

## **ADDENDUM #3**

PROJECT: FY2020 WASTEWATER TREATMENT FACILITY UPGRADES

ACTION: Contract Documents and Specification Changes, Contractor Questions and Answers

DATE: July 19, 2022

ORIGINAL BID DATE: July 14, 2022

REVISED BID DATE: July 28, 2022

The following questions, comments, and clarifications are for the above referenced plans and/or contract documents:

1. Q: The new electrical engineer is calling out all kinds of NETA third party testing that is going to be in the 10's of thousands. Was going to see if this really something wanted it or if it is a cut copy and paste.  
A: NETA certified testing agencies were specified in multiple electrical specification sections. These requirements have been eliminated. See items 11-21 below.
2. Q: Bid document state the use of galvanized strut channel for supporting means. WWTP's projects generally use Stainless Steel or Aluminum Strut channel or structural formed members to corrosion resistance. Consider revising?  
A: Plan sheet E0.1 of the bid documents has been changed to note acceptance of aluminum strut channel. The revised plan sheet is attached.
3. Q: Bid document state the use of PVC coated conduit for all installations. I know that budget is an issue for this project. To reduce the overall cost of the electrical work required for this project consider using Aluminum above grade and PVC Sch 40 or 80 below grade.  
A: Plan sheet E0.1 of the bid documents has been revised to allow for Sch 80 PVC below ground and aluminum above grade. The revised plan sheet is attached.
4. Q: Whom will be responsible for cost of material and labor for tested conductors that fail and will need to be replaced?  
A: The contractor will be asked to provide pricing for the material and labor to replace the failed conductors. Upon approval, funds will be provided from the Supplemental Work Allowance to cover the cost of the additional work.
5. Q: Will all existing breakers require the removal from service and NETA testing? If so, what is the strategy for maintaining the operation of equipment each breaker

services? We understand that you are applying the requirement of NFPA to this facility for testing and maintenance but most of these types of facilities do not have the option to shut down the process like a manufacturing facility does for this type of testing.

A: Third party NETA testing requirements are to be eliminated from the specifications, however the testing called out on Sheet E0.1, General Note D will be required for existing wire and conduit running to new or replaced pieces of equipment. It is anticipated that the equipment to be replaced will be able to be taken offline for testing with a redundant piece of equipment in operation.

6. Q: Will the NETA testing requirements pertain to the new equipment and breakers to be installed?

A: Third party NETA testing requirements to be eliminated from the specifications, however the testing called out on Sheet E0.1, General Note D will be required for existing wire and conduit to serve to new or replaced pieces of equipment.

7. Q: Does cable testing have to be done by Third Party or will the contractor be permitted to do this? Will the testing need to be witnessed by engineer?

A: Testing may be completed by the contractor and will not need to be witnessed by the engineer. However, records of testing and results shall be kept with a copy provided to the engineer upon test completion.

8. Q: Will the contractor be responsible for warranty of existing conduits after testing?

A: No, the contractor warranty will not cover existing conduits/wires/breakers that have passed testing. Contractor warranty shall only apply to new conduits/wires/breakers.

9. Q: Notes and procedures for temporary pumping and power has been noted on Sheet E6.2 for the replacement of SWB-2A. There is no requirement for temporary power or pumping to change out all other electrical equipment shown to be changed out?

A: We do not anticipate a requirement for temporary power to change out the other electrical equipment as the plant has built in redundancy. However, this will require scheduling on the part of the primary contractor and electrical subs to keep the minimum number of units in service. The minimum number of units in service will vary depending on the process. The drawings have been revised to include shut down notes on pages P5.1, E1.1, E1.2, E3.1, E4.1, and E5.1. The revised drawings are attached.

10. Q: Can a list of specific items to be included in Bid Form item number 12 be provided so we can make sure there is not overlap in other bid items and no assumptions made?

A: Yes. Bid Form Item number 12 should include:

- Pump House Demolition and Installation of new breakers in SWB-1 and SWB-2, new SWB-2A, and feeder to MCC-1. (Per details 2/ES1.1)
- Leachate Pump Power System Demolition and Installation of new wiring/conduit/mounting supports and panels HLP & LLP. (Per details 3/ES1.1)
- Work associated with Demolition items B and C on ES1.1.
- Strip Heaters for repair work to MCC-7.

