOSURES THAT ARE EXTERIOR AND/OR IN NON-AIRCONDITIONED SPACES, SUCH AS PANELBOARDS, DISCONNECT SWITCHES, CONTROL PANELS, JUNCTION BOXES & ETC., SHALL BE NEMA 4X, 316 STAINLESS STEEL UNLESS OTHERWISE NOTED.
49. ALL REFERENCES TO 4X, NEMA 4X, OR NEMA 4X STAINLESS STEEL SHALL BE CONSTRUED AS MEANING NEMA 4X 316 STAINLESS STEEL.
50. CONTRACTOR SHALL PROVIDE TO THE OWNER WITHIN 30 DAYS AFTER THE DATE OF SYSTEM ACCEPTANCE RECORD DRAWINGS DEPICTING THE COMPLETED INSTALLATION AS INSTALLED INCLUDING A SINGLE LINE DIAGRAM OF THE BUILDING ELECTRICAL DISTRIBUTION AND FLOOR PLANS INDICATING THE LOCATION AND AREA SERVED BY ALL INSTALLED DISTRIBUTIONS PER THE FLORIDA BUILDING CODE-ENERGY CONSERVATION C405.6.4.1.
51. CONTRACTOR SHALL PROVIDE TO THE OWNER OPERATING AND MAINTENANCE MANUALS (O&M MANUALS) FOR ALL EQUIPMENT PER THE FLORIDA BUILDING CODE-ENERGY CONSERVATION C405.6.4.2. THE MANUALS SHALL INCLUDE:
    51.1. SUBMITTAL DATA STATING EQUIPMENT RATING AND SELECTED OPTIONS FOR EACH PIECE OF EQUIPMENT REQUIRING MAINTENANCE.
    51.2. O&M MANUALS FOR EACH PIECE OF EQUIPMENT REQUIRING MAINTENANCE.
    51.3. REQUIRED ROUTINE MAINTENANCE ACTIONS SHALL BE CLEARLY IDENTIFIED. NAMES AND ADDRESSES OF AT LEAST ONE QUALIFIED SERVICE AGENCY
52. BRANCH AND FEEDER CONDUCTORS ARE SIZED FOR MAXIMUM VOLTAGE DROP OF 5 PERCENT COMBINED AT DESIGN LOAD PER THE FLORIDA BUILDING CODE -ENERGY CONSERVATION-C405.6.3.
53. CITY HAS FIRST RIGHT TO SALVAGE OF EQUIPMENT/MATERIAL DEMOLISHED/REMOVED UNDER THIS PROJECT. THE CONTRACTOR SHALL DELIVER ALL CITY SALVAGED EQUIPMENT/MATERIAL TO A SITE SPECIFIED BY THE CITY. ANY MATERIAL REFUSED BY THE CITY SHALL BE DISPOSED OF BY THE CONTRACTOR.
54. AS PART OF THE WORK OF THIS CONTRACT THE CONTRACTOR SHALL INVESTIGATE ALL UNDERGROUND DUCTBANKS AND RACEWAYS DESCRIBED IN THE DRAWINGS TO VERIFY CABLE ROUTING FOR REMOVAL AND REPLACEMENT OF CABLES IN EXISTING RACEWAYS. CONTRACTOR SHALL DOCUMENT ANY DEVIATIONS OR MISSING MANHOLES AND PULL BOXES DISCOVERED DURING THE INVESTIGATION.
55. CONTRACTOR SHALL PERFORM UNDERGROUND INVESTIGATIONS (SOFT DIGS, GROUND PENETRATING RADAR, ETC.) IN AREAS OF PROPOSED NEW DUCTBANKS TO IDENTIFY POSSIBLE INTERFERENCES NOT SHOWN ON DRAWINGS.
56. DRAWINGS WERE DEVELOPED FROM AVAILABLE AS-BUILT INFORMATION FURNISHED BY THE OWNER AS BEST INFORMATION AVAILABLE. ENGINEER ASSUMES NO LIABILITY AS TO THE ACCURACY OF FACILITIES THAT ARE NOT READILY OBSERVABLE AND THE CONTRACTOR IS CAUTIONED TO PERFORM ITS OWN INVESTIGATION OF FACILITIES IN AREAS OF THE WORK TO DETERMINE AND AVOID INTERFERENCES TO THE GREATEST EXTENT POSSIBLE.
57. DRAWINGS THAT ILLUSTRATE EXISTING STRUCTURES, PIPING, ELECTRICAL AND EQUIPMENT ARE BASED UPON RECORD DRAWINGS AVAILABLE UPON REQUEST FOR GENERAL INFORMATIONAL PURPOSES ONLY. LOCATION, SIZE, AND ALIGNMENT OF EXISTING FACILITIES HAVE BEEN DETERMINED FROM AVAILABLE RECORDS. THIS INFORMATION IS FURNISHED AS A GUIDE FOR THE CONTRACTOR. THE ENGINEER AND THE OWNER DO NOT GUARANTEE THE ACCURACY OF THIS DATA. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR DETERMINING THE LOCATION AND PROTECTING ALL TYPES OF UTILITIES AND STRUCTURES ENCOUNTERED DURING THE COURSE OF OPERATION ON THIS PROJECT. FIELD OBSERVATIONS INDICATE THAT FIELD CONDITIONS DO NOT FULLY MATCH THE ABOVE REFERENCED RECORD DRAWINGS.
58. THE ELECTRICAL CONTRACTOR SHALL SUBMIT FOR APPROVAL A MINIMUM OF 1/4"=1'-0" SCALED LAYOUT OF EXPOSED CONDUIT ROUTING AND CONDUIT SUPPORTS BEFORE INSTALLATION.
59. CONTRACTOR SHALL MAINTAIN THE OPERATIONS OF THE PLANT AS OUTLINED IN THE CONSTRUCTION CONSTRAINTS OF SPECIFICATION SECTION 16010.

NO	DATE	REVISION	BY	NO	DATE	REVISION	BY

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WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

ELECTRICAL GENERAL NOTES

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022

DATE: JUNE 2020 **BID SET**

SCALE: NONE

PROJECT No: PP14

SHEET: **E-2**

NOTES:

1. ELECTRICAL CONDUIT ROUTING AND MANHOLE LOCATIONS ARE SHOWN FOR SUGGESTED LOCATION AND ILLUSTRATION PURPOSES ONLY. CONTRACTOR SHALL FIELD VERIFY THE CONDUIT ROUTING AND MANHOLE LOCATIONS WITH EXISTING CONDITIONS AND EXISTING PIPING, DRAINAGE, ETC. TO AVOID CONFLICTS AND ADJUST ACCORDINGLY. CONTRACTOR SHALL PERFORM UNDERGROUND INVESTIGATION TO DETERMINE BEST LOCATION FOR MANHOLE AND BEST ROUTE FOR NEW DUCTBANKS. SOME CONDUIT ROUTINGS REQUIRE FIELD DETERMINATION OF THE ROUTINGS TO AVOID CONFLICTS WITH EXISTING CONDITIONS AND IT IS PART OF CONTRACTOR'S RESPONSIBILITY.
2. SAW CUT EXISTING PAVEMENT/SIDEWALK/CURBING, HAND EXCAVATE AND INSTALL NEW CONDUITS AND MANHOLES. INSTALL NEW DUCTBANK AND MANHOLES AS PER DETAILS. RESTORE PAVEMENT/SIDEWALK/CURBING ACCORDINGLY TO MATCH EXISTING. REMOVE AND REPLACE COMPLETE SIDEWALK SECTIONS.
3. CONTRACTOR SHALL UTILIZE EXISTING MANHOLES AS SHOWN.
4. CONTRACTOR SHALL CORE DRILL EXISTING CONCRETE WALLS FOR INSTALLATION OF NEW CONDUITS. SEAL, PATCH AND PAINT TO MATCH EXISTING.
5. REFER TO MANHOLE DETAIL FOR MANHOLE DIMENSIONS AND REQUIREMENTS.
6. DUCTBANK GROUND WIRE SHALL BE CONNECTED TO ALL MANHOLE GROUND RODS. DUCTBANK GROUND WIRE SHALL BE CONNECTED TO THE EXISTING GROUNDING RING/ROD OF A BUILDING. IF THE EXISTING GROUNDING RING/ROD CANNOT BE LOCATED, PROVIDE AND INSTALL A NEW GROUND ROD AND CONNECT DUCTBANK GROUNDING WIRE ACCORDINGLY.
7. REFER TO SPECIFICATION 16010 SECTION 1.05 FOR CONSTRUCTION CONSTRAINTS, TEMPORARY POWER REQUIREMENTS AND SUGGESTED CONSTRUCTION SEQUENCE.
8. LOCATION OF FP&L UNDERGROUND IS APPROXIMATE, COORDINATE WITH FP&L FOR EXACT LOCATIONS.

CALL 48 HOURS BEFORE YOU DIG
IT'S THE LAW! DIAL 811
811 Know what's below. Call before you dig.
SUNSHINE STATE ONE CALL OF FLORIDA, INC.

1"=30'-0"

30 15 0 30'

NEUTRALIZER BUILDING
LIFT STATION
WEST SURGE TANK
APPROXIMATE LOCATION OF EXIST PANEL PP1
WEST TRANSFER PUMP STATION
APPROXIMATE LOCATION OF EXIST MCC-7
HEADWORKS BUILDING
WWTU NO.5
WWTU NO.4
WWTU NO.3
WWTU NO.1
WWTU NO.2
FUEL TANK
ODOR CONTROL SYSTEM
SLUDGE TANK
SLUDGE BUILDING
CONTROL BUILDING
WEST MAIN ELECTRICAL BUILDING, REFER TO SHEET E-9
WEST BLOWER ROOM
APPROXIMATE LOCATIONS OF EXIST PANELS MDP-1 AND MDP-2
APPROXIMATE LOCATIONS OF EXIST PANELS PP1 AND LP1
APPROXIMATE LOCATION OF EXIST MCC-5 (ON SECOND FLOOR)
APPROXIMATE LOCATION OF EXIST PANEL H
EAST SURGE TANK
EAST TRANSFER PUMP STATION
APPROXIMATE LOCATION OF EXIST PANEL PDP
EAST MAIN ELEC. BLDG, REFER TO SHEET E-8
EAST BLOWER ROOM
EXIST MANHOLE EJB#11
APPROXIMATE LOCATIONS OF EXIST PANELS MDP-1 AND MDP-2
SAW CUT EXISTING SIDEWALK AND RESTORE.
HYDO-PNEUMATIC SYSTEM
NEW EXPOSED CONDUITS BETWEEN BUILDING WALLS WITH EXPANSION FITTINGS AND UNISTRUT SUPPORT.
EPS ELEC. BLDG, REFER TO SHEETS E-4 & E-5
EPS PUMP BLDG, REFER TO SHEETS E-6 & E-7
OLD EPS
OLD CONTROL BUILDING
EFFLUENT STORAGE
CHLORINE BUILDING
OLD HYDO-PNEUMATIC SYSTEM
METER VAULT
DEEP INJECTION WELL NO.1
DEEP INJECTION WELL NO.2
NEW MANHOLE MV-MH-1
NEW MANHOLE MV-MH-2
APPROXIMATE LOCATION OF EXIST MCC-2
NEW PAD MOUNTED TRANSFORMER MV-T-1
NEW PAD MOUNTED TRANSFORMER MV-T-2
FRONT
REFER TO NOTE 2, TYPICAL
REFER TO NOTE 8
PEMBROKE ROAD
SOUTH LINE OF CITY LIMITS OF PEMBROKE PINES
LAKE

7	11
E-15	E-15

19	20
E-16	E-16

5	8	11
E-15	E-15	E-15

26
E-17

YC001 YC002 YC003 YC004 YC005 YC006

NO	DATE	REVISION	BY	NO	DATE	REVISION	BY

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WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

ELECTRICAL SITE PLAN

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022

DATE: JUNE 2020

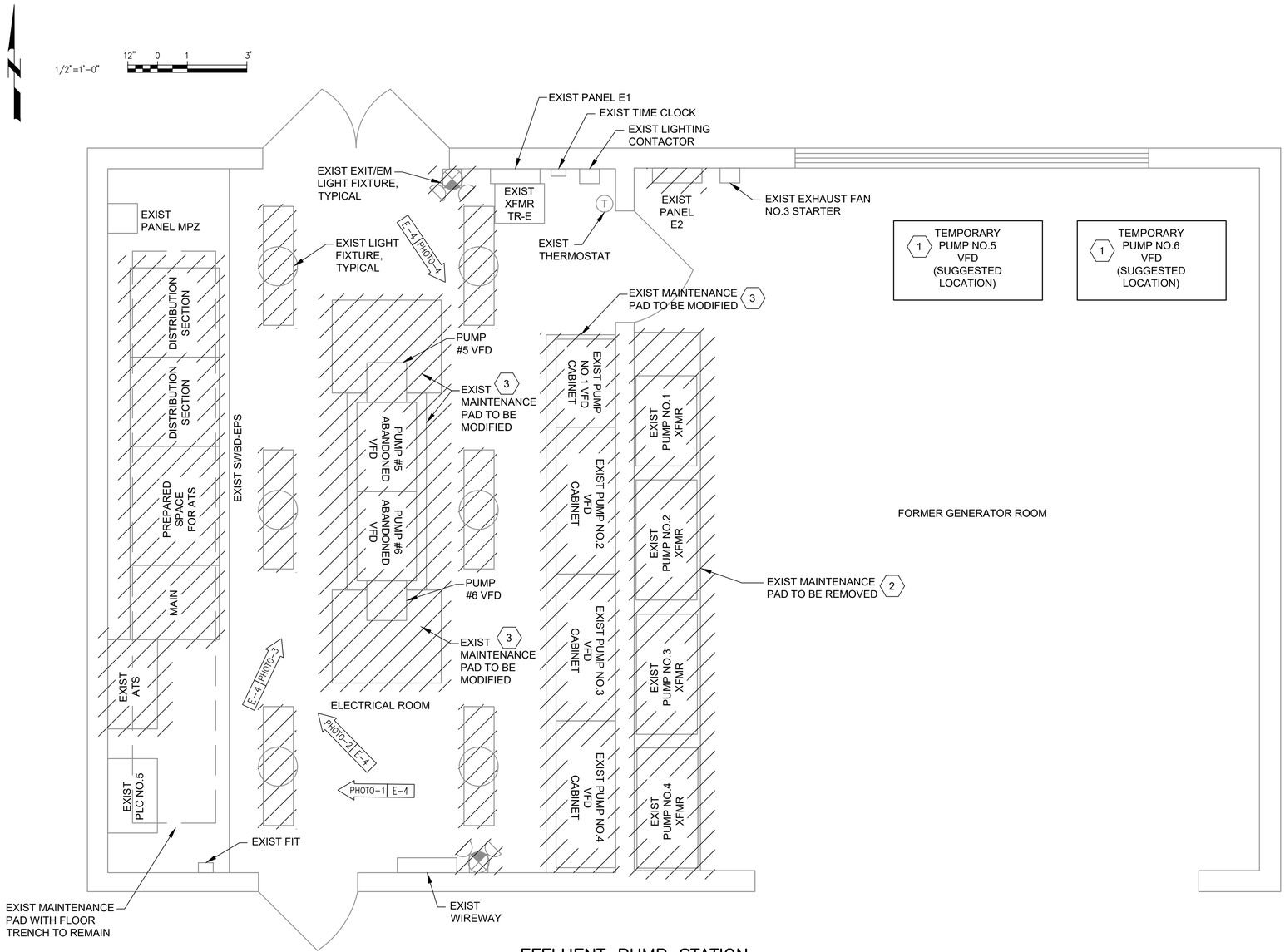
BID SET

SCALE: AS NOTED

PROJECT No: PP14

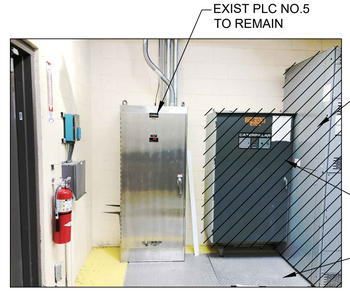
SHEET: **E-3**

File Name: E:\PROJECTS\PP\PP14\dwg\PP14E03.dwg - (Plotted by: Channess, Steve on Monday, June 01, 2020 9:25:33 AM)



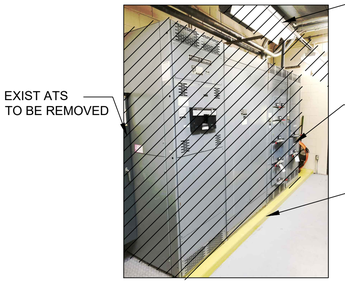
EFFLUENT PUMP STATION ELECTRICAL ROOM – DEMOLITION PLAN

SCALE: 1/2" = 1'-0"



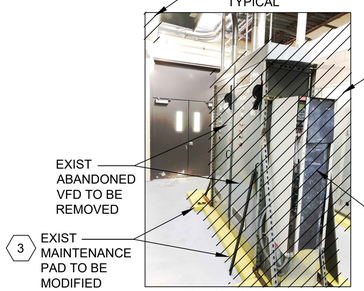
PHOTO–1 (PLC NO.5 AND ATS)

SCALE: NOT TO SCALE



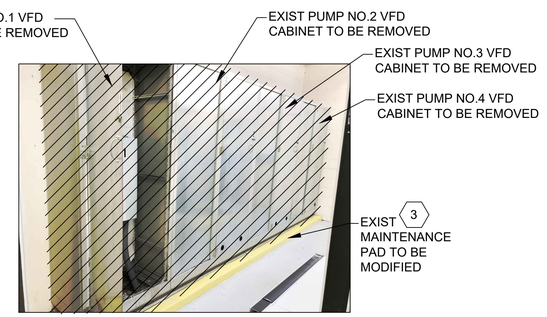
PHOTO–2 (SWBD–EPS)

SCALE: NOT TO SCALE



PHOTO–3 (VFD NO.5 & 6)

SCALE: NOT TO SCALE



PHOTO–4 (PUMP NO.1–4 VFD CABINETS)

SCALE: NOT TO SCALE

KEYED NOTES:

1. CONTRACTOR SHALL PROVIDE AND INSTALL A NEW PUMP NO. 5 VFD AND NEW PUMP NO. 6 VFD TO TEMPORARY OPERATE THE PUMPS NO. 5 & 6 DURING CONSTRUCTION, REFER TO SHEETS E-11 AND E-13 FOR TEMPORARY CONDUIT AND CONDUCTOR REQUIREMENTS.
2. CONTRACTOR SHALL SAWCUT/CHIP OUT AND REMOVE THE EXISTING CONCRETE MAINTENANCE PAD FOR PUMP ISOLATION TRANSFORMERS. GRIND SMOOTH THE AREA AND PAINT FLOOR TO MATCH EXISTING. PAINT SHALL BE A SERIES 287 ENVIRO-POX SEMIGLOSS, COORDINATE WITH OWNER FOR PAINT COLOR.
3. CONTRACTOR SHALL SAWCUT/CHIP OUT AND MODIFY EXISTING CONCRETE MAINTENANCE PAD FOR NEW EQUIPMENT IN ELECTRICAL ROOM. IN AREAS TO BE REMOVED, GRIND SMOOTH AND PAINT FLOOR TO MATCH EXISTING. PAINT SHALL BE A SERIES 287 ENVIRO-POX SEMIGLOSS, COORDINATE WITH OWNER FOR PAINT COLOR.

NOTES:

1. REFER TO SPECIFICATION 16010 SECTION 1.05 FOR CONSTRUCTION CONSTRAINTS AND SUGGESTED CONSTRUCTION SEQUENCE.
2. EXISTING LIGHT FIXTURES, EMERGENCY LIGHTS, SWITCHES, ETC. AND ASSOCIATED CONDUITS/WIRES SHALL BE REMOVED. PROVIDE AND INSTALL NEW LIGHTING SYSTEM COMPLETE IN PLACE AS SHOWN ON OTHER DRAWINGS AND AS DESCRIBES IN SPECIFICATIONS.