A new bid item (#10A) will be added to include MCC-8 and wire/conduit to feed MCC-8. Wire and conduit from MCC-8 to various pieces of equipment shall be included in the line items for the associated equipment. The revised Bid Tab is included as part of the addendum.

11. Specification 00410 BID FORM has been revised to include Bid Item 10A – MCC-8. The new BID FORM is attached.

12. Specification 260526 GROUNDING AND BONDING, PART 1 - GENERAL. Remove the following text:

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by NETA

13. Specification 262419 MOTOR CONTROL CENTERS, PART 3 – EXECUTION, 3.4 FIELD QUALITY CONTROL, C. Test and Inspections: Remove the following text:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

14. Specification 262913.06 SOFT-START MOTOR CONTROLLERS, PART 1 - GENERAL. Remove the following text:

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA

1. Testing agency's Field Supervisor: Certified by NETA to supervise on-site testing.

15. Specification 262913.06 SOFT-START MOTOR CONTROLLERS, PART 3 – EXECUTION, 3.4 FIELD QUALITY CONTROL. Remove the following text:

A. Manufacturer's Field Services: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installation, including connections.

16. Specification 262913.06 SOFT-START MOTOR CONTROLLERS, PART 3 – EXECUTION. Remove the following text:
  - 3.6 DEMONSTRATION
    - A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain motor controllers.
17. Specification 262923 – VARIABLE-FREQUENCY MOTOR CONTROLLERS, PART 1 - GENERAL. Remove the following text:
  - 1.7 QUALITY ASSURANCE
    - A. Testing Agency Qualifications: Accredited by NETA
      1. Testing agency’s Field Supervisor: Certified by NETA to supervise on-site testing
18. Specification 262923 – VARIABLE-FREQUENCY MOTOR CONTROLLERS, PART 3 – EXECUTION, 3.5 FIELD QUALITY CONTROL. Remove the following text:
  - A. Manufacturer’s Field Services: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installation, including connections.
19. Specification 262923 – VARIABLE-FREQUENCY MOTOR CONTROLLERS, PART 3 – EXECUTION. 3.5 FIELD QUALITY CONTROL, C. Test and Inspections: Remove the following text:
  6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
20. Specification 262923 – VARIABLE-FREQUENCY MOTOR CONTROLLERS, PART 3 – EXECUTION. Remove the following text:
  - 3.6 STARTUP SERVICE
    - A. Engage a factory-authorized service representative to perform startup service.
21. Specification 262923 – VARIABLE-FREQUENCY MOTOR CONTROLLERS, PART 3 – EXECUTION. Remove the following text:
  - 3.9 DEMONSTRATION
    - A. Engage a factory-authorized service representative to train Owner’s personnel to adjust, operate, reprogram, and maintain VFCs.
22. Electrical specification sections 260519 through 262923 are attached and include all revisions shown in items 12 – 21 above.

23. Plan sheet C0.0, P5.1. E0.1, E1.1, E1.2, E3.1. E4.1. and E5.1 have been revised and are attached per the previous questions and responses.

All bidders shall acknowledge receipt of all addenda issued where indicated on the bid sheets. (SECTION 00410 - BID FORM, Page 2)

**ATTENTION**

**ALL BIDDERS SHALL MARK IN THE SPACE PROVIDED ON THE BID SHEET(S) TO INDICATE RECEIPT OF THIS ADDENDUM.**

**BIDDERS ARE ADVISED THAT IT IS THEIR RESPONSIBILITY TO VERIFY THAT ANY AND ALL ADDENDA HAVE BEEN RECEIVED PRIOR TO SUBMISSION OF THE BID. IN CASE ANY BIDDER FAILS TO ACKNOWLEDGE RECEIPT OF ANY SUCH ADDENDA IN THE SPACE PROVIDED ON THE BID FORM, THE BID WILL NEVERTHELESS BE CONSTRUED AS THOUGH THE BIDDER HAS RECEIVED AND ACKNOWLEDGED ALL SUCH ADDENDA, AND THE SUBMISSION OF THE BID WILL CONSTITUTE ACKNOWLEDGEMENT AND RECEIPT OF SAME.**