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WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

EFFLUENT PUMP STATION ELECTRICAL BUILDING - DEMOLITION PLAN

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022

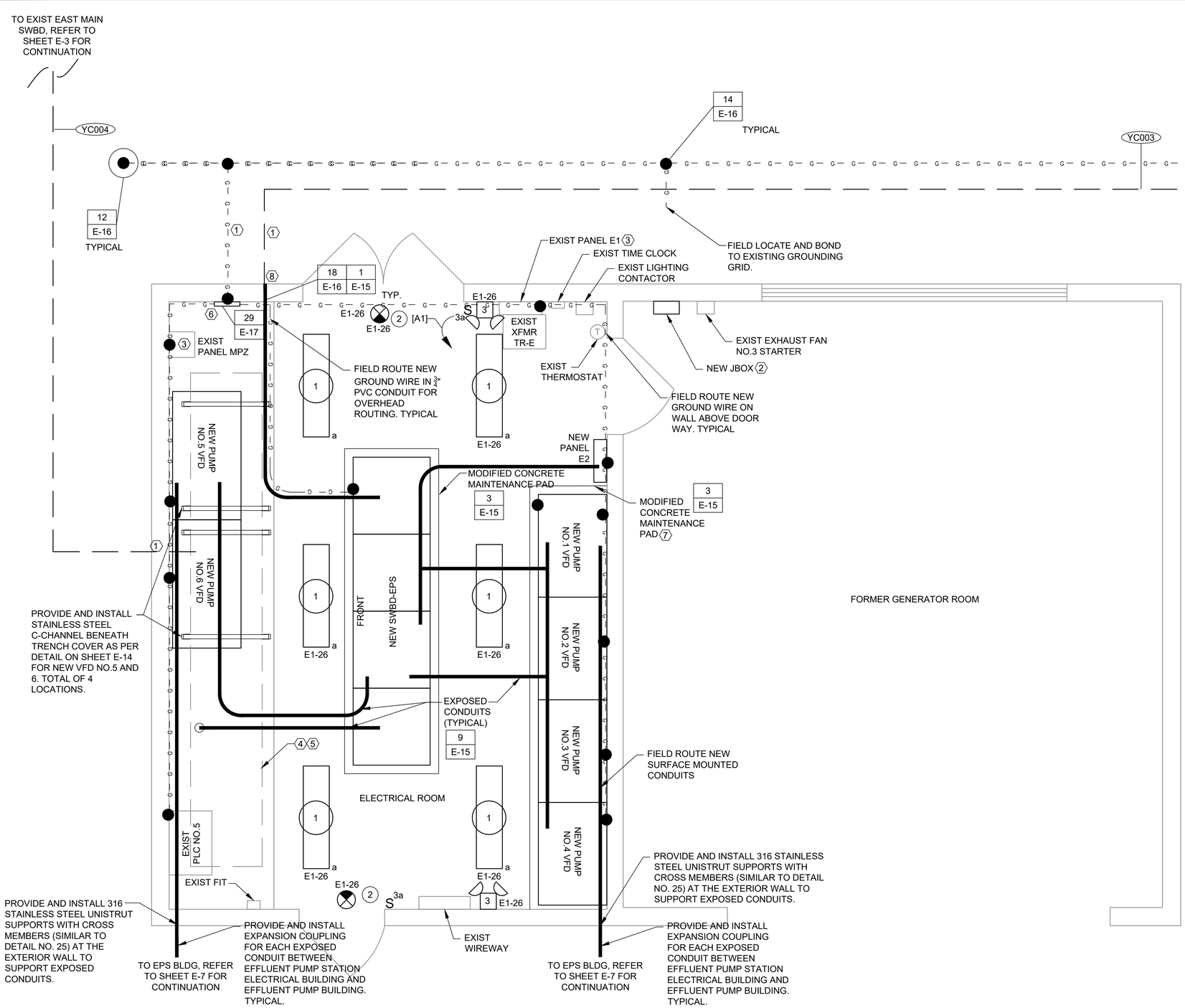
DATE: JUNE 2020

BID SET

SCALE: AS NOTED

PROJECT No: PP14

SHEET: **E-4**



EFFLUENT PUMP STATION ELECTRICAL BUILDING MODIFICATION PLAN

SCALE: 1/2" = 1'-0"

CIRCUIT LEGEND

[A1] = 3#12, 1#12G, 3/4"C

ABBREVIATIONS

E1-# = PANEL E1-CKT#

NOTES:

1. DUCTBANK GROUNDING WIRE/CONDUCTOR SHALL BE CONNECTED TO THE GROUNDING GRID AND TO ALL MANHOLE GROUND RODS.
2. COMBINING OF NEUTRAL CONDUCTORS SHALL NOT BE ALLOWED. ALL CONDUCTORS LEAVING A CIRCUIT BREAKER IN A PANELBOARD SHALL CARRY A SEPARATE NEUTRAL CONDUCTOR IDENTICAL IN SIZE. LIGHTING CIRCUIT ROUTING IS NOT SHOWN ON PLAN VIEW FOR CLARITY.
3. BEFORE INSTALLATION, COORDINATE LOCATION OF FIXTURES AND DEVICES WITH ALL DISCIPLINES, INCLUDING PIPING, OVERHEAD CRANES, HVAC EQUIPMENT AND DUCT, TO AVOID CONFLICTS AND MOVE FIXTURES AND DEVICES IF NECESSARY AFTER APPROVAL FROM ENGINEER.
4. SOME CONDUIT/CABLES NOT SHOWN ON FACILITY PLAN FOR CLARITY. PROVIDE COMPLETE WORKING LIGHTING, RECEPTACLE, ETC. SYSTEM. PROVIDE MINIMUM 3/4"C, 2#12, 1#12G.
5. REFER SPECIFICATION 16010 SECTION 1.05 FOR CONSTRUCTION CONSTRAINTS AND SUGGESTED CONSTRUCTION SEQUENCE.

KEYED NOTES:

1. CONTRACTOR SHALL SAW CUT AND REMOVE THE EXISTING SIDEWALK, HAND EXCAVATE AND CORE DRILL THE EXISTING CONCRETE WALL AND PROVIDE AND INSTALL NEW CONDUIT AND CONDUCTOR SYSTEMS AND GROUNDING SYSTEMS. RESTORE SIDEWALK.
2. CONTRACTOR SHALL INTERCEPT THE EXISTING CONDUIT AND CONDUCTOR SYSTEMS AND PROVIDE AND INSTALL A NEW JUNCTION BOX. PROVIDE AND INSTALL NEW SPLICE KITS AND EXTEND THE EXISTING CIRCUITS TO THE NEW PANEL E2 AS SHOWN IN RISER DIAGRAM.
3. CONTRACTOR SHALL INVESTIGATE, TRACE OUT AND AS-BUILT EACH CIRCUIT POWERED FROM PANEL AND PROVIDE AND INSTALL NEW PANEL SCHEDULE.
4. CONTRACTOR SHALL MODIFY THE EXISTING FLOOR TRENCH WITH CONCRETE TO SLOPE WATER TOWARDS SOUTH END OF THE TRENCH AND PROVIDE AND INSTALL NEW FLOW SWITCH "HIGH LEVEL". COORDINATE WITH ENGINEER AND FIELD LOCATE FLOAT SWITCH DURING CONSTRUCTION. SEAL ALL CONDUITS WITH DUCT SEAL. PROVIDE AND INSTALL NEW TRENCH COVER PLATES WITH SUPPORTS IN ALL EXPOSED AREAS. TRENCH DIRECTLY UNDER VFDS AND PLC SHALL REMAIN OPEN TO BOTTOM WITH NO PLATE. ALL COVER PLATES SHALL BE REMOVABLE FOR EASE OF ACCESS. PROVIDE REMOVABLE PLATE FOR ACCESS AT SOUTH END FOR ACCESS BY A PORTABLE SUMP PUMP.
5. CONTRACTOR SHALL ROUTE POWER CONDUCTORS WITHIN FLOOR TRENCH ON OPPOSITE WALLS AS EXISTING INSTRUMENTATION/CONTROL CABLES. MAINTAIN SEPARATION BETWEEN POWER AND INSTRUMENTATION/CONTROL CONDUCTORS/CABLES TO THE GREATEST EXTENT POSSIBLE, REFER TO SHEET E-2 NOTE 20.
6. CONTRACTOR SHALL PROVIDE AND INSTALL A NEW GROUND BUS BAR. PROVIDE AND INSTALL NEW #4 AWG BARE TINNED COPPER GROUND WIRE TO ALL VFDS, PANELS, MANUAL TRANSFER SWITCHES, SWITCHBOARDS, TRANSFORMERS, AND PLC CABINETS. PROVIDE AND INSTALL NEW GROUND LUGS AS NECESSARY FOR A COMPLETE GROUNDING SYSTEM IN PLACE.
7. CONTRACTOR SHALL MODIFY/EXTEND THE EXISTING CONCRETE EQUIPMENT PAD AS REQUIRED FOR NEW EQUIPMENT.
8. CONTRACTOR SHALL PROVIDE AND INSTALL OLB (CONDUIT OUTLET BODY FOR EACH CONDUIT) FOR WIRE PULLING AS NEEDED.

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WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

EFFLUENT PUMP STATION ELECTRICAL BUILDIG - MODIFICATION PLAN

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022

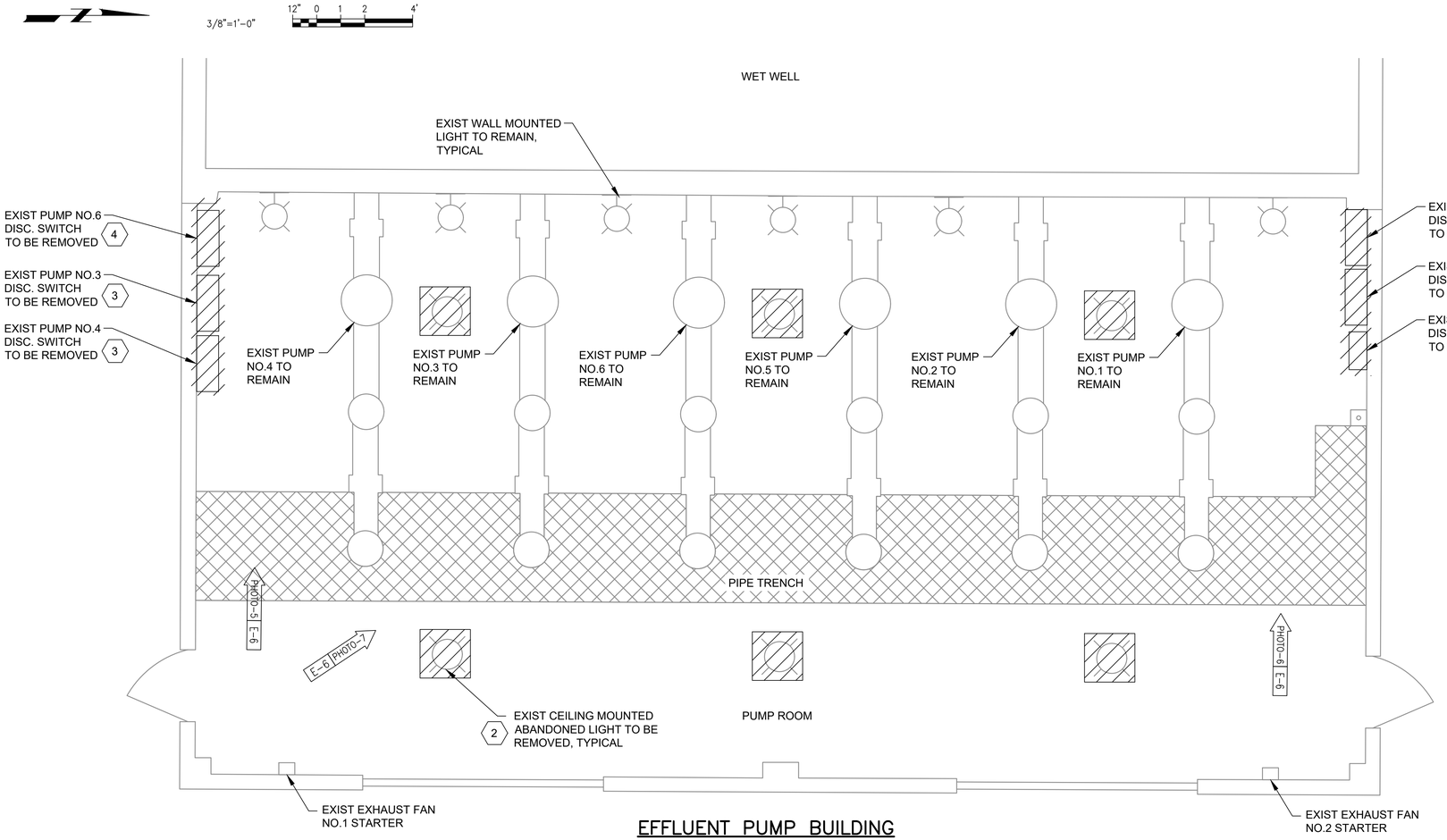
DATE: JUNE 2020

BID SET

SCALE: AS NOTED

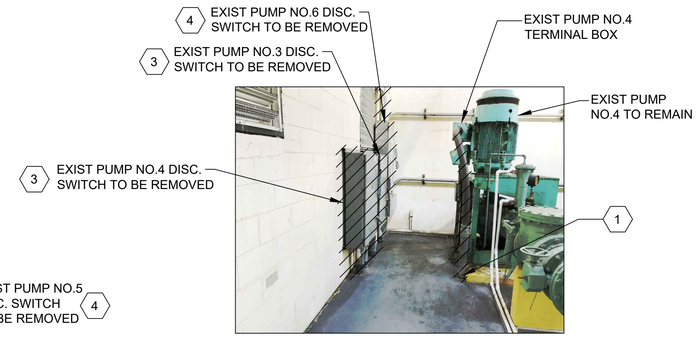
PROJECT No: PP14

SHEET: E-5



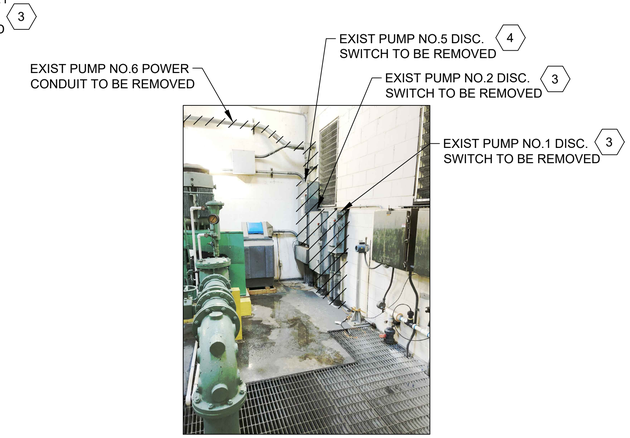
EFFLUENT PUMP BUILDING DEMOLITION PLAN

SCALE: 3/8" = 1'-0"



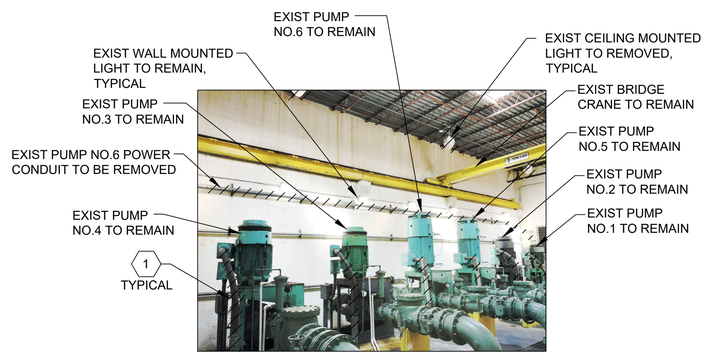
PHOTO–5
(PUMP NO.4 AND SOUTH WALL DISC. SWITCHES)

SCALE: NOT TO SCALE



PHOTO–6
(PUMP NO.1 AND NORTH WALL DISC. SWITCHES)

SCALE: NOT TO SCALE



PHOTO–7
(WEST WALL AND PUMPS 1 THRU 6)

SCALE: NOT TO SCALE

KEYED NOTES:

1. CONTRACTOR SHALL DISCONNECT AND REMOVE THE EXISTING POWER CONDUCTORS AND CUT AND CAP CONDUIT FLUSH WITH MAINTENANCE PAD. TYPICAL FOR PUMPS 1, 2, 3, 4 ,5 AND 6.
2. CONTRACTOR SHALL REMOVE AND DISPOSE OF THE EXISTING LIGHT FIXTURES AND PROVIDE AND INSTALL COVER PLATE FOR EXISTING CEILING MOUNTED LIGHTING JUNCTION BOXES. EXISTING CONDUCTORS SHALL REMAIN AND BE MODIFIED TO MAINTAIN THE EXISTING LIGHTING CIRCUIT(S) IN OPERATION.
3. CONTRACTOR SHALL DISCONNECT AND REMOVE THE EXISTING DISCONNECT SWITCH AND CUT AND CAP POWER CONDUIT 4" ABOVE FINISHED FLOOR. TYPICAL FOR PUMP DISCONNECT SWITCHES 1, 2, 3 AND 4.
4. CONTRACTOR SHALL DISCONNECT AND REMOVE THE EXISTING DISCONNECT SWITCH, REMOVE POWER CONDUIT BETWEEN EXISTING WIREWAY AND SEAL CONDUIT OPENINGS IN WIREWAY. TYPICAL FOR PUMP DISCONNECT SWITCHES 5 AND 6.

NOTES:

1. REFER TO SPECIFICATION 16010 SECTION 1.05 FOR CONSTRUCTION CONSTRAINTS AND SUGGESTED CONSTRUCTION SEQUENCE.

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WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

EFFLUENT PUMP STATION PUMP BUILDING DEMOLITION PLAN

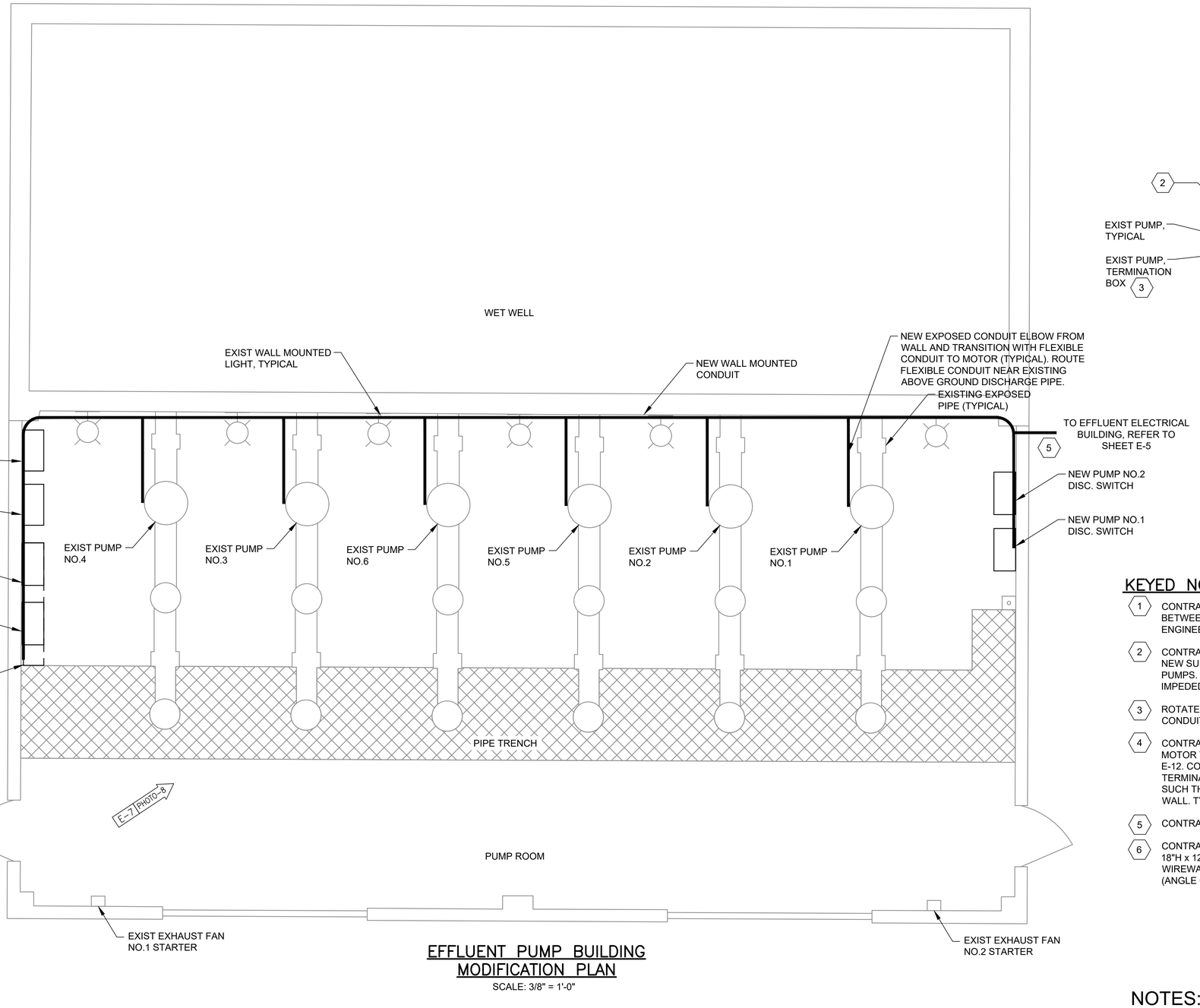
PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022
DATE: JUNE 2020

BID SET

SCALE: AS NOTED
PROJECT No: PP14
SHEET: E-6

3/8"=1'-0"

12" 0 1 2 4'



EFFLUENT PUMP BUILDING MODIFICATION PLAN

SCALE: 3/8" = 1'-0"

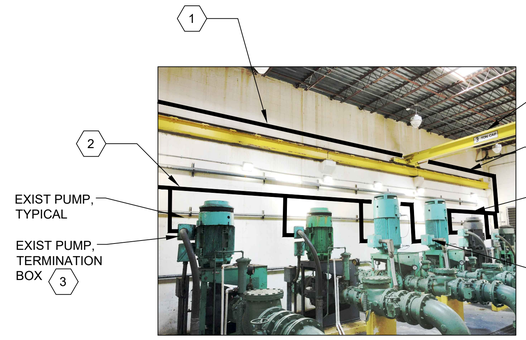


PHOTO-8 (WEST WALL)

SCALE: NOT TO SCALE

NEMA 4X 316 STAINLESS STEEL WIREWAY MINIMUM 18" H X 12" D X 120" L BELOW DISCONNECTS FOR ROUTING LOAD WIRES TO DISCONNECTS

KEYED NOTES:

1. CONTRACTOR SHALL FIELD ROUTE EXPOSED CONDUITS ABOVE BRIDGE CRANE SUPPORTS ON WALL BETWEEN VFDS AND PUMP NO. 3, 4, 5 AND 6 DISCONNECT SWITCHES. COORDINATE WITH OWNER AND ENGINEER PRIOR TO CONSTRUCTION. CONDUITS SHALL NOT IMPEDED BRIDGE CRANE OPERATION.
2. CONTRACTOR SHALL ROUTE CONDUITS BELOW BRIDGE CRANE SUPPORTS AND LIGHT FIXTURES FOR NEW SURFACE MOUNTED CONDUIT BETWEEN PUMP NO. 3, 4, 5 AND 6 DISCONNECT SWITCHES AND PUMPS. COORDINATE WITH OWNER AND ENGINEER PRIOR TO CONSTRUCTION. CONDUITS SHALL NOT IMPEDED BRIDGE CRANE OPERATION.
3. ROTATE EXISTING MOTOR TERMINATION BOX SUCH THAT CONDUIT OPENING ALIGNS WITH THE NEW CONDUIT ROUTING ALONG WEST PUMP STATION WALL. TYPICAL FOR PUMPS 1, 2, 3 AND 4.
4. CONTRACTOR SHALL REMOVE THE EXISTING MOTOR TERMINATION BOX AND PROVIDE AND INSTALL NEW MOTOR TERMINATION BOX WITH TWO CONDUIT OPENINGS AS PER THE CONDUIT SIZE SHOWN ON SHEET E-12. COORDINATE WITH THE EXISTING MOTOR MANUFACTURER, U.S. MOTORS, FOR THE NEW TERMINATION BOX FOR THE EXISTING MOTOR FRAME 449VP. ROTATE NEW MOTOR TERMINATION BOX SUCH THAT CONDUIT OPENINGS ALIGN WITH THE NEW CONDUIT ROUTING ALONG WEST PUMP STATION WALL. TYPICAL FOR PUMPS 5 AND 6.
5. CONTRACTOR SHALL PROVIDE EXPANSION COUPLINGS FOR CONDUITS ROUTED BETWEEN BUILDINGS.
6. CONTRACTOR SHALL PROVIDE AND INSTALL NEW NEMA 4X 316 STAINLESS STEEL WIREWAY MINIMUM 18"H x 12"D x 72" L BELOW NEW DISCONNECTS FOR ROUTING LOAD WIRES TO DISCONNECTS. UPSIZE WIREWAY IF NEEDED AS PER NEC REQUIREMENTS AND ACTUAL CONDUIT ENTRY/EXIT CONFIGURATION (ANGLE OR U PULL).

NOTES:

1. REFER SPECIFICATION 16010 SECTION 1.05 FOR CONSTRUCTION CONSTRAINTS AND SUGGESTED CONSTRUCTION SEQUENCE.

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WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

EFFLUENT PUMP STATION PUMP BUILDING MODIFICATION PLAN

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022

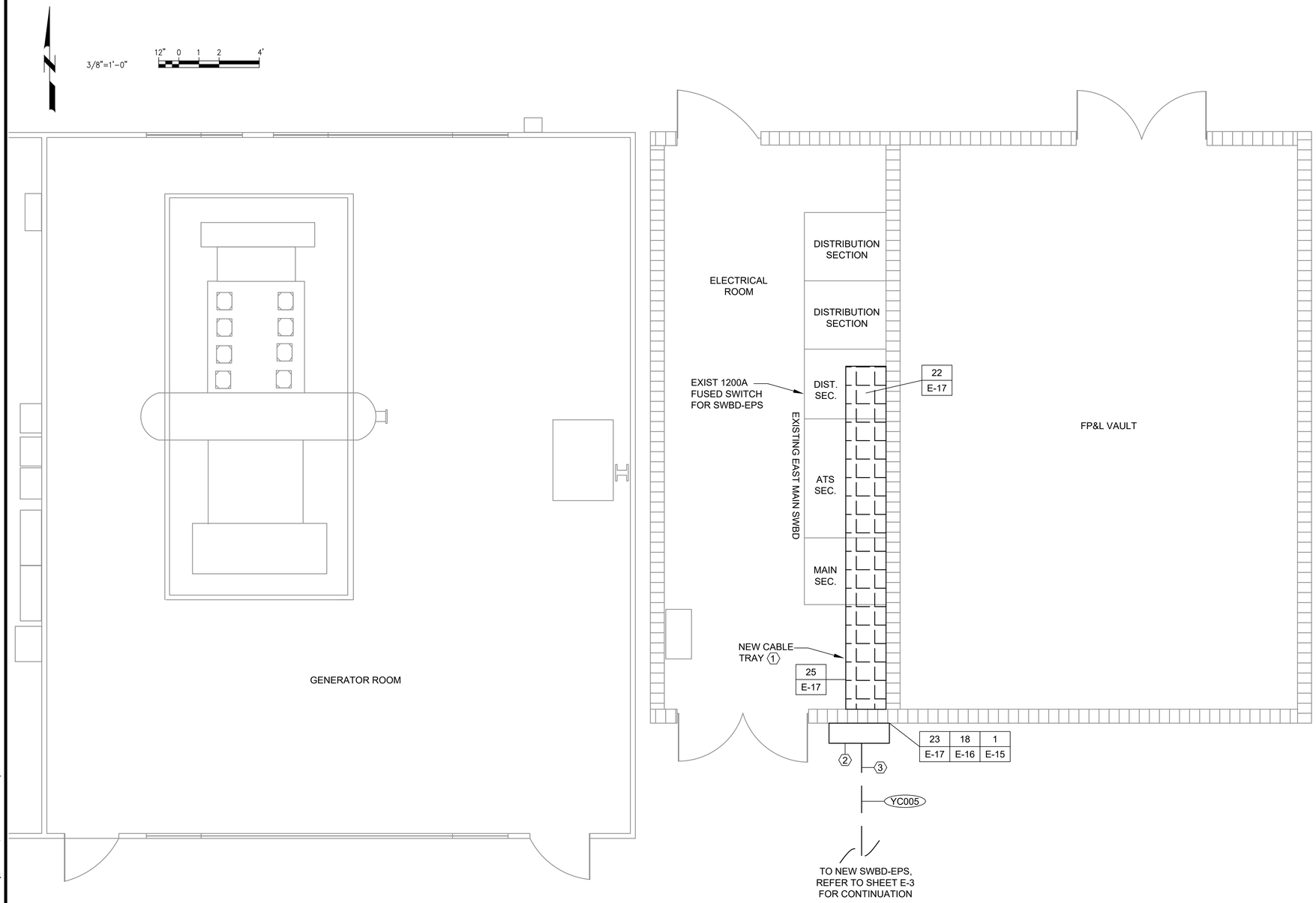
DATE: JUNE 2020

BID SET

SCALE: AS NOTED

PROJECT No: PP14

SHEET: E-7



KEYED NOTES:

1. CONTRACTOR SHALL PROVIDE AND INSTALL NEW CABLE TRAY. CABLE TRAY SHALL BE ROUTED AS SHOWN WITH A MAXIMUM MOUNTING HEIGHT OF 18" BELOW CEILING. REFER TO SPECIFICATION 16110 AND DETAILS FOR ADDITIONAL INFORMATION.

2. CONTRACTOR SHALL PROVIDE AND INSTALL A NEW 36"H x 36"W x 12"D (MIN) 316 STAINLESS STEEL NEMA 4X JUNCTION BOX. MOUNT JUNCTION BOX IN ASSOCIATION WITH CABLE TRAY HEIGHT TO ALLOW FOR CONDUIT ENTRY THROUGH CONCRETE WALL TO BE ABOVE CABLE TRAY AND TO TRANSITION INTO CABLE TRAY PER DETAIL.

3. CONTRACTOR SHALL SAW CUT AND REMOVE THE EXISTING SIDEWALK BETWEEN EXPANSION JOINTS, HAND EXCAVATE AND INSTALL NEW CONDUITS. RESTORE SIDEWALK ACCORDINGLY TO MATCH EXISTING. REMOVE AND REPLACE COMPLETE SIDEWALK SECTIONS.

NOTES:

1. REFER SPECIFICATION 16010 SECTION 1.05 FOR CONSTRUCTION CONSTRAINTS AND SUGGESTED CONSTRUCTION SEQUENCE. R

2. REFER TO ONE-LINE DIAGRAM SHEET E-12 FOR ADDITIONAL INFORMATION.

EAST MAIN ELECTRICAL BUILDING MODIFICATION PLAN

SCALE: 3/8" = 1'-0"

NO	DATE	REVISION	BY	NO	DATE	REVISION	BY

HILLERS ELECTRICAL ENGINEERING, INC.
23257 STATE ROAD 7, SUITE 100
BOCA RATON, FLORIDA 33428
(561) 451-9165
(561) 451-4886 FAX
LICENSE NO: EB 0006877

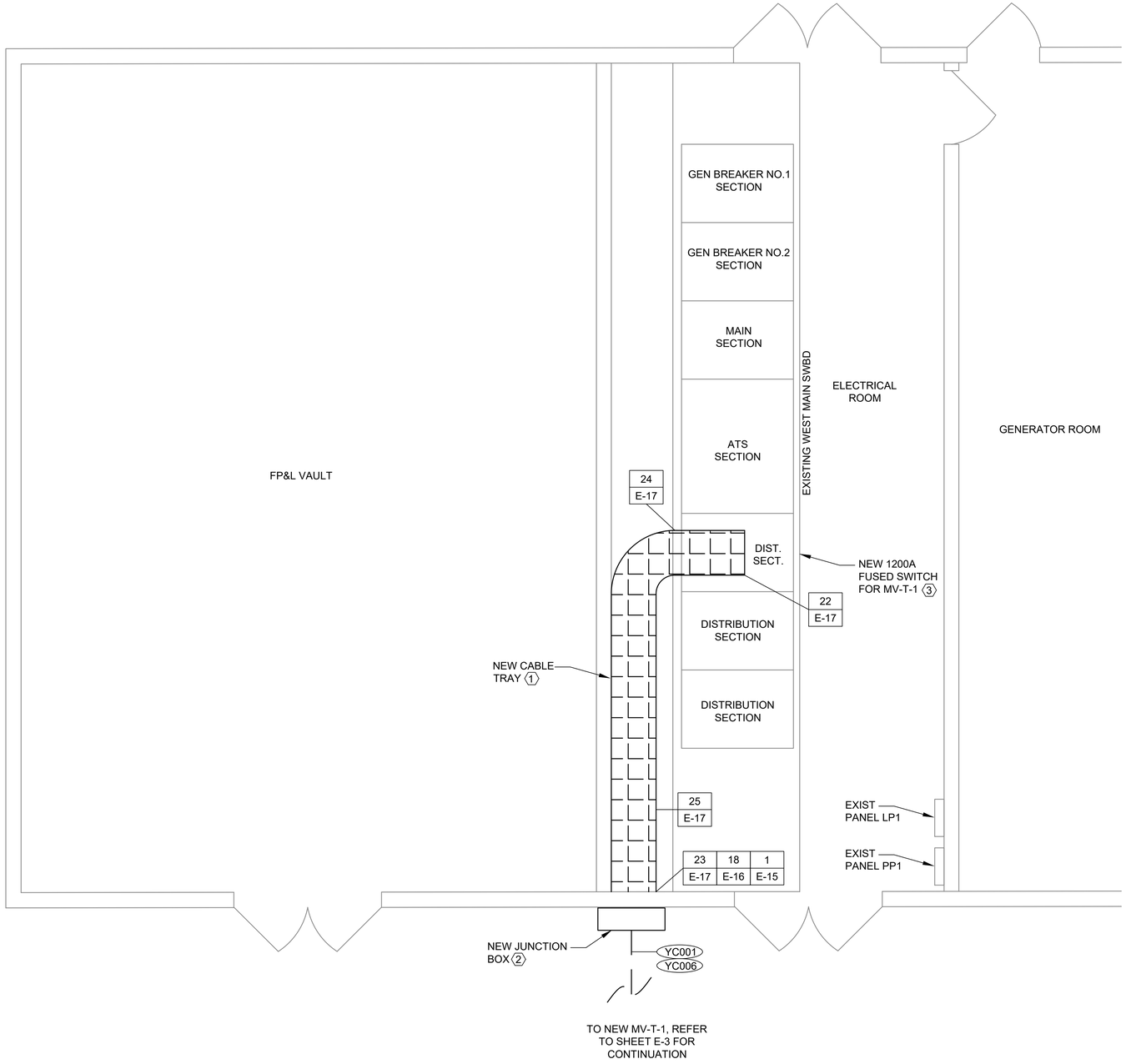
WASTE WATER TREATMENT PLANT EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

EAST MAIN ELECTRICAL BUILDING MODIFICATION PLAN

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022
DATE: JUNE 2020

BID SET

SCALE: 3/8" = 1'-0"
PROJECT No: PP14
SHEET: **E-8**



WEST MAIN ELECTRICAL BUILDING MODIFICATION PLAN

SCALE: 3/8" = 1'-0"

3/8"=1'-0"

12" 0 1 2 4'

KEYED NOTES:

(1) CONTRACTOR SHALL PROVIDE AND INSTALL NEW CABLE TRAY. CABLE TRAY SHALL BE ROUTED AS SHOWN WITH A MAXIMUM MOUNTING HEIGHT OF 24" ABOVE SWITCHBOARD. REFER TO SPECIFICATION 16110 AND DETAILS FOR ADDITIONAL INFORMATION.

(2) CONTRACTOR SHALL PROVIDE AND INSTALL A NEW 36"H x 36"W x 12"D (MIN) 316 STAINLESS STEEL NEMA 4X JUNCTION BOX. MOUNT JUNCTION BOX IN ASSOCIATION WITH CABLE TRAY HEIGHT TO ALLOW FOR CONDUIT ENTRY THROUGH CONCRETE WALL TO BE ABOVE CABLE TRAY AND TO TRANSITION INTO CABLE TRAY PER DETAIL.

(3) REFER TO ONE-LINE DIAGRAMS SHEET E-11 AND E-12 FOR ADDITIONAL INFORMATION.

NOTES:

1. REFER SPECIFICATION 16010 SECTION 1.05 FOR CONSTRUCTION CONSTRAINTS AND SUGGESTED CONSTRUCTION SEQUENCE.

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WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

WEST MAIN ELECTRICAL BUILDING MODIFICATION PLAN

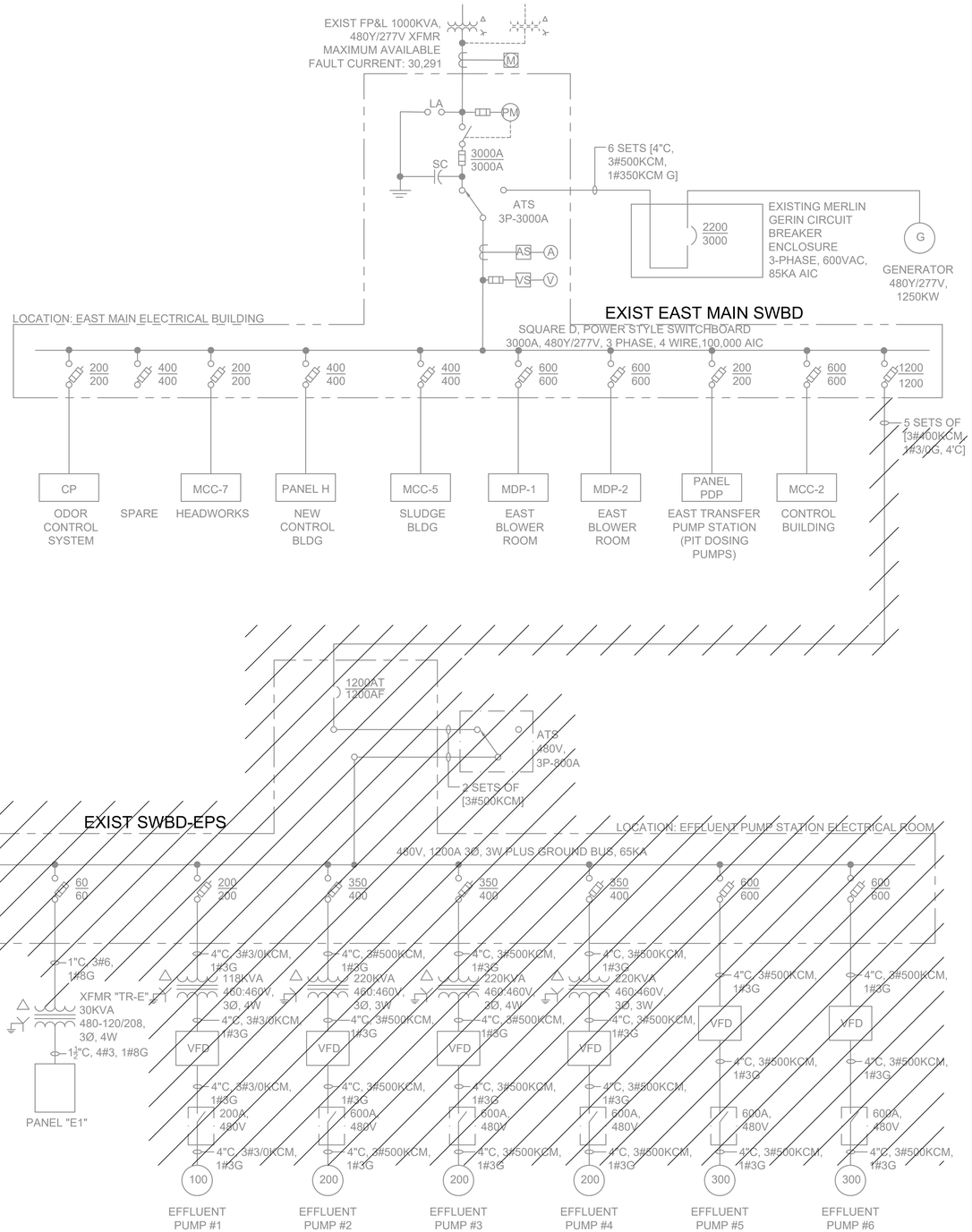
PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022

DATE: JUNE 2020 **BID SET**

SCALE: AS NOTED

PROJECT No: **PP14**

SHEET: **E-9**



NOTES:

1. REFER SPECIFICATION 16010 SECTION 1.05 FOR CONSTRUCTION CONSTRAINTS AND SUGGESTED CONSTRUCTION SEQUENCE.

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WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

ELECTRICAL ONE-LINE DIAGRAMS

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022

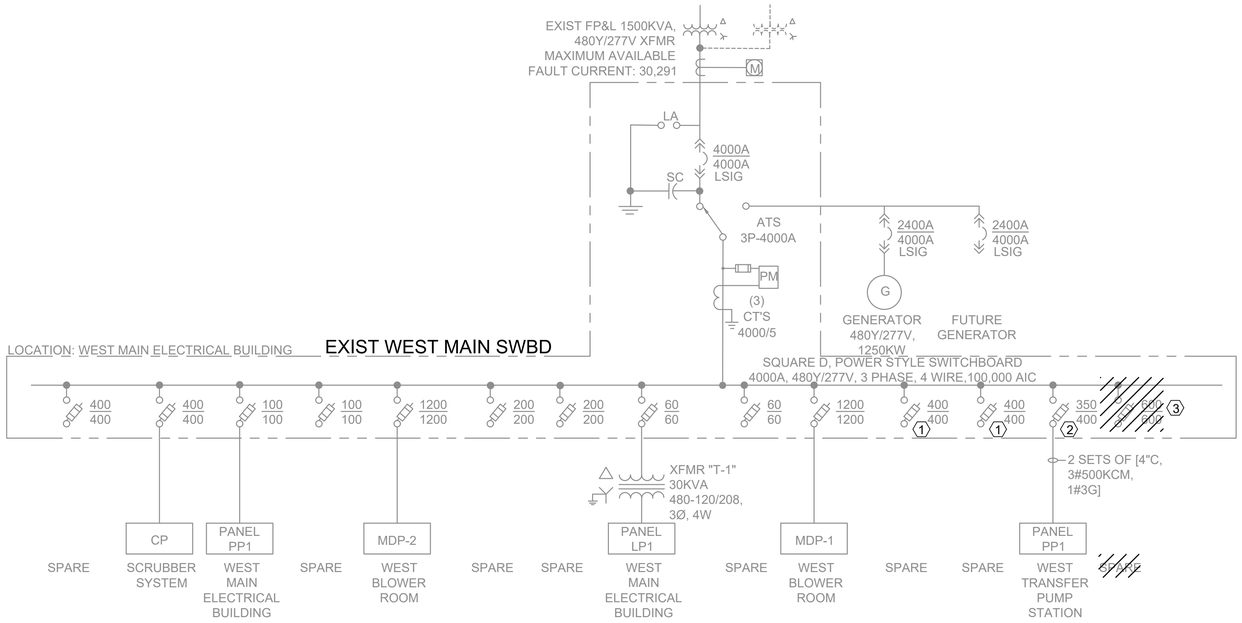
DATE: JUNE 2020

BID SET

SCALE: NONE

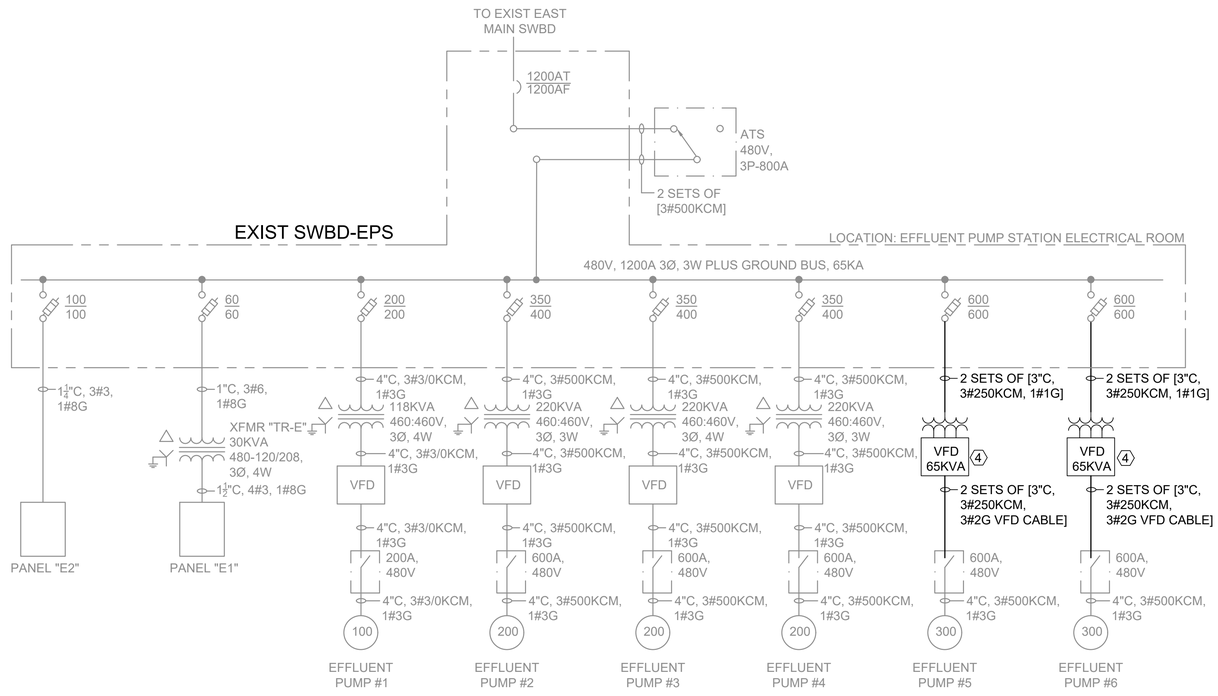
PROJECT No: PP14

SHEET: **E-10**



EXISTING WEST MAIN SWBD ONE-LINE

NOT TO SCALE



EXISTING SWBD-EPS ONE-LINE - TEMPORARY POWER

NOT TO SCALE

PHOTO-1 (WEST MAIN SWBD)