**SECTION 00410  
BID FORM**

**PROJECT IDENTIFICATION:**

FY 2020 Wastewater Treatment Facility Upgrades

**CONTRACT IDENTIFICATION AND NUMBER:**

W3000.105

**THIS BID IS SUBMITTED TO:**

City of Waycross  
417 Pendleton Street  
Waycross, GA 31501

**THIS BID IS SUBMITTED FROM:**

Bidder: \_\_\_\_\_

Address: \_\_\_\_\_

\_\_\_\_\_

Phone: \_\_\_\_\_

State of Georgia Utility Contractor's License No.: \_\_\_\_\_

1. The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an agreement with Owner in the form included in the Contract Documents to perform and furnish all Work as specified or indicated in the Contract Documents for the Contract Price and within the Contract Time indicated in this Bid and in accordance with the other terms and conditions of the Contract Documents.
2. Bidder accepts all of the terms and conditions of the Advertisement or Invitation to Bid and Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance for 60 days after the day of Bid opening. Bidder will sign and submit the Agreement with the Bonds and other documents required by the Bidding Requirements within fifteen days after the date of Owner's Notice of Award.
3. In submitting this Bid, Bidder represents, as more fully set forth in the Agreement, that:

- (a) Bidder has examined copies of all the Bidding Documents and of the following Addenda (receipt of all which is hereby acknowledged):

Date	Addendum Number

- (b) Bidder has familiarized itself with the nature and extent of the Contract Documents, Work, site, locality, and all local conditions and Laws and Regulations that in any manner may affect cost, progress, performance or furnishing of the Work.
- (c) Bidder has studied carefully all reports and drawings of subsurface conditions and drawings of physical conditions which are identified in the Supplementary Conditions as provided in paragraph 4.2 of the General Conditions, and accepts the determination set forth in paragraph 4.2.1 of the Supplementary Conditions of the extent of the technical data contained in such reports and drawings upon which Bidder is entitled to rely.
- (d) Bidder has obtained and carefully studied (or assumes responsibility for obtaining and carefully studying) all such examinations, investigations, explorations, tests and studies (in addition to or to supplement those referred to in (c) above) which pertain to the subsurface or physical conditions at the site or otherwise may affect the cost, progress, performance or furnishing of the Work as Bidder considers necessary for the performance or furnishing of the Work at the Contract Price, within the Contract Time and in accordance with the other terms and conditions of the Contract Documents, including specifically the provisions of paragraph 4.2 of the General Conditions; and no additional examinations, investigations, explorations, tests, reports or similar information or data are or will be required by Bidder for such purposes.
- (e) Bidder has reviewed and checked all information and data shown or indicated on the Contract Documents with respect to existing Underground Facilities at or contiguous to the site and assumes responsibility for the accurate location of said Underground Facilities. No additional examinations, investigations, explorations, tests, reports or similar information or data in respect of said Underground Facilities are or will be required by Bidder in order to perform and furnish the Work

at the Contract Price, within the Contract Time and in accordance with the other terms and conditions of the Contract Documents, including specifically the provisions of paragraph 4.3 of the General Conditions.

- (f) Bidder has correlated the results of all such observations, examinations, investigations, explorations, tests, reports and studies with the terms and conditions of the Contract Documents. Bidder has given Engineer written notice of all conflicts, errors or discrepancies that it has discovered in the Contract Documents and the written resolution thereof by Engineer is acceptable to Bidder.
- (g) This Bid is genuine and not made in the interest of or on behalf of any undisclosed person, firm or corporation and is not submitted in conformity with an agreement or rules of any group, association, organization or corporation; Bidder has not directly or indirectly induced or solicited any other corporation to refrain from bidding; and Bidder has not sought by collusion to obtain for itself any advantage over any other Bidder or over Owner.
- (h) Bidder agrees to commence work under this Agreement on or before a date to be specified in a written "Notice to Proceed" of the Owner.

Bidder accepts the provisions of the Agreement as to liquidated damages in the event of failure to complete the Work on time.

4. Bidder will complete the Work in accordance with the Contract Documents for the following price(s):

**(a) BASE BID:**

WWTP IMPROVEMENTS					
ITEM NO.	QTY.	UNIT	DESCRIPTION	UNIT PRICE	TOTAL PRICE
1	1	LS	MOBILIZATION/DEMOBILIZATION	\$	\$
2	1	LS	PRIMARY CLARIFIER REHAB INCLUDING LONGITUDINAL AND CROSS COLLECTORS, WEIR REPLACEMENTS, NEW SCUM TROUGHS, AND ASSOCIATED POWER	\$	\$
3	1	LS	PRIMARY CLARIFIER SLUDGE REMOVAL SYSTEM INCLUDING NEW PLUG VALVES, ACTUATORS, AND ASSOCIATED POWER AND CONTROLS	\$	\$