NOT TO SCALE

KEYED NOTES:

1. CONTRACTOR SHALL RELOCATE THE TWO SPARE 400A FUSED SWITCHES UPWARDS TO FACILITATE INSTALLATION OF NEW 1200A FUSED SWITCH.
2. CONTRACTOR SHALL RELOCATE THE EXISTING WEST TRANSFER PUMP STATION 400A FUSED SWITCH UPWARDS TO FACILITATE THE NEW 1200A FUSED SWITCH. CONTRACTOR SHALL ADJUST EXISTING CONDUCTORS AS NECESSARY TO FACILITATE CONNECTION TO THE RELOCATED SWITCH.
3. CONTRACTOR SHALL REMOVED THE EXISTING SPARE 600A FUSED SWITCH AND PREPARE SPACE FOR NEW 1200A FUSED SWITCH. DELIVER SWITCH TO OWNER FOR SALVAGE.
4. CONTRACTOR SHALL TEMPORARILY POWER THE NEW TEMPORARILY LOCATED VFDS NO. 5 AND 6 FROM THE EXISTING SWITCHBOARD DURING CONSTRUCTION. PRIOR TO THE REMOVALE OF THE EXISTING SWITCHBOARD, CONTRACTOR SHALL TEMPORARILY POWER NO.5 AND 6 FROM THE NEW SWITCHBOARD TO MAINTAIN OPERATION DURING CONSTRUCTION.

NOTES:

1. REFER SPECIFICATION 16010 SECTION 1.05 FOR CONSTRUCTION CONSTRAINTS AND SUGGESTED CONSTRUCTION SEQUENCE.

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WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

ELECTRICAL ONE-LINE DIAGRAMS

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022

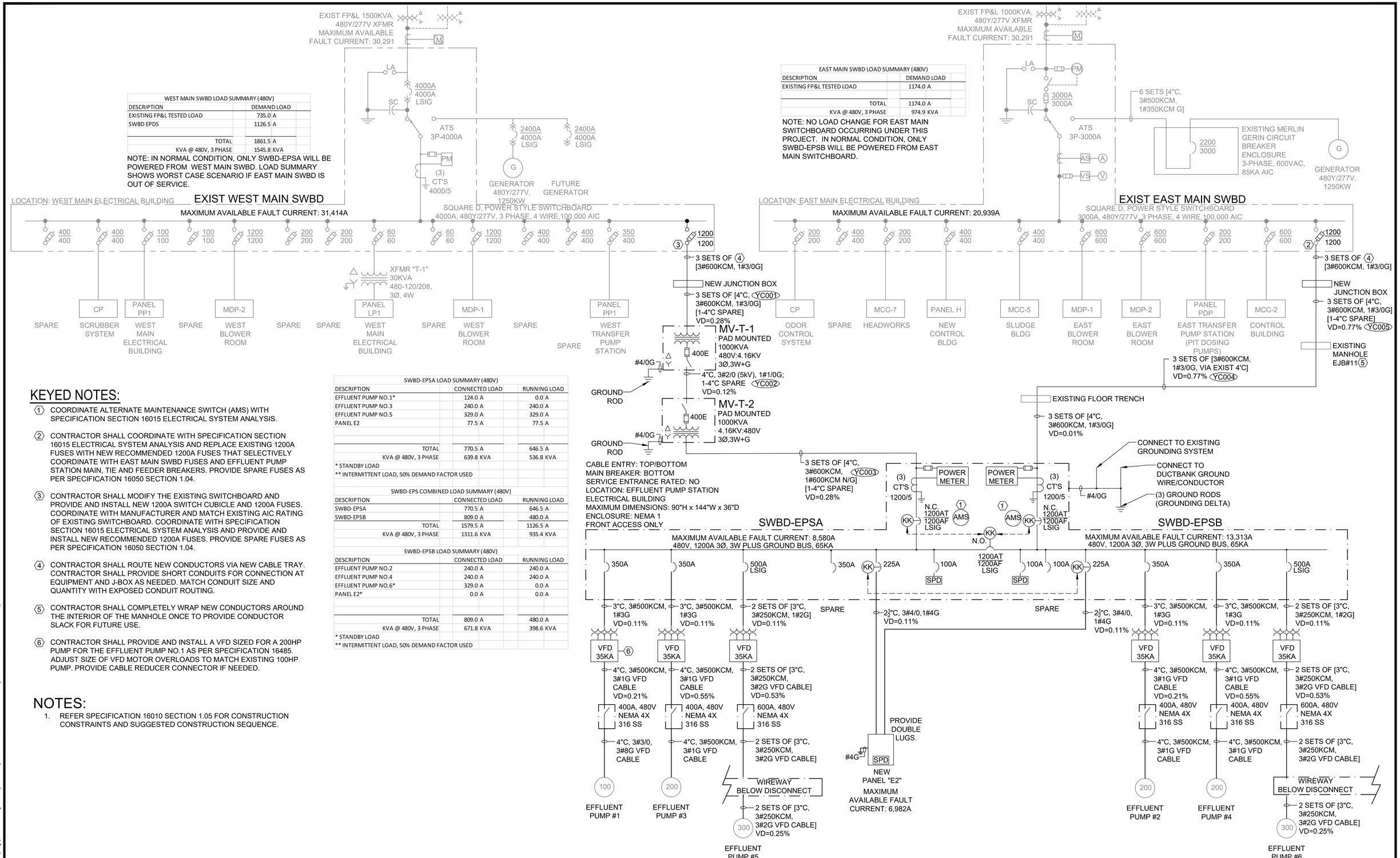
DATE: JUNE 2020

BID SET

SCALE: NONE

PROJECT No: PP14

SHEET: E-11



SWBD-EPSA AND SWBD-EPSB ONE-LINES

NOT TO SCALE

KEYED NOTES:

1. COORDINATE ALTERNATE MAINTENANCE SWITCH (AMS) WITH SPECIFICATION SECTION 16015 ELECTRICAL SYSTEM ANALYSIS.
2. CONTRACTOR SHALL COORDINATE WITH SPECIFICATION SECTION 16015 ELECTRICAL SYSTEM ANALYSIS AND REPLACE EXISTING 1200A FUSES WITH NEW RECOMMENDED 1200A FUSES THAT SELECTIVELY COORDINATE WITH EAST MAIN SWBD FUSES AND EFFLUENT PUMP STATION MAIN, TIE AND FEEDER BREAKERS. PROVIDE SPARE FUSES AS PER SPECIFICATION 16050 SECTION 1.04.
3. CONTRACTOR SHALL MODIFY THE EXISTING SWITCHBOARD AND PROVIDE AND INSTALL NEW 1200A SWITCH CUBICLE AND 1200A FUSES. COORDINATE WITH MANUFACTURER AND MATCH EXISTING AIC RATING OF EXISTING SWITCHBOARD. COORDINATE WITH SPECIFICATION SECTION 16015 ELECTRICAL SYSTEM ANALYSIS AND PROVIDE AND INSTALL NEW RECOMMENDED 1200A FUSES. PROVIDE SPARE FUSES AS PER SPECIFICATION 16050 SECTION 1.04.
4. CONTRACTOR SHALL ROUTE NEW CONDUCTORS VIA NEW CABLE TRAY. CONTRACTOR SHALL PROVIDE SHORT CONDUITS FOR CONNECTION AT EQUIPMENT AND J-BOX AS NEEDED. MATCH CONDUIT SIZE AND QUANTITY WITH EXPOSED CONDUIT ROUTING.
5. CONTRACTOR SHALL COMPLETELY WRAP NEW CONDUCTORS AROUND THE INTERIOR OF THE MANHOLE ONCE TO PROVIDE CONDUCTOR SLACK FOR FUTURE USE.
6. CONTRACTOR SHALL PROVIDE AND INSTALL A VFD SIZED FOR A 200HP PUMP FOR THE EFFLUENT PUMP NO.1 AS PER SPECIFICATION 16485. ADJUST SIZE OF VFD MOTOR OVERLOADS TO MATCH EXISTING 100HP PUMP. PROVIDE CABLE REDUCER CONNECTOR IF NEEDED.

NOTES:

1. REFER SPECIFICATION 16010 SECTION 1.05 FOR CONSTRUCTION CONSTRAINTS AND SUGGESTED CONSTRUCTION SEQUENCE.

SWBD-EPSA LOAD SUMMARY (480V)

DESCRIPTION	CONNECTED LOAD	RUNNING LOAD
EFFLUENT PUMP NO.1*	124.0 A	0.0 A
EFFLUENT PUMP NO.3	240.0 A	240.0 A
EFFLUENT PUMP NO.5	329.0 A	329.0 A
PANEL E2	77.5 A	77.5 A
TOTAL	770.5 A	646.5 A
KVA @ 480V, 3 PHASE	639.8 KVA	536.8 KVA

* STANDBY LOAD
** INTERMITTENT LOAD, 50% DEMAND FACTOR USED

SWBD-EPS COMBINED LOAD SUMMARY (480V)

DESCRIPTION	CONNECTED LOAD	RUNNING LOAD
SWBD-EPSA	770.5 A	646.5 A
SWBD-EPSB	809.0 A	480.0 A
TOTAL	1579.5 A	1126.5 A
KVA @ 480V, 3 PHASE	1311.6 KVA	935.4 KVA

SWBD-EPSB LOAD SUMMARY (480V)

DESCRIPTION	CONNECTED LOAD	RUNNING LOAD
EFFLUENT PUMP NO.2	240.0 A	240.0 A
EFFLUENT PUMP NO.4	240.0 A	240.0 A
EFFLUENT PUMP NO.6*	329.0 A	0.0 A
PANEL E2*	0.0 A	0.0 A
TOTAL	809.0 A	480.0 A
KVA @ 480V, 3 PHASE	671.8 KVA	398.6 KVA

* STANDBY LOAD
** INTERMITTENT LOAD, 50% DEMAND FACTOR USED

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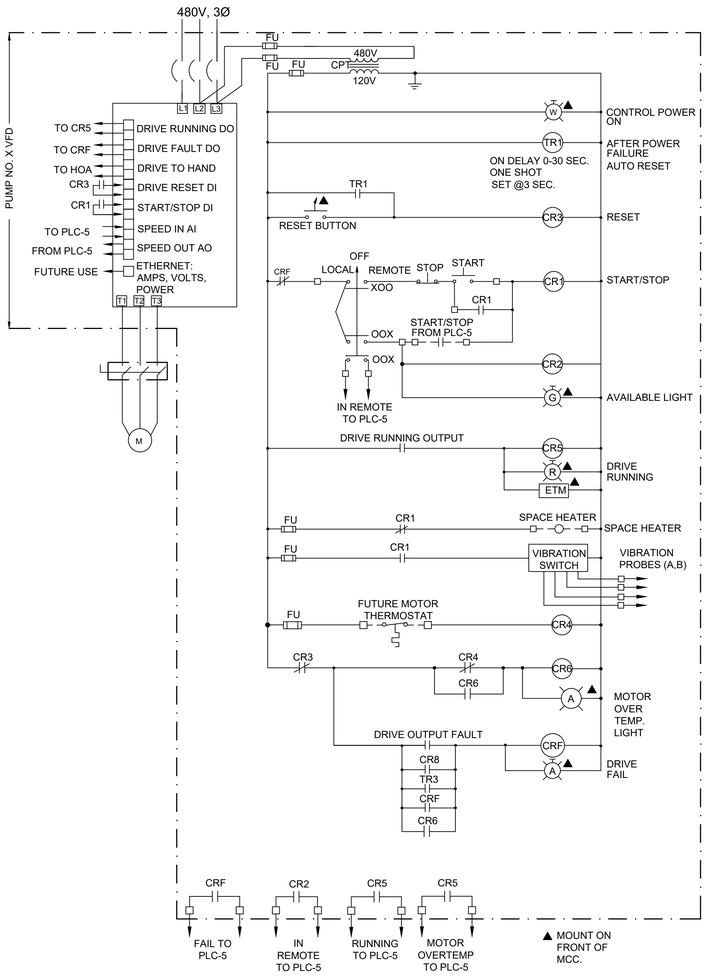
WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

ELECTRICAL ONE-LINE DIAGRAMS

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022
DATE: JUNE 2020

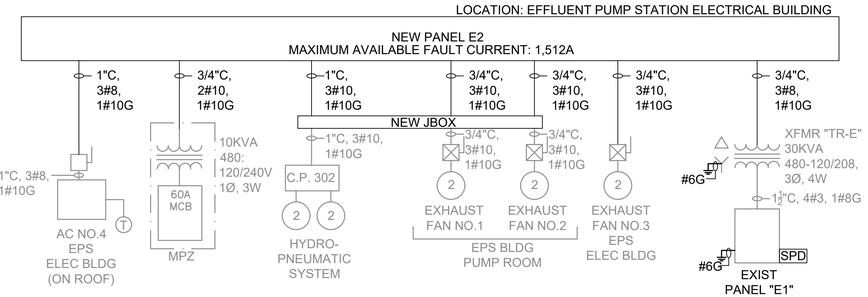
BID SET

SCALE: NONE
PROJECT No: **PP14**
SHEET: **E-12**



EFFLUENT PUMP NO.X VFD SCHEMATIC

NOT TO SCALE
X = 1,2,3,4,5,6



NEW PANEL E2 RISER

NOT TO SCALE

PLC-5 MODIFIED RISER

NOT TO SCALE

KEYED NOTES:

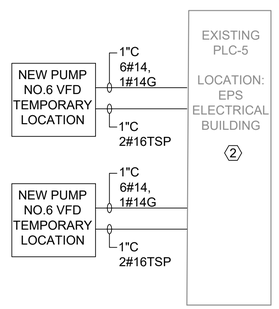
1. PRIOR TO THE DISCONNECTION/ REMOVAL OF EXISTING CABLES, CONTRACTOR SHALL TRACE OUT AND AS-BUILT THE EXISTING CABLING BETWEEN EXISTING VFDS, PUMPS AND PLC. CONTRACTOR SHALL RECONNECT ALL VFD DISCREET AND ANALOG INPUTS/OUTPUTS VIA NEW CABLES/CONDUCTORS. REFER TO DRAWINGS E-18 THRU E-26 FOR INSTRUMENTATION RELATED MODIFICATIONS. THE CONTRACTOR SHALL PERFORM LOOP CHECKS IN THE PRESENCE OF ENGINEER ON ALL NEW CABLING/CONDUCTORS. CONTRACTOR SHALL MODIFY THE EXITING PLC PANEL AS SHOWN ON OTHER DRAWINGS AND AS DESCRIBES IN SPECIFICATIONS.

2. CONTRACTOR SHALL PROVIDE AND INSTALL TEMPORARILY CONTROL WIRES TO THE NEW TEMPORARILY LOCATED VFDS NO. 5 AND 6 FROM THE EXISTING PLC-5 DURING CONSTRUCTION.

3. CONTRACTOR SHALL PROVIDE A NEW UPPER AND LOWER VIBRATION SWITCH, MODEL NUMBER METRIX 440 AND CORRESPONDING SENSORS, FOR PUMPS NO. 5 AND NO.6 MOTORS. DISCONNECT AND REMOVE THE EXISTING VIBRATION SENSORS FOR THE EXISTING PUMP MOTOR AND COORDINATE MOUNTING OF NEW SENSORS PER PUMP MOTOR MANUFACTURER AND VIBRATION SENSOR MANUFACTURER RECOMMENDATIONS. REFER TO DRAWING E-20 FOR ADDITIONAL INFORMATION. UTILIZE EXISTING VIBRATION SWITCH SETTINGS AND PUMP MANUFACTURER RECOMMENDATIONS FOR NEW VIBRATION SWITCH SETTINGS. COORDINATE WITH SPECIFICATION 16485 AND LOCATE VIBRATION SWITCHES WITHIN NEW VFD CABINET AND POWER VIBRATION SWITCHES FROM VFD CONTROL POWER.

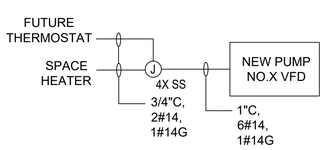
NOTES:

1. REFER SPECIFICATION 16010 SECTION 1.05 FOR CONSTRUCTION CONSTRAINTS AND SUGGESTED CONSTRUCTION SEQUENCE.



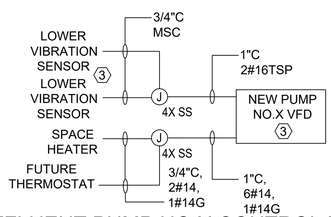
PLC-5 RISER - TEMPORARY

NOT TO SCALE



EFFLUENT PUMP NO.X CONTROL RISER

NOT TO SCALE
X = 1,2,3,4



EFFLUENT PUMP NO.X CONTROL RISER

NOT TO SCALE
X = 5,6

NO	DATE	REVISION	BY	NO	DATE	REVISION	BY

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WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

ELECTRICAL RISERS AND SCHEMATIC DIAGRAMS

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022
DATE: JUNE 2020
BID SET

SCALE: NONE
PROJECT No: PP14
SHEET: **E-13**

NEW PANEL "E2" SCHEDULE

BUS AMPS A	BUS AMPS B	BUS AMPS C	CIRCUIT NAME	POLES	AMPS	BUS	AMPS	POLES	CIRCUIT NAME	BUS AMPS A	BUS AMPS B	BUS AMPS C
20.1			XFMR-TR-E	3	45	1	2	20	1	SPARE			
	19.5		|	|	|	3	4	30	2	MPZ		20.8	
		14.9	|	|	|	5	6	|	|	|			20.8
3.4			EXHAUST FAN NO.1	3	20	7	8	20	3	C.P. 302 HYDRO PANEL	7		
	3.4		|	|	|	9	10	|	|	|		7	
		3.4	|	|	|	11	12	|	|	|			7
3.4			EXHAUST FAN NO.2	3	20	13	14	30	3	SPARE			
	3.4		|	|	|	15	16	|	|	|			
		3.4	|	|	|	17	18	|	|	|			
3.4			EXHAUST FAN NO.3	3	20	19	20	20	3	SPARE			
	3.4		|	|	|	21	22	|	|	|			
		3.4	|	|	|	23	24	|	|	|			
20			AC NO.4	3	40	25	26	20	3	SPARE			
	20		|	|	|	27	28	|	|	|			
		20	|	|	|	29	30	|	|	|			
			SPARE	3	40	31	32	20	3	SPARE			
			|	|	|	33	34	|	|	|			
			|	|	|	35	36	|	|	|			
			SPARE	3	20	37	38	30	3	SPD			
			|	|	|	39	40	|	|	|			
			|	|	|	41	42	|	|	|			

TOTAL AMPS: BUS A 57.3 BUS B 77.5 BUS C 72.9 KVA 64.3

RATED VOLTAGE ❒ 120/208 ■ 277/480 ❒ 120/240	Branch Poles: ❒ 12 ❒18 ❒30 ■42 ❒84		Switchboard: ❒
RATED AMPS r100 ■225 ❒400 ❒1000	Cabinet: ■Surface ❒Flush		
NEUTRAL BUS ■100% ❒150% ❒200%	■GROUND BUS	■HINGED DOOR	■KEYED DOOR LATCH LOCATION: EFFLUENT PUMP STATION ELECTRIC BLDG
CIRCUIT BREAKER (BOLT IN) BRANCH DEVICES	■SPD	Enclosure Type ■Nema 1 ❒Nema 3R ❒Nema 4X	
❒ MAIN LUGS ONLY	MAIN 225 AMPS ■BREAKER ❒■ _____ TO BE GFI		
PANEL BOARD MUST BE RATED TO INTERRUPT A SHORT CIRCUIT OF 42,000 AMPS SYMETRICAL			
APPROVED MF'RS SEE SPECIFICATION	COPPER BUSSES	MAIN LUGS:	SET SIZE:

EXISTING PANEL "E1" SCHEDULE

BUS AMPS A	BUS AMPS B	BUS AMPS C	CIRCUIT NAME	POLES	AMPS	BUS	AMPS	POLES	CIRCUIT NAME	BUS AMPS A	BUS AMPS B	BUS AMPS C
7.2			EFFL. PMP-SUMP PUMP 1/3HP	1	20	1	2	20	1	LIGHTING (PUMP BLDG)	8		
	7.2		METER VLT-SUMP PUMP 1/3HP	1	20	3	4	20	1	RECEPTACLES (PUMP BLDG)		5	
		1	CP-1	1	20	5	6	20	1	RECEPTACLES (PUMP BLDG)			5
1			CP-2	1	20	7	8	20	1	OUTDOOR LGTS (PUMP BLDG)	4		
	1		CP-3	1	20	9	10	20	1	SPARE			
		1	CP-4	1	20	11	12	20	1	SPARE			
1			CP-5	1	20	13	14	20	1	CP-300	3		
	1		CP-6	1	20	15	16	20	1	CP-301		1	
		1	CP-11	1	20	17	18	20	1	CP-303			1
1			CP-12	1	20	19	20	20	1	CP-400	1		
	1		CP-13	1	20	21	22	20	1	CP-401		1	
		1	CP-14	1	20	23	24	20	1	LIGHTING (PUMP BLDG)			8
1			CP-15	1	20	25	26	20	1	ELEC ROOM LIGHTING	1.78		
	5		PLC-5 CONTROL PANEL	1	20	27	28	20	1	LIGHTING		7.4	
		8.3	LIGHTING (WALKWAY)	1	20	29	30	20	1	EMERGENCY LIGHTING			5
8.3			LIGHTING (ROADWAY)	1	20	31	32	20	1	RECEPTACLES	9		
	8.3		LIGHTING (ROADWAY)	1	20	33	34	20	1	LIGHTING (OUTDOOR)		6	
			SPARE	1	20	35	36	20	1	LIGHTING (HYDRO-PNEUMATIC)			3
			SPD	3	30	37	38	20	1	TIME CLOCK AND LGT. CONTACTOR	0.2		
			|	|	|	39	40	20	1	FIRE ALARM PANEL		1	
			|	|	|	41	42	20	1	SPARE			

TOTAL AMPS: BUS A 46.5 BUS B 44.9 BUS C 34.3 KVA 16.7

RATED VOLTAGE ■ 120/208 ❒ 277/480 ❒ 120/240	Branch Poles: ❒ 12 ❒18 ❒30 ■42 ❒84		Switchboard: ❒
RATED AMPS ■100 ❒225 ❒400 ❒1000	Cabinet: ■Surface ❒Flush		
NEUTRAL BUS ■100% ❒150% ❒200%	■GROUND BUS	■HINGED DOOR	■KEYED DOOR LATCH LOCATION: EFFLUENT PUMP STATION ELECTRICAL BUILDING
CIRCUIT BREAKER (BOLT IN) BRANCH DEVICES	❒SPD	Enclosure Type ■Nema 1 ❒Nema 3R ❒Nema 4X	
❒ MAIN LUGS ONLY	MAIN 100 AMPS ■BREAKER ❒ _____ TO BE GFI		
PANEL BOARD MUST BE RATED TO INTERRUPT A SHORT CIRCUIT OF 10,000 AMPS SYMETRICAL			
EXISTING MF'RS: SQUARE D	COPPER BUSSES	❒ SUBFEED LUGS	

YARD CONDUIT SCHEDULE

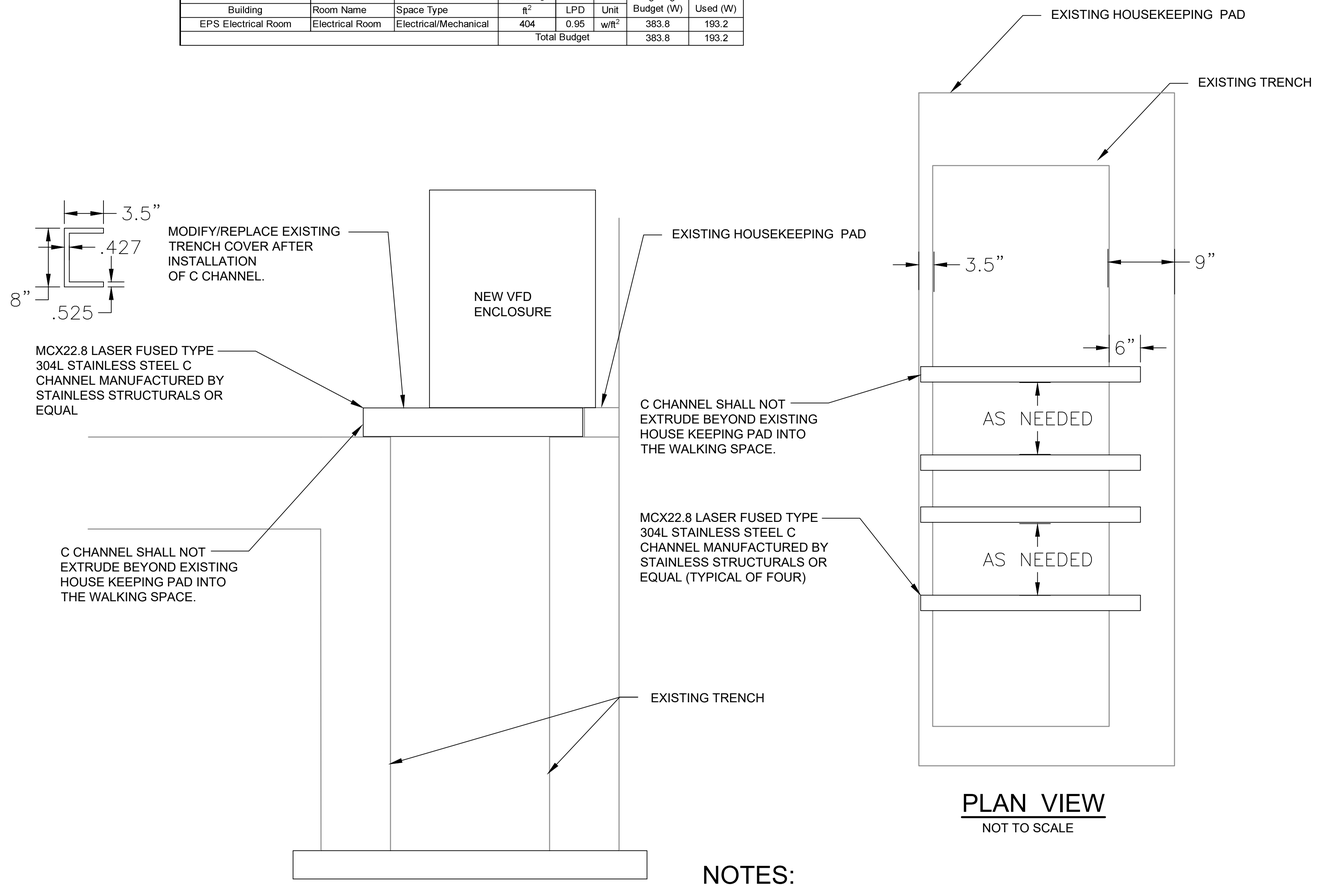
NUMBER	CONDUIT FROM	CONDUIT TO	REMARKS
YC001	EXIST WEST MAIN SWBD @ WEST MAIN ELEC. BLDG	NEW TRANSFORMER MV-T-1	REFER TO SHEET E-12
YC002	NEW TRANSFORMER MV-T-1	NEW TRANSFORMER MV-T-2	REFER TO SHEET E-12
YC003	NEW TRANSFORMER MV-T-2	NEW SWBD-EPS @ EPS ELECTRICAL BUILDING	REFER TO SHEET E-12
YC004	EXIST MANHOLE EJB#11	NEW SWBD-EPS @ EPS ELECTRICAL BUILDING	REFER TO SHEET E-12
YC005	EXIST EAST MAIN SWBD @ EAST MAIN ELEC. BLDG	EXIST MANHOLE EJB#11	REFER TO SHEET E-12
YC006	EXIST WEST MAIN ELEC. BLDG	NEW MANHOLE MV-MH-1	2 SPARE 4"C

LIGHT FIXTURE SCHEDULE

FIXTURE NUMBER	DESCRIPTION	MANUFACTURER	CATALOG NUMBER	LAMPS	INPUT WATTS	MOUNTING	MOUNTING HEIGHT
1	4' LED WRAPAROUND	METALUX	4WNLED-LD4-40SL-F-UNV-L840-CD1	LED	32.2W	STEM	10
2	EXIT LIGHT (SINGLE/DOUBLE FACE, RED LETTERS)	ISOLITE	RL-EM-R-WH-UN-SD-120	LED	3.2W	SURFACE	OVER DOOR
3	LOCATION EMERGENCY LIGHT	ISOLITE	BUG-6-WH-SD	LED	6W	SURFACE	8.5'

Lighting Power Densities

Building	Room Name	Space Type	Area/Length	LPD	Unit	Lighting Budget (W)	Amount Used (W)
EPS Electrical Room	Electrical Room	Electrical/Mechanical	404	0.95	W/ft^2	383.8	193.2
			Total Budget			383.8	193.2



ELEVATION VIEW
NOT TO SCALE

PLAN VIEW
NOT TO SCALE

NOTES:

1. CONTRACTOR SHALL PROVIDE AND INSTALL STAINLESS STEEL "C" CHANNEL SUPPORTS TO SPAN THE EXISTING TRENCH FOR VFD INSTALLATION. CONTRACTOR SHALL MODIFY EXISTING HOUSEKEEPING PAD TO EMBED "C" CHANNEL AND GROUT IN-PLACE.

EFFLUENT PUMP STATION ELECTRIC ROOM VFD SUPPORT DETAIL

NOT TO SCALE

NO	DATE	REVISION	BY	NO	DATE	REVISION	BY

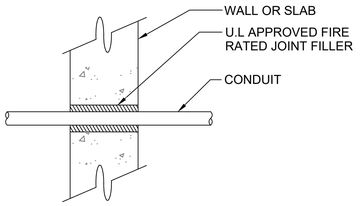
HILLERS ELECTRICAL ENGINEERING, INC.
23257 STATE ROAD 7, SUITE 100
BOCA RATON, FLORIDA 33428
(561) 451-9165
(561) 451-4886 FAX
LICENSE NO: EB 0006877

WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

ELECTRICAL SCHEDULES

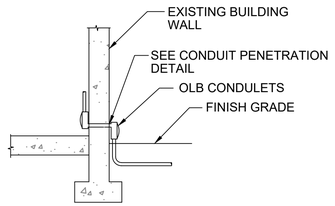
PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022
DATE: JUNE 2020
BID SET

SCALE: NONE
PROJECT No: PP14
SHEET: **E-14**



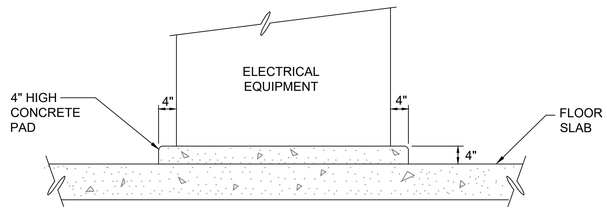
1 VAR. **CONDUIT PENETRATION AT WALL OR SLAB**

NOT TO SCALE



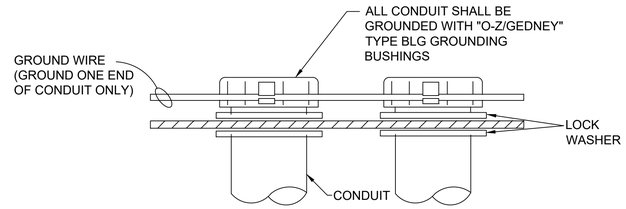
2 VAR. **CONDUIT ENTRANCE**

NOT TO SCALE



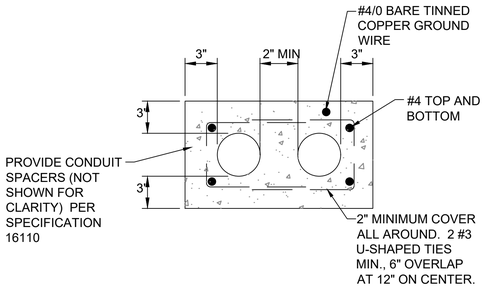
3 VAR. **EQUIPMENT HOUSE KEEPING PAD**

NOT TO SCALE



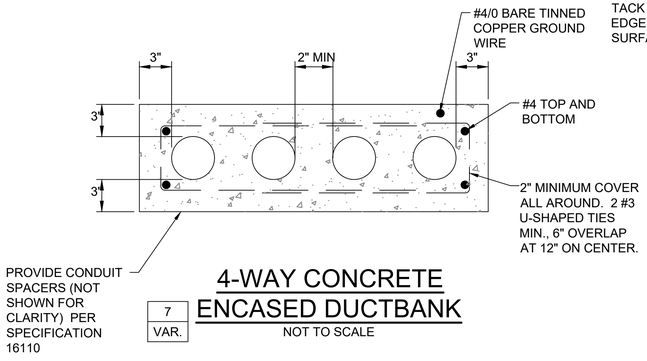
4 VAR. **CONDUIT GROUNDING**

NOT TO SCALE



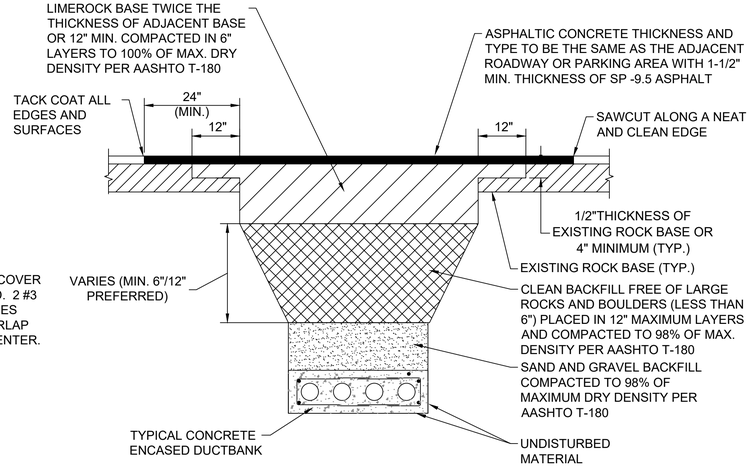
5 VAR. **2-WAY CONCRETE ENCASED DUCTBANK**

NOT TO SCALE



7 VAR. **4-WAY CONCRETE ENCASED DUCTBANK**

NOT TO SCALE

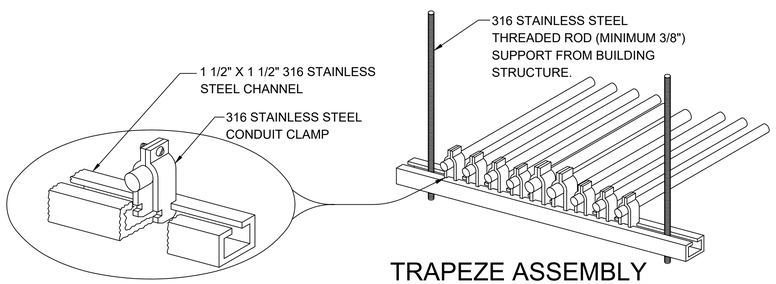


8 VAR. **PAVEMENT RESTORATION FOR LOCAL ROADS AND PARKING LOTS**

NOT TO SCALE

DUCTBANK NOTES:

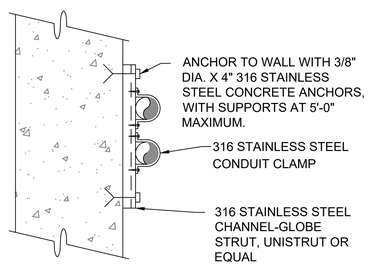
1. CONCRETE ENCASE DUCTBANK DETAILS SHOW CENTERLINE SPACES AS TYPICAL WITH 4 INCH CONDUIT SPACERS. CENTERLINE SPACING WILL DIFFER IF SMALLER CONDUIT SPACERS ARE USED. ONLY ONE CONDUIT PER SPACER IS ALLOWED.
2. HORIZONTALLY STAGGER THE ARRANGEMENT USING DETAIL NO.11 (E-15).



CONDUIT PIPE STRAP MOUNTING DETAILS

9 VAR. **CONDUIT SUPPORT DETAIL**

NOT TO SCALE

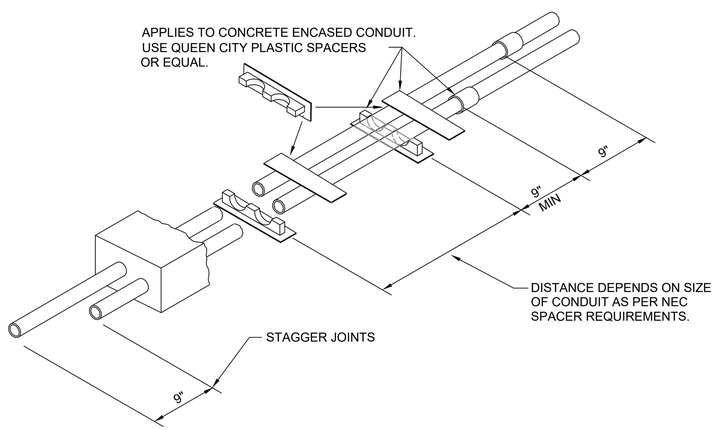


10 VAR. **CONDUIT SUPPORT ON WALL**

NOT TO SCALE

CONDUIT SUPPORT NOTES:

1. THIS DETAIL TYPICAL FOR BOTH VERTICAL AND HORIZONTAL MOUNTING
2. CHANNEL AND ALL SUPPORT DEVICES TO BE 316 STAINLESS STEEL.
3. CHANNELS TO BE SPACED 5' MAXIMUM.



11 VAR. **HORIZONTAL STAGGERING OF SPACERS AND JOINTS**

NOT TO SCALE

NO	DATE	REVISION	BY	NO	DATE	REVISION	BY

HILLERS ELECTRICAL ENGINEERING, INC.
23257 STATE ROAD 7, SUITE 100
BOCA RATON, FLORIDA 33428
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WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

ELECTRICAL DETAILS - SHEET 1

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022

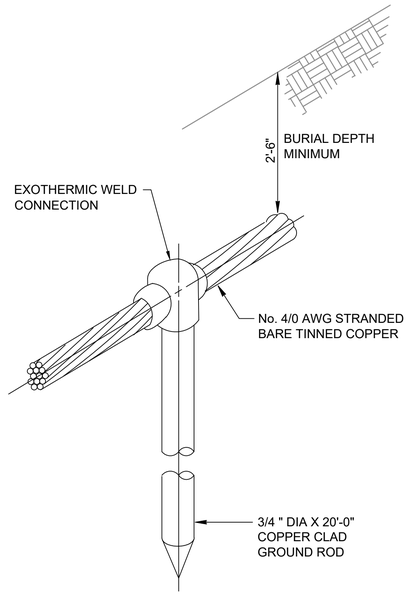
DATE: JUNE 2020 **BID SET**

SCALE: NONE

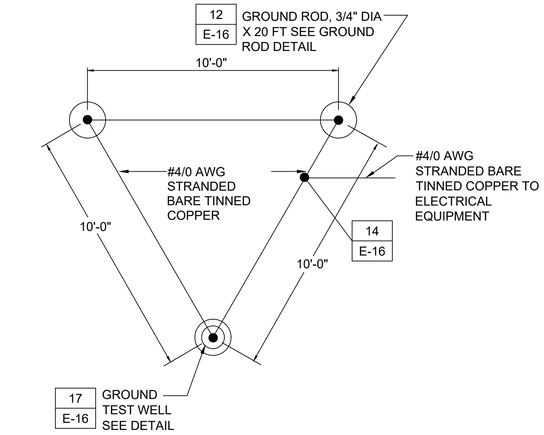
PROJECT No: **PP14**

SHEET: **E-15**

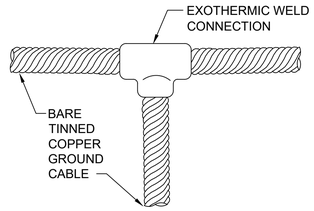
File Name: E:\PROJECTS\PP\PP14\dwg\PP14E15.dwg - (Plotted by: Chamness, Steve on Monday, June 01, 2020 9:26:51 AM)



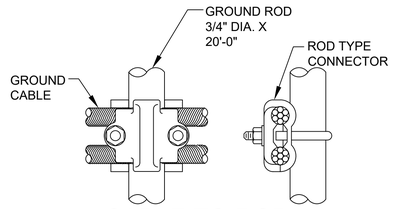
12 VAR. **GROUND ROD DETAIL**
NOT TO SCALE



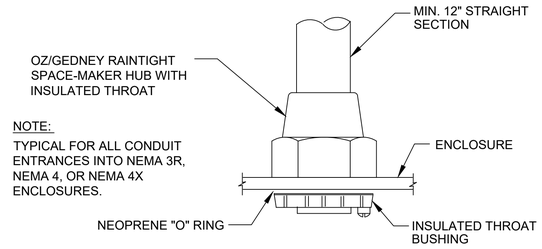
13 VAR. **GROUNDING DELTA LAYOUT**
NOT TO SCALE



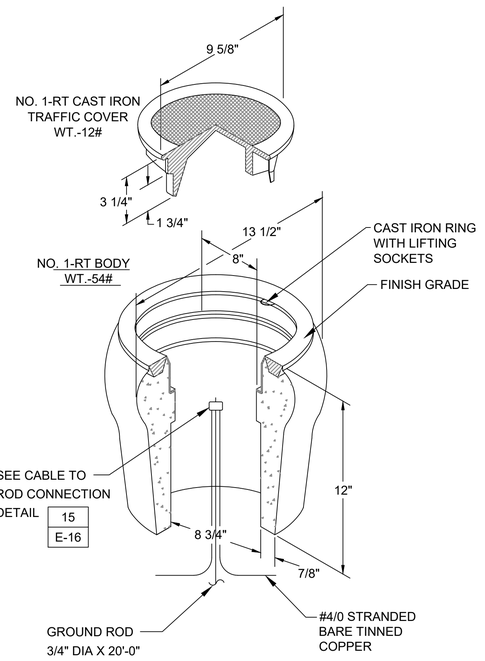
14 VAR. **GROUND CABLE CONNECTION**
NOT TO SCALE



15 VAR. **CABLE TO ROD CONNECTION**
NOT TO SCALE

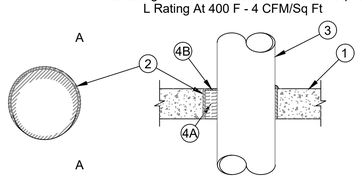


16 VAR. **CONDUIT HUB**
NOT TO SCALE



17 VAR. **GROUND TEST WELL DETAIL**
NOT TO SCALE

System No. C-AJ-1226
F RATING = 3-HR.
T RATING = 0-HR.
L Rating At Ambient - Less than 1 CFM/Sq Ft
L Rating At 400 F - 4 CFM/Sq Ft



SECTION A-A

1. Floor or Wall Assembly: Min 4-1/2 in. thick reinforced lightweight or normal weight (100-150 pcf) concrete. Wall may also be constructed of any UL Classified Concrete Blocks*. Max diam of opening is 32 in.

2. Metallic Sleeve: (Optional) Nom 32 in. diam (or smaller) Schedule 40 (or heavier) steel sleeve cast or grouted into floor or wall assembly, flush with floor or wall surfaces.

3. Through-Penetrant One metallic pipe or conduit to be installed either concentrically or eccentrically within the firestop system. The annular space between pipe or conduit and periphery of opening shall be min 0 in. (point contact) to max 1-7/8 in. Pipe may be installed with continuous point contact. Pipe or conduit to be rigidly supported on both sides of floor or wall assembly. The following types and sizes of metallic pipes or conduits may be used:
   - A. Steel Pipe Nom 30 in. diam (or smaller) Schedule 10 (or heavier) steel pipe.
   - B. Iron Pipe Nom 30 in. diam (or smaller) cast or ductile iron pipe.
   - C. Copper Pipe Nom 6 in. diam (or smaller) Regular (or heavier) copper pipe.
   - D. Copper Tubing Nom 6 in. diam (or smaller) Type L (or heavier) copper tubing.
   - E. Conduit Nom 6 in. diam (or smaller) steel conduit. f
   - F. Conduit Nom 4 in. diam (or smaller) steel electrical metallic tubing (EMT).

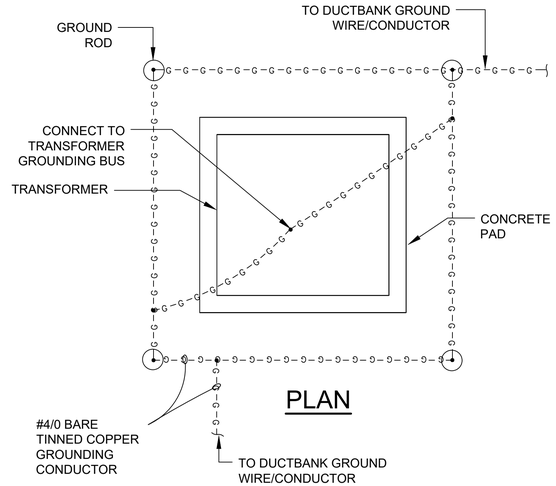
4. Firestop System The firestop system shall consist of the following:
   - A. Packing Material Min 4 in. thickness of min 4 pcf mineral wool batt insulation firmly packed into opening as a permanent form. Packing material to be recessed from top surface of floor or from both surfaces of wall as required to accommodate the required thickness of fill material.
   - B. Fill, Void or Cavity Material* -- Sealant Min 1/4 in. thickness of fill material applied within the annulus, flush with top surface of floor or with both surfaces of wall. At the point or continuous contact locations between pipe and concrete, a min 1/4 in. diam bead of fill material shall be applied at the concrete/pipe interface on the top surface of floor and on both surfaces of wall.

HILTI CONSTRUCTION CHEMICALS, DIV OF HILTI INC
FS-One Sealant *Bearing the UL Classification Marking

HILTI® FIRESTOP SYSTEMS

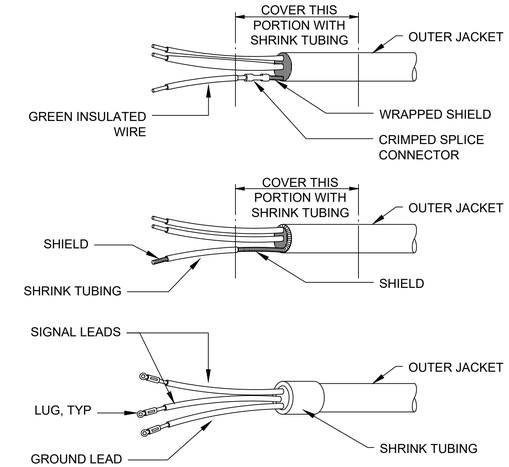
Reproduced by HILTI, Inc. Courtesy of Underwriters Laboratories, Inc. January 09, 2003

18 VAR. **CONDUIT PENETRATION AT WALL OR SLAB**
NOT TO SCALE

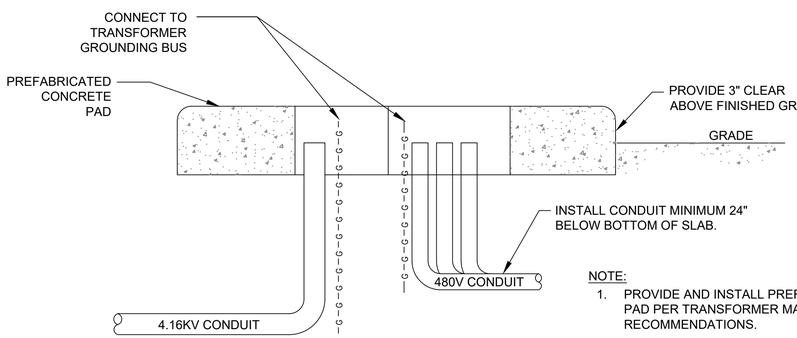


PLAN

19 VAR. **PAD MOUNTED TRANSFORMER GROUNDING**
NOT TO SCALE



21 VAR. **TERMINATION OF SHIELDED CONTROL CABLE**
NOT TO SCALE
NOTE: SHIELD GROUNDED AT TERMINATION.



NOTE:
1. PROVIDE AND INSTALL PREFABRICATED CONCRETE PAD PER TRANSFORMER MANUFACTURER'S RECOMMENDATIONS.
2. INSTALL THREADED INSERTS AS REQUIRED BY TRANSFORMER MANUFACTURER TO ANCHOR TRANSFORMER TO PAD.

20 VAR. **PAD MOUNT TRANSFORMER PAD DETAIL**
NOT TO SCALE

File Name: E:\PROJECTS\PP\PP14\dwg\PP14E16.dwg - (Plotted by: Chamness, Steve on Monday, June 01, 2020 9:26:57 AM)

NO	DATE	REVISION	BY	NO	DATE	REVISION	BY

HILLERS ELECTRICAL ENGINEERING, INC.
23257 STATE ROAD 7, SUITE 100
BOCA RATON, FLORIDA 33428
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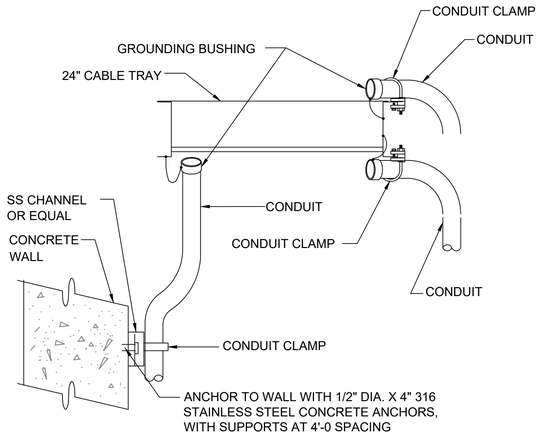
WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

ELECTRICAL DETAILS - SHEET 2

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022

DATE: JUNE 2020 **BID SET**

SCALE: NONE
PROJECT No: PP14
SHEET: E-16

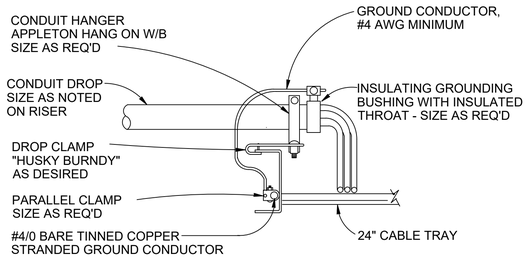


22 VAR.

CONDUIT DROP FROM CABLE TRAY

NOT TO SCALE

NOTE: ALL HARDWARE SHALL BE 316 STAINLESS STEEL.

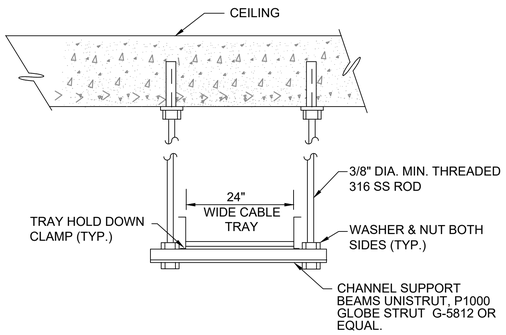


23 VAR.

CONDUIT DROP TO CABLE TRAY

NOT TO SCALE

NOTE: ALL HARDWARE SHALL BE 316 STAINLESS STEEL.

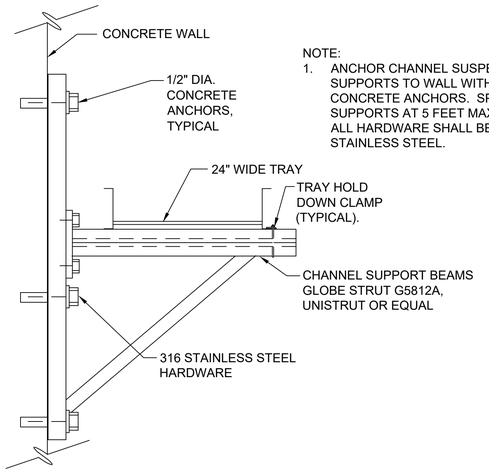


24 VAR.

DUAL TRAY SUPPORT SYSTEM (BEAM MOUNTING)

NOT TO SCALE

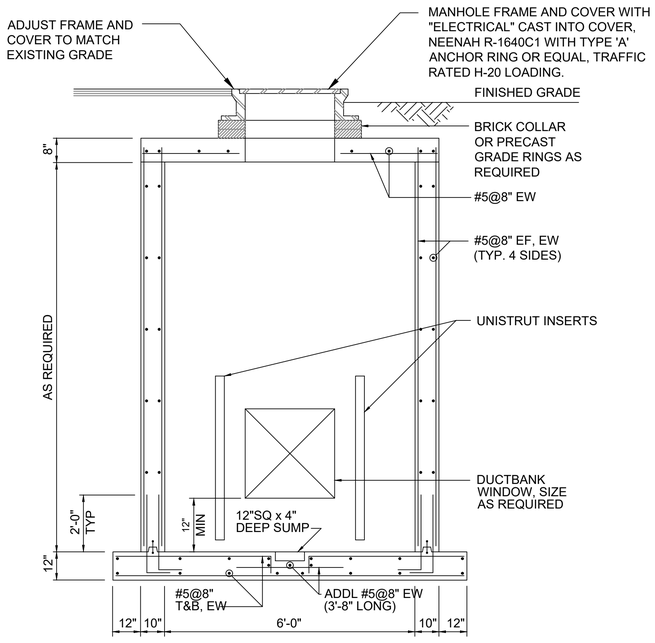
NOTE: ALL HARDWARE SHALL BE 316 STAINLESS STEEL.



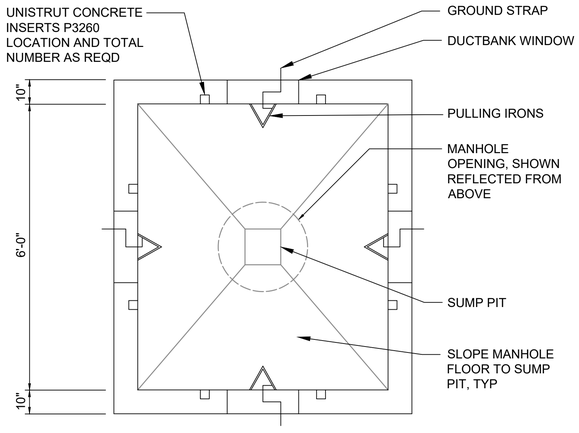
25 VAR.

CABLE TRAY SUPPORT SYSTEM (SUSPENSION)

NOT TO SCALE



ELEVATION VIEW



PLAN VIEW

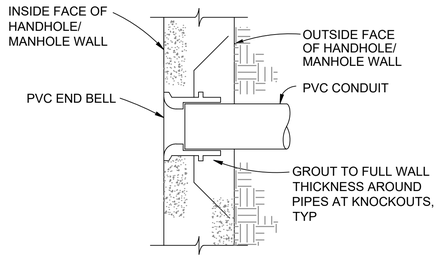
26 VAR.

MEDIUM VOLTAGE ELECTRICAL MANHOLE

NOT TO SCALE

NOTES FOR ALL MANHOLES:

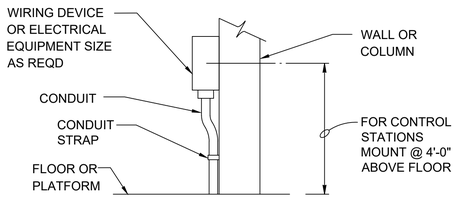
1. HEAVY DUTY NON-METALLIC CABLE RACKS & ARMS ON ALL FOUR WALLS.
   CABLE RACK, API CR24-B OR EQUAL
   CABLE HOOKS, API RA08 OR EQUAL
   ARM LOCK, API HDL OR EQUAL
2. PULLING-IN-IRONS INSTALL OPPOSITE CONDUIT ENTRANCE. POSITION BELOW LEVEL OF CONDUIT ENTRANCE. HUBBART & CO. CATALOG 9119 OR EQUAL.
3. CONTRACTOR SHALL PROVIDE REQUIRED END BELL LOCATIONS TO MANHOLE MANUFACTURER BEFORE MANUFACTURING.
4. ALL MANHOLES SHALL BE H-20 TRAFFIC RATED.
5. THE HEIGHT OF CONDUIT ENTRANCES SHALL BE COORDINATED BY THE CONTRACTOR TO ACCOMMODATE OTHER UTILITIES IN THE AREA.
6. CONTRACTOR SHALL COORDINATE CONDUIT ENTRY REQUIREMENTS WITH SITE PLAN, PRIOR TO ORDERING MANHOLES.
7. GROUND ROD, 3/4"X20'-0, COPPER CLAD.



27 VAR.

CONDUIT MANHOLE ENTRANCE DETAIL

NOT TO SCALE

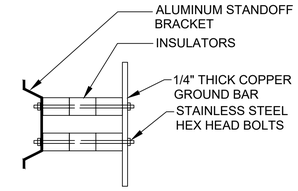


28 VAR.

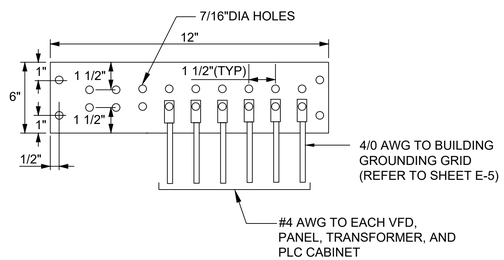
WALL OR COLUMN MOUNTED DEVICE

NOT TO SCALE

NOTE:
ALL MOUNTING HARDWARE SHALL BE STAINLESS STEEL.



SIDE VIEW



ELEVATION VIEW

29 VAR.

GROUNDING BUSBAR

NOT TO SCALE

File Name: E:\PROJECTS\PP\PP14\.dwg\PP14E17.dwg – (Plotted by: Chamness, Steve on Monday, June 01, 2020 9:27:01 AM)

NO	DATE	REVISION	BY	NO	DATE	REVISION	BY

HILLERS ELECTRICAL ENGINEERING, INC.
23257 STATE ROAD 7, SUITE 100
BOCA RATON, FLORIDA 33428
(561) 451-9165
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LICENSE NO: EB 0006877

WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

ELECTRICAL DETAILS - SHEET 3

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022

DATE: JUNE 2020

BID SET

SCALE: NONE

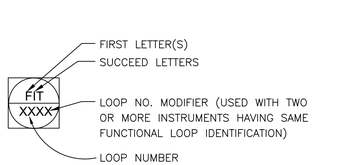
PROJECT No: PP14

SHEET: E-17

IDENTIFICATION LETTERS

	FIRST LETTER		SUCCEEDING LETTER		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM	USER'S CHOICE	USER'S CHOICE
B	BURNER, COMBUSTION		USER'S CHOICE		
C	CONDUCTIVITY			CONTROL	(CLOSED)
D	DENSITY	DIFFERENTIAL			
E	VOLTAGE (EMF)		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	GAUGE		GLASS, VIEWING DEVICE		
H	HAND (MANUAL)				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	MOISTURE	MOMENTARY			MIDDLE INTERMEDIATE
N	USER'S CHOICE	(NORMALLY)	USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
O	USER'S CHOICE		ORIFICE, RESTRICTION		(OPEN)
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TORQUE, TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL	UNCLASSIFIED	
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED		UNCLASSIFIED
Y	EVENT, STATE, OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

INSTRUMENT IDENTIFICATION




FIELD MOUNTED INSTRUMENT


REAR OF PANEL MOUNTED INSTRUMENT


FRONT OF PANEL MOUNTED INSTRUMENT

MOTOR STATUS/CONTROL WITH INTERLOCKS (OFTEN LOCATED IN MCC)

PLC (PROGRAMMABLE LOGIC CONTROLLER)

HMI


ALARM ANNUNCIATOR OR STATUS INDICATING LIGHT

TIMER

NOTES:

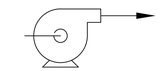
1. COMPONENTS AND PANELS SHOWN WITH A DIAMOND (◆) ARE TO BE PROVIDED UNDER SECTION "INSTRUMENTATION & CONTROLS".
2. COMPONENTS AND PANELS SHOWN WITH A DOUBLE ASTERISK (**) ARE TO BE PROVIDED AS PART OF A PACKAGED OR MECHANICAL SYSTEM.
3. COMPONENTS AND PANELS SHOWN WITH A TRIANGLE (▲) ARE EXISTING.
4. COMPONENTS AND PANELS SHOWN WITH A HEXAGON (⬣) ARE EXISTING TO BE MODIFIED AND/OR RELOCATED.
5. COMPONENTS AND PANELS SHOWN WITH A SQUARE (■) ARE FUTURE.
6. DURING SHOP DRAWING PREPARATION, THE CONTRACTOR SHALL FIELD VERIFY ALL THE EXISTING ANALOG AND DISCRETE POINTS FOR DETAILED INTERFACE AND INCLUDE IT AS PART OF SUBMITTAL.
7. THE SINGLE INSTRUMENT & CONTROL SUPPLIER SHALL HAVE A U.L. APPROVED SHOP.
8. ALL PROCESS TUBING AND ISOLATION VALVES SHALL BE 1/4"– 316 S.S., UNLESS OTHERWISE NOTED ON OTHER DRAWINGS.
9. ALL CONTROL PANELS SHALL BE FURNISHED AND INSTALLED WITH A 1P–15A CIRCUIT BREAKER.
10. SEE MECHANICAL PLANS AND SPECIFICATIONS FOR EQUIPMENT NUMBERS.
11. NO ELECTRICAL CONDUITS, INSTRUMENTS, OR PANEL SHALL BE MOUNTED ON HANDRAIL.

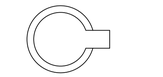
INSTRUMENT ABBREVIATION

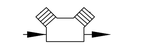
ACC	ACCELATOR
AT	AUTO–TEST
BFP	BELT FILTER PRESS
CL2	CHLORINE
CLW	CLEARWELL
COM	COMMON
COND	CONDUCTIVITY
CP	CONTROL PANEL
DI, AI	DISCRETE INPUT, ANALOG INPUT
DO, AO	DISCRETE OUTPUT, ANALOG OUTPUT
D.O.	DISSOLVED OXYGEN
DR	DISTANCE RELAY
EFFL	EFFLUENT
EP	ELECTRICAL PANEL
ES	EMERGENCY STOP
ETM	ELAPSED TIME METER
FD	CHEMICAL FEEDER
FIL	FILTER
FIS	FLOW INDICATING SWITCH
FRS	FORWARD–REVERSE–STOP
GEN	GENERATOR
HLO	HIGH–LOW–OFF
HLOR	HIGH–LOW–OFF–REMOTE
HOA	HAND–OFF–AUTO
HOR	HAND–OFF–REMOTE
HOTC	HAND–OFF–TIMER–COMPUTER
H/L	HIGH/LOW
HSP	HIGH SERVICE PUMP
IND	INDICATION
INFL	INFLUENT
JP	JOCKEY PUMP
LOR	LOCAL–OFF–REMOTE
LOS	LOCK–OUT–STOP
LPU	LINE PROTECTION UNIT
MCC	MOTOR CONTROL CENTER
MCP	MAIN CONTROL PANEL
ME	MISCELLANEOUS EQUIPMENT
M.G.	MILLION GALLON
MOA	MANUAL–OFF–AUTO
MOV	MOTOR OPERATED VALVE
OCA	OPEN–CLOSE–AUTO
OC	OPEN–CLOSE
OO	ON–OFF
ORP	OXIDATION REDUCTION POTENTIAL
OSC	OPEN–STOP–CLOSE
OSCR	OPEN–STOP–CLOSE–REMOTE
PAFM	POWER APPLIED FOR MOVEMENT
PRES	PRESSURE
PH	HYDROGEN ION CONCENTRATION
RES	RESTORE
REF	REFERENCE
RF	RF (ADMITTANCE) LEVEL MONITOR
RIP	REMOTE I/O PANEL
R/L	REMOTE/LOCAL
RSP	REMOTE SETPOINT
SA	SURGE ARRESTER
SEC	SECONDARY
SL	SLAKER
SF	SONIC FLOWMETER
SP	SETPOINT
SS	START/STOP
ST	STEP
STOR	STORAGE
SUS	SUSPENDED SOLIDS
SSRVS	SOLID STATE REDUCED VOLTAGE STARTER
TD	THERMAL DISPERSION
TP	TRANSFER PUMP
TURB	TURBIDITY
VFD	VARIABLE FREQUENCY DRIVE

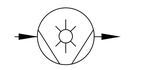
INSTRUMENTATION LEGEND

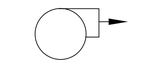
PUMPS & COMPRESSORS

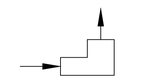

CENTRIFUGAL PUMP


CENTRIFUGAL PUMP (WET PIT)

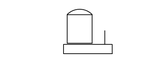

COMPRESSOR


VACUUM PUMP


BLOWER/FAN


METERING PUMP


PROGRESSING CAVITY PUMP


SUMP PUMP

INSTRUMENT LINE SYMBOLS

PRIMARY PROCESS FLOW

FUTURE PRIMARY PROCESS FLOW

SECONDARY PROCESS FLOW, CONNECTION TO PROCESS FLOW, MECHANICAL LINK OR INSTRUMENT SUPPLY

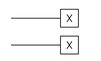
ELECTRICAL SIGNAL (DISCRETE)

ELECTRICAL SIGNAL (ANALOG)

PNEUMATIC SIGNAL

FIBER OPTIC

DEVICENET



PROCESS OR SIGNAL CONTINUED SOMEWHERE ELSE (X=1,2,3,...)

ACTUATOR OR OPERATORS

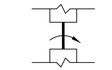
SOLENOID VALVE

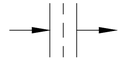
MOTOR

HYDRAULIC

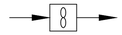
PNEUMATIC

PRIMARY ELEMENTS

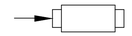

WEIR


ORIFICE PLATE


VENTURI


PROPELLER METER


ROTAMETER


ELECTROMAGNETIC FLOWMETER

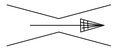

LEVEL (BUBBLE TUBE)

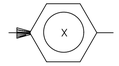

LEVEL (FLOAT)


LEVEL (ULTRASONIC)

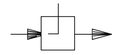

ULTRASONIC FLOWMETER (IN–LINE MAGNETIC)

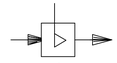
RF ADMITTANCE


PARSHALL FLUME



DENSITY METER
(X: N = NUCLEAR
O = OPTICAL
U = ULTRASONIC)


PITOT–STATIC


VORTEX METER

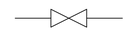

SUSPENDED SOLIDS


PROPELLER PUMP

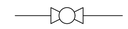

HEAT EXCHANGER

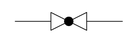
VALVES & GATES

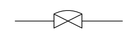

BUTTERFLY


GATE

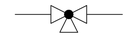

CHECK


BALL


GLOBE


DIAPHRAGM


PLUG


3–WAY VALVE

CULVERT GATE


PRESSURE REGULATING VALVE

ELECTRICAL DEVICES


DISCONNECT

NO	DATE	REVISION	BY	NO	DATE	REVISION	BY

HILLERS ELECTRICAL ENGINEERING, INC.
23257 STATE ROAD 7, SUITE 100
BOCA RATON, FLORIDA 33428
(561) 451–9165
(561) 451–4886 FAX
LICENSE NO: EB 0006877

WASTE WATER TREATMENT PLANT EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

INSTRUMENTATION LEGEND AND SYMBOLS

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022

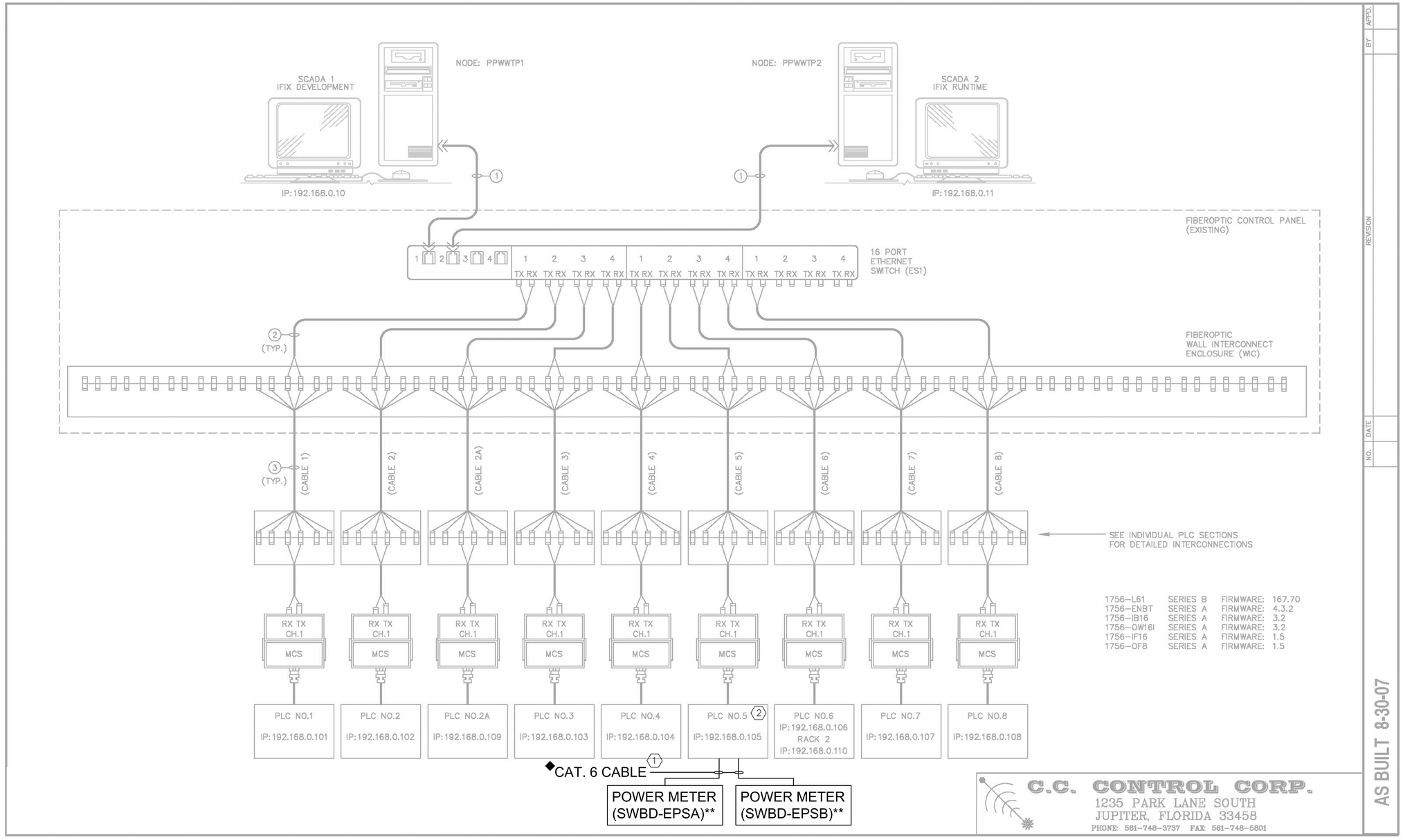
DATE: JUNE 2020

BID SET

SCALE: NONE

PROJECT No: PP14

SHEET: **E-18**



KEY NOTES

1. CONTRACTOR SHALL PROVIDE AND INSTALL NEW CAT-6 ETHERNET CABLE FROM NEW POWER METERS TO THE EXISTING PLC-5 PANEL. EACH CABLE SHALL BE PROVIDED WITH MINIMUM OF 5 FEET EXTRA INSIDE THE PLC-5 PANEL FOR FUTURE CONNECTION. THE INTEGRATION OF POWER METER INTO THE PLANT SCADA SYSTEM AND ADDING NEW ETHERNET SWITCH IN THE PLC-5 PANEL IS NOT PART THIS PROJECTION.

2. REFER TO OTHER INSTRUMENTATION DRAWINGS FOR ADDITIONAL MODIFICATIONS RELATING TO THE EXISTING PLC-5 PANEL AND PERFORM ACCORDINGLY.

NO	DATE	REVISION	BY	NO	DATE	REVISION	BY

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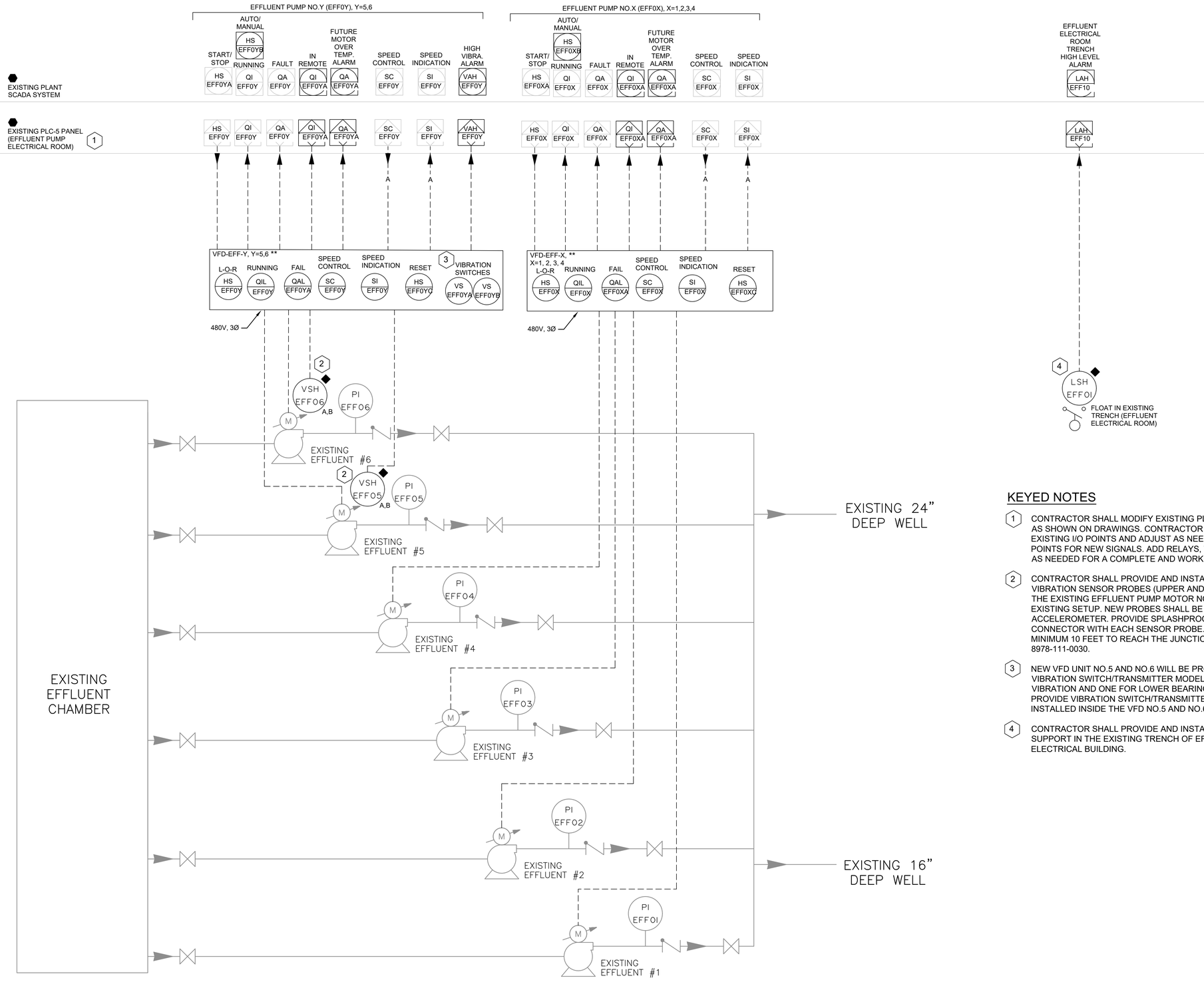
WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

COMMUNICATION BLOCK DIAGRAM

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022
DATE: JUNE 2020

BID SET

SCALE: NONE
PROJECT No: **PP14**
SHEET: **E-19**



KEYED NOTES

1. CONTRACTOR SHALL MODIFY EXISTING PLC-5 PANEL TO ADD NEW SIGNALS AS SHOWN ON DRAWINGS. CONTRACTOR SHALL FIELD VERIFY THE EXISTING I/O POINTS AND ADJUST AS NEEDED. USE EXISTING SPARE I/O POINTS FOR NEW SIGNALS. ADD RELAYS, TERMINAL BLOCKS, WIRING, ETC. AS NEEDED FOR A COMPLETE AND WORKING PLC SYSTEM IN PLACE.
2. CONTRACTOR SHALL PROVIDE AND INSTALL/REPLACE NEW MOTOR VIBRATION SENSOR PROBES (UPPER AND LOWER VIBRATION SWITCH) ON THE EXISTING EFFLUENT PUMP MOTOR NO.5 AND NO.6 SIMILAR TO THE EXISTING SETUP. NEW PROBES SHALL BE METRIX MODEL SA6200 ACCELEROMETER. PROVIDE SPLASHPROOF CABLE ASSEMBLY WITH CONNECTOR WITH EACH SENSOR PROBE. CABLE LENGTH SHALL BE MINIMUM 10 FEET TO REACH THE JUNCTION AND USE PART NUMBER: 8978-111-0030.
3. NEW VFD UNIT NO.5 AND NO.6 WILL BE PROVIDED WITH TWO METRIX VIBRATION SWITCH/TRANSMITTER MODEL:440, ONE FOR UPPER BEARING VIBRATION AND ONE FOR LOWER BEARING VIBRATION. CONTRACTOR SHALL PROVIDE VIBRATION SWITCH/TRANSMITTERS TO THE VFD SUPPLIER TO BE INSTALLED INSIDE THE VFD NO.5 AND NO.6.
4. CONTRACTOR SHALL PROVIDE AND INSTALL FLOAT WITH MOUNTING SUPPORT IN THE EXISTING TRENCH OF EFFLUENT PUMP STATION ELECTRICAL BUILDING.

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WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

P&ID - EFFLUENT PUMP STATION

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022

DATE: JUNE 2020 **BID SET**

SCALE: NONE
PROJECT No: PP14
SHEET: **E-20**

EXISTING PLC-5 CONTROL PANEL (WITH DOOR OPEN)

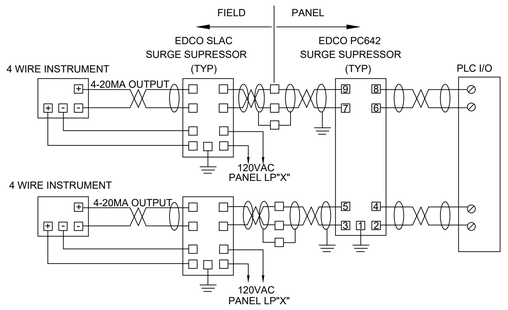
NOT TO SCALE

EXISTING I/O POINTS TO BE REUSED:

PLC-5:R1/S2/DI00: EFFLUENT PUMP NO.4 RUNNING
PLC-5:R1/S2/DI01: EFFLUENT PUMP NO.4 FAIL
PLC-5:R1/S2/DI02: EFFLUENT PUMP NO.3 RUNNING
PLC-5:R1/S2/DI03: EFFLUENT PUMP NO.3 FAIL
PLC-5:R1/S2/DI10: EFFLUENT PUMP NO.5 RUNNING
PLC-5:R1/S2/DI11: EFFLUENT PUMP NO.5 FAIL
PLC-5:R1/S2/DI13: EFFLUENT PUMP NO.6 RUNNING
PLC-5:R1/S2/DI14: EFFLUENT PUMP NO.6 FAIL
PLC-5:R1/S3/DI00: EFFLUENT PUMP NO.2 RUNNING
PLC-5:R1/S3/DI01: EFFLUENT PUMP NO.2 FAIL
PLC-5:R1/S3/DI02: EFFLUENT PUMP NO.1 RUNNING
PLC-5:R1/S3/DI03: EFFLUENT PUMP NO.1 FAIL
PLC-5:R1/S4/DO00: EFFLUENT PUMP NO.4 START/STOP
PLC-5:R1/S4/DO01: EFFLUENT PUMP NO.3 START/STOP
PLC-5:R1/S4/DO02: EFFLUENT PUMP NO.2 START/STOP
PLC-5:R1/S4/DO03: EFFLUENT PUMP NO.1 START/STOP
PLC-5:R1/S4/DO04: EFFLUENT PUMP NO.5 START/STOP
PLC-5:R1/S4/DO05: EFFLUENT PUMP NO.6 START/STOP
PLC-5:R1/S5/AI04: EFFLUENT PUMP NO. 5 SPEED FEEDBACK
PLC-5:R1/S5/AI07: EFFLUENT PUMP NO. 6 SPEED FEEDBACK
PLC-5:R1/S7/AI00: EFFLUENT PUMP NO. 4 SPEED FEEDBACK
PLC-5:R1/S7/AI01: EFFLUENT PUMP NO. 3 SPEED FEEDBACK
PLC-5:R1/S7/AI04: EFFLUENT PUMP NO. 2 SPEED FEEDBACK
PLC-5:R1/S7/AI05: EFFLUENT PUMP NO. 1 SPEED FEEDBACK
PLC-5:R1/S9/AO00: EFFLUENT PUMP NO. 4 SPEED CONTROL
PLC-5:R1/S9/AO01: EFFLUENT PUMP NO. 3 SPEED CONTROL
PLC-5:R1/S9/AO02: EFFLUENT PUMP NO. 2 SPEED CONTROL
PLC-5:R1/S9/AO03: EFFLUENT PUMP NO. 1 SPEED CONTROL
PLC-5:R1/S9/AO06: EFFLUENT PUMP NO. 5 SPEED CONTROL
PLC-5:R1/S9/AO07: EFFLUENT PUMP NO. 6 SPEED CONTROL

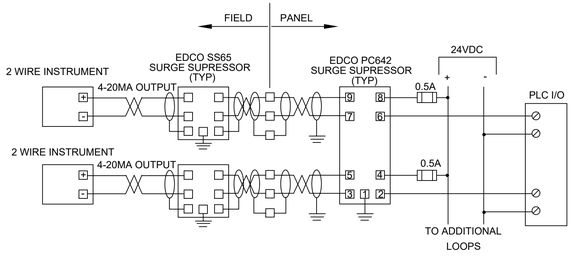
NEW I/O SIGNALS USING EXISTING I/O POINTS:

PLC-5:R1/S2/DI04: EFFLUENT PUMP NO.5 IN REMOTE
PLC-5:R1/S2/DI05: EFFLUENT PUMP NO.5 MOTOR OVER TEMP. ALARM
PLC-5:R1/S2/DI12: EFFLUENT PUMP NO.6 IN REMOTE
PLC-5:R1/S2/DI15: EFFLUENT PUMP NO.6 MOTOR OVER TEMP. ALARM
PLC-5:R1/S3/DI04: EFFLUENT PUMP NO.4 IN REMOTE
PLC-5:R1/S3/DI05: EFFLUENT PUMP NO.4 MOTOR OVER TEMP. ALARM
PLC-5:R1/S3/DI06: EFFLUENT PUMP NO.3 IN REMOTE
PLC-5:R1/S3/DI07: EFFLUENT PUMP NO.3 MOTOR OVER TEMP. ALARM
PLC-5:R1/S3/DI09: EFFLUENT PUMP NO.2 IN REMOTE
PLC-5:R1/S3/DI10: EFFLUENT PUMP NO.2 MOTOR OVER TEMP. ALARM
PLC-5:R1/S3/DI11: EFFLUENT PUMP NO.1 IN REMOTE
PLC-5:R1/S3/DI12: EFFLUENT PUMP NO.1 MOTOR OVER TEMP. ALARM
PLC-5:R1/S3/DI13: EFFLUENT PUMP NO.5 HIGH VIBRATION ALARM
PLC-5:R1/S3/DI14: EFFLUENT PUMP NO.6 HIGH VIBRATION ALARM
PLC-5:R1/S3/DI15: EFFLUENT ELEC ROOM TRENCH HIGH LEVEL ALARM



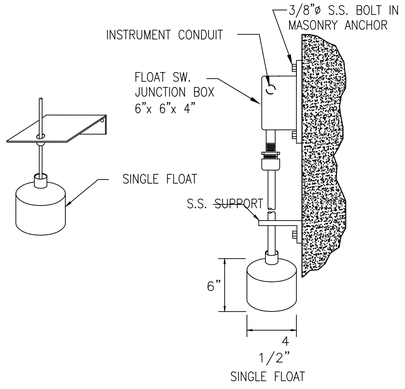
1 VAR. TYPICAL 4 WIRE INSTRUMENT ISOLATOR

NOT TO SCALE



2 VAR. TYPICAL 2 WIRE INSTRUMENT ISOLATOR

NOT TO SCALE



3 VAR. LEVEL FLOAT SWITCH DETAIL

NOT TO SCALE

File Name: E:\PROJECTS\PP\PP14\dwg\PP14E21.dwg – (Plotted by: Chamness, Steve on Monday, June 01, 2020 9:27:21 AM)

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WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

EXISTING PLC-5 PANEL MODIFICATION

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022

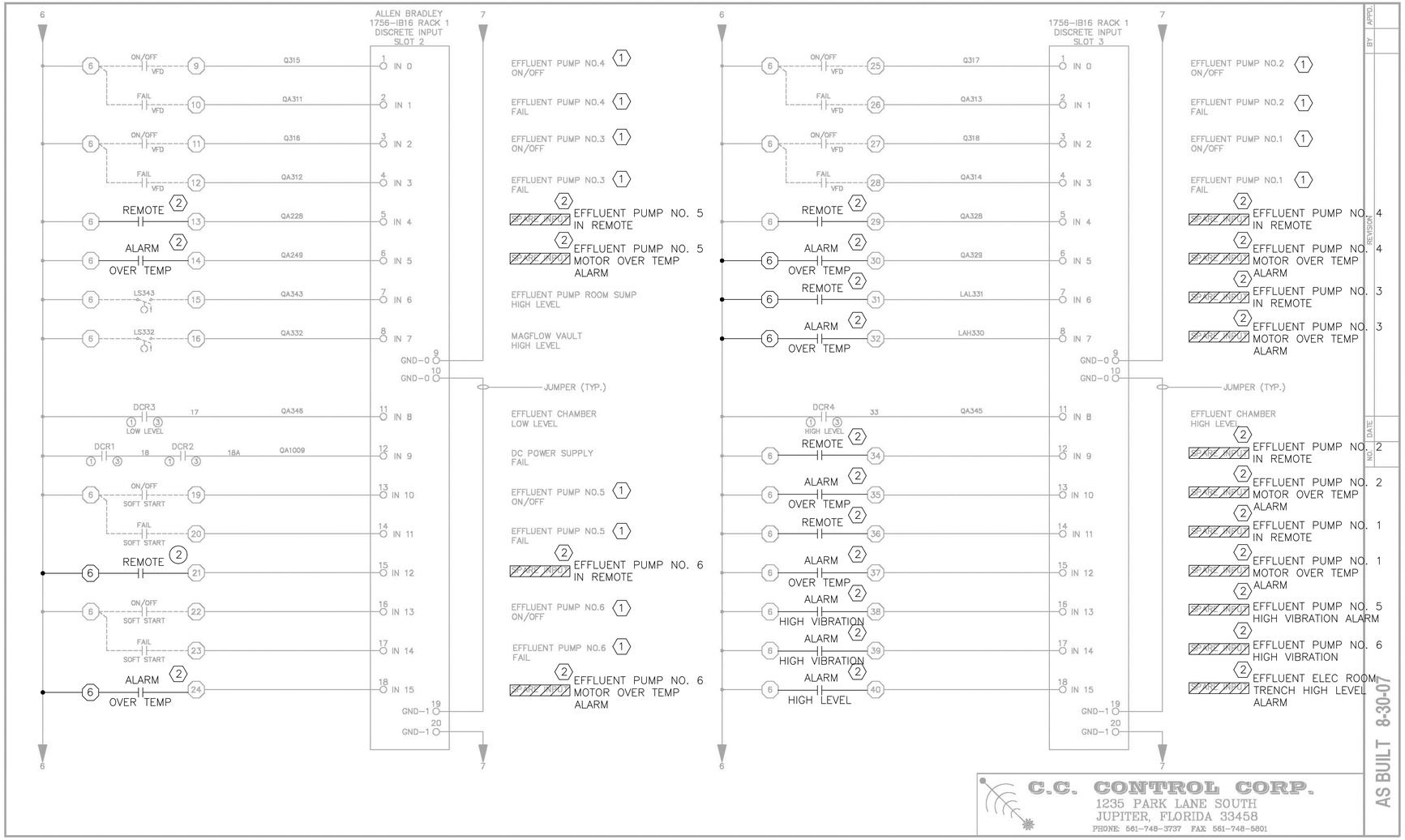
DATE: JUNE 2020

BID SET

SCALE: NONE

PROJECT No: PP14

SHEET: E-21



C.C. CONTROL CORP.
1235 PARK LANE SOUTH
JUPITER, FLORIDA 33458
PHONE: 561-748-3737 FAX 561-748-5801

KEY NOTES

1. CONTRACTOR SHALL FIELD IDENTIFY AND VERIFY THE EXISTING I/O POINTS ASSOCIATED WITH THE EFFLUENT VFD UNITS BEFORE DISCONNECTING THEM AND LABEL THEM AS NEEDED. RECONNECT EXISTING SIGNALS TO NEW/REPLACEMENT VFD UNITS SIMILAR TO EXISTING.

2. CONTRACTOR SHALL USE EXISTING SPARE I/O POINTS AS SHOWN ON DRAWINGS FOR NEW SIGNALS. MODIFY EXISTING SPARE I/O POINTS AS NEEDED, INCLUDING ADDING RELAYS, SURGE ARRESTORS, TERMINAL BLOCKS, WIRING, ETC. FOR A COMPLETE AND FUNCTIONAL I/O SYSTEM IN PLACE.

NO	DATE	REVISION	BY

HILLERS ELECTRICAL ENGINEERING, INC.
23257 STATE ROAD 7, SUITE 100
BOCA RATON, FLORIDA 33428
(561) 451-9165
(561) 451-4886 FAX
LICENSE NO: EB 0006877

WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

IO LOOP DIAGRAMS - SHEET 1

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022

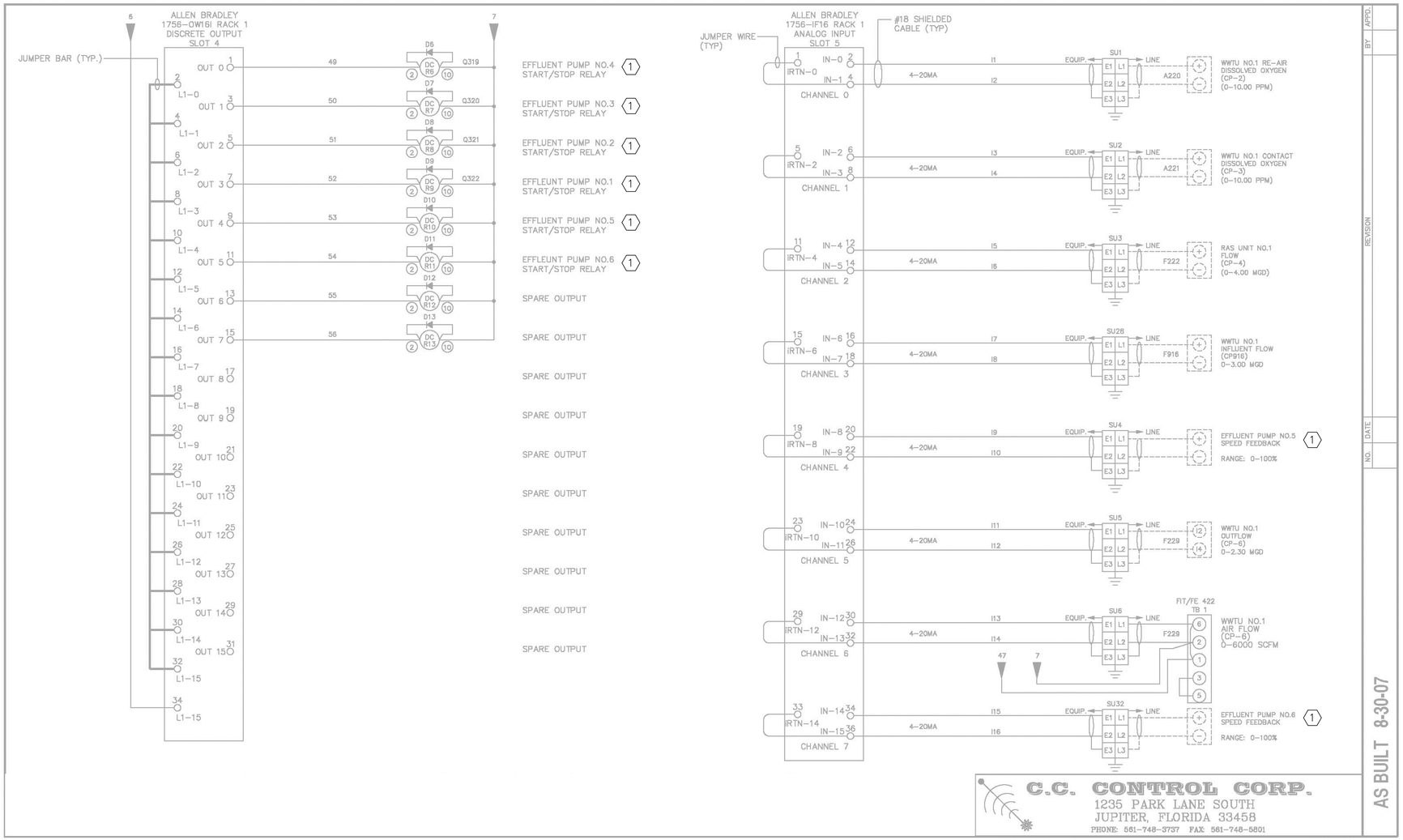
DATE: JUNE 2020

BID SET

SCALE: NONE

PROJECT No: PP14

SHEET: **E-22**



C.C. CONTROL CORP.
1235 PARK LANE SOUTH
JUPITER, FLORIDA 33458
PHONE: 561-748-3737 FAX: 561-748-5801

KEY NOTES

1. CONTRACTOR SHALL FIELD IDENTIFY AND VERIFY THE EXISTING I/O POINTS ASSOCIATED WITH THE EFFLUENT VFD UNITS BEFORE DISCONNECTING THEM AND LABEL THEM AS NEEDED. RECONNECT EXISTING SIGNALS TO NEW/REPLACEMENT VFD UNITS SIMILAR TO EXISTING.

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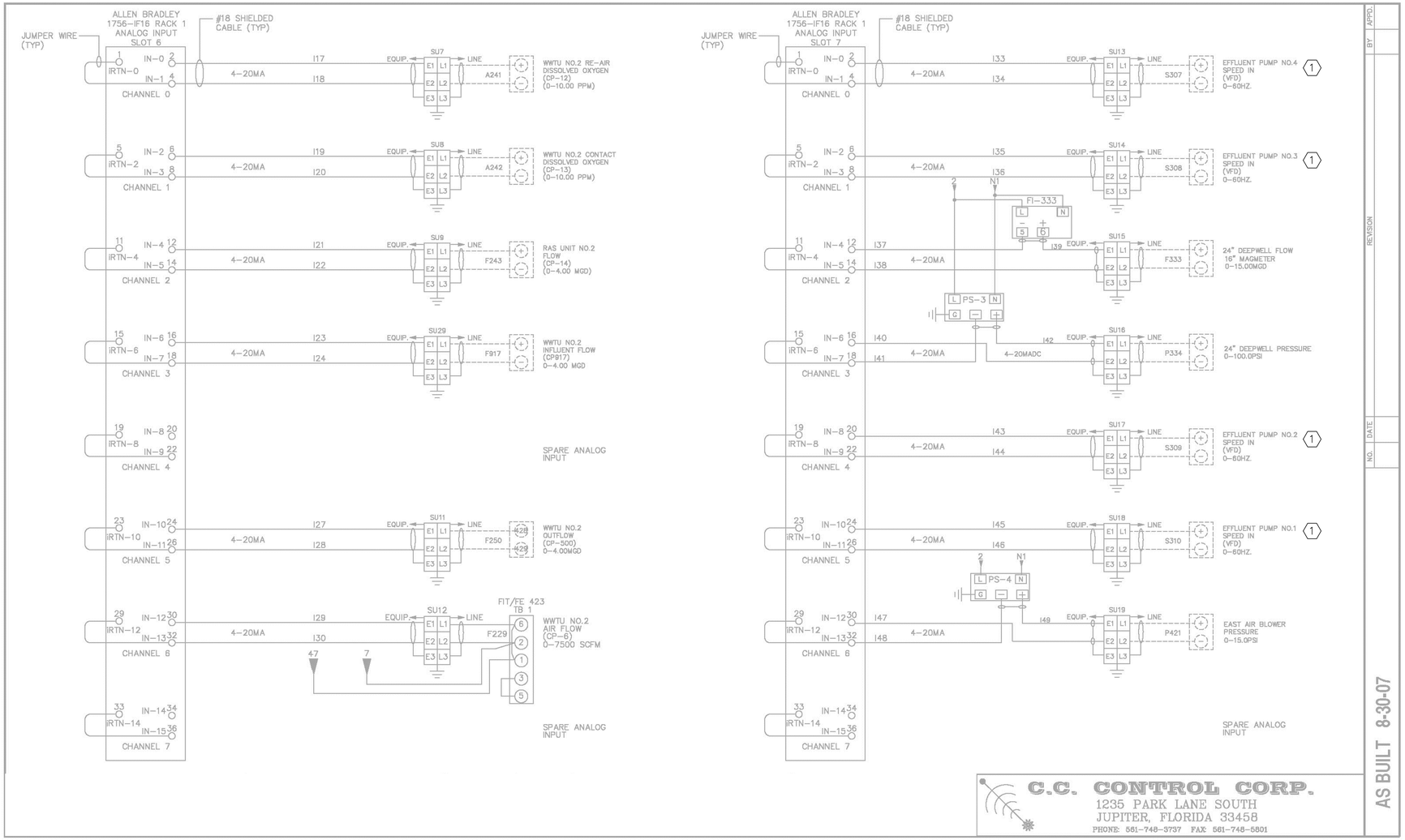
WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

IO LOOP DIAGRAMS - SHEET 2

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022

DATE: JUNE 2020 **BID SET**

SCALE: NONE
PROJECT No: **PP14**
SHEET: **E-23**



KEY NOTES

(1) CONTRACTOR SHALL FIELD IDENTIFY AND VERIFY THE EXISTING I/O POINTS ASSOCIATED WITH THE EFFLUENT VFD UNITS BEFORE DISCONNECTING THEM AND LABEL THEM AS NEEDED. RECONNECT EXISTING SIGNALS TO NEW/REPLACEMENT VFD UNITS SIMILAR TO EXISTING.

NO	DATE	REVISION	BY	NO	DATE	REVISION	BY
1							

HILLERS ELECTRICAL ENGINEERING, INC.
23257 STATE ROAD 7, SUITE 100
BOCA RATON, FLORIDA 33428
(561) 451-9165
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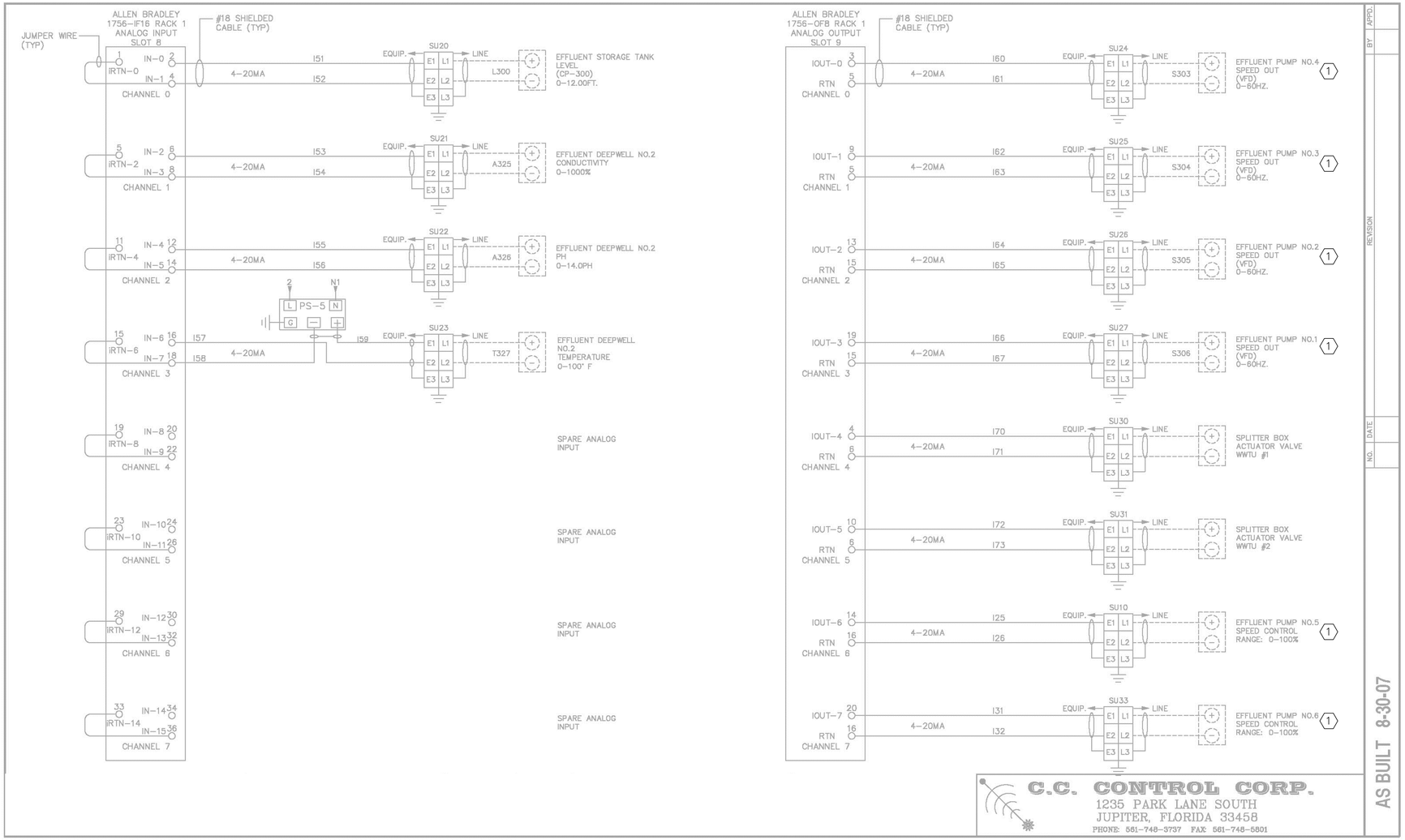
WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

IO LOOP DIAGRAMS - SHEET 3

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022
DATE: JUNE 2020

BID SET

SCALE: NONE
PROJECT No: **PP14**
SHEET: **E-24**



KEY NOTES

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NO	DATE	REVISION	BY	NO	DATE	REVISION	BY

HILLERS ELECTRICAL ENGINEERING, INC.
23257 STATE ROAD 7, SUITE 100
BOCA RATON, FLORIDA 33428
(561) 451-9165
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LICENSE NO: EB 0006877

WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

IO LOOP DIAGRAMS - SHEET 4

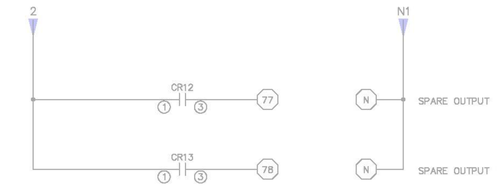
PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022

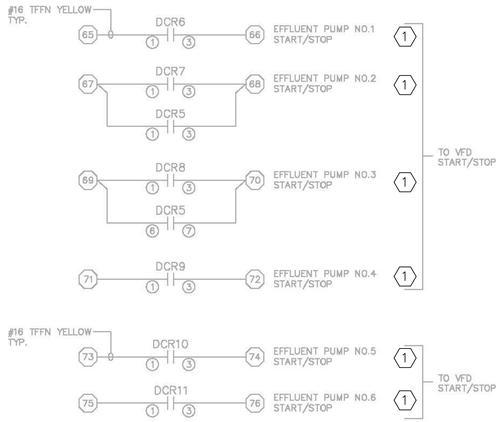
DATE: JUNE 2020 **BID SET**

SCALE: NONE

PROJECT No: **PP14**

SHEET: **E-25**





REVISION | NO. | DATE | BY | APPD.

AS BUILT 8-30-07

C.C. CONTROL CORP.
1235 PARK LANE SOUTH
JUPITER, FLORIDA 33458
PHONE: 561-748-3737 FAX: 561-748-5801

KEY NOTES

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HILLERS ELECTRICAL ENGINEERING, INC.
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WASTE WATER TREATMENT PLANT
EFFLUENT PUMP STATION ELECTRICAL REHABILITATION
PEMPROKE PINES, FLORIDA

RELAY WIRING

PAUL F. HILLERS, P.E.
STATE OF FLORIDA PROFESSIONAL ENGINEER
LICENSE No.41022

DATE: JUNE 2020

BID SET

SCALE: NONE

PROJECT No: **PP14**

SHEET: **E-26**