4	1	LS	SLUDGE LINE REHABILITATION INCLUDING 6" DUCTILE IRON PIPE, PLUG VALVES, AND PAVEMENT REPLACEMENT	\$	\$
5	1	LS	PRIMARY SPLITTER BOX CONCRETE REHABILITATION, INCLUDING CONCRETE COATING, BY-PASS PUMPING CONNECTION AND TEMPORARY BY-PASS PIPING	\$	\$
6	1	LS	SURGE TANK REHABILITATION INCLUDING CONCRETE COATING, SLIDE GATES, AND BY-PASS PUMPING OPERATIONS	\$	\$
7	1	LS	CARROUSEL BASIN STRUCTURAL REPAIRS	\$	\$
8	1	LS	EFFLUENT PUMP REPLACEMENT INCLUDING PIPE COATING AND NEW SOFT STARTS	\$	\$
9	1	LS	PRIMARY SLUDGE PUMPING SYSTEM INCLUDING DEMO, NEW POSITIVE DISPLACEMENT PUMPS, NEW VFD CONTROL PANEL, REQUIRED PUMP POWER, AND PIPING WORK INSIDE THE DIGESTER HEAD HOUSE	\$	\$
10	1	LS	DIGESTER REHABILITATION INCLUDING DEMOLITION WORK, NEW POLE BARN, NEW AERATION AND MIXING EQUIPMENT, AS WELL AS ASSOCIATED POWER AND CONTROLS.	\$	\$
10A	1	LS	MCC – 8 INCLUDING WIRE AND CONDUIT TO FEED MCC-8.		
11	1	LS	WAS PUMPS INCLUDING RELATED DEMO, PIPING, POWER AND CONTROLS	\$	\$
12	1	LS	ELECTRICAL WORK FOR SWITCHBOARDS, BREAKERS, AND PANELS NOT DIRECTLY ASSOCIATED WITH NEW OR REPLACEMENT EQUIPMENT, INCLUDING REPAIR OF MCC 7. INCLUDE COST RELATED TO TEMPORARY POWER OR PUMPING FOR ASSOCIATED DOWNTIMES.	\$	\$
<b>WWTP IMPROVEMENTS SUBTOTAL</b>					\$

ALLOWANCES					
ITEM				UNIT	TOTAL
NO.	QTY.	UNIT	DESCRIPTION	PRICE	PRICE
13	1	LS	SUPPLEMENTARY WORK AGREEMENT (SWA)	\$ 135,000.00	\$ 135,000.00
14	1	LS	DIGESTER CLEANING ALLOWANCE	\$ 600,000.00	\$ 600,000.00
15	1	LS	ENGINEER'S TESTING ALLOWANCE	\$ 15,000.00	\$ 15,000.00
<b>ALLOWANCES SUBTOTAL</b>					\$ 750,000.00

<b>TOTAL BASE BID (WWTP IMPROVEMENTS + ALLOWANCES SUBTOTAL)</b>	\$
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\$ \_\_\_\_\_  
(Numbers)

5. Bidder agrees that the Work will be substantially complete and ready for final payment in accordance with paragraph 14.13 of the General Conditions within 330 calendar days after the date when the Contract Times commence to run.
6. Bidder accepts the provisions of the Agreement as to liquidated damages in the event of failure to complete the Work within the times specified in the Agreement.
7. The following documents are attached to and made a condition of this Bid:
  - a. Required Bid Security in the form of 5% of the Bid Total Price.
8. The undersigned further agrees that in case of failure on his part to execute the said contract and the Bond within fifteen (15) consecutive calendar days after written notice being given of the award of the contract, the check or bid bond accompanying this bid, and the monies payable thereon shall be paid into the funds of the Owner as liquidated damages for such failure, otherwise, the check or bid bond accompanying this proposal shall be returned to the undersigned.
9. Communications concerning this Bid shall be addressed to:
 

ESG Engineering, Inc  
6400 Peake Rd  
Macon, GA 31210  
Attn: Margaret Hildebrand  
[mhildebrand@esgengineering.com](mailto:mhildebrand@esgengineering.com)

Terms used in this Bid which are defined in the General Conditions or Instructions to Bidders will have the meanings indicated in the General Conditions of Instructions.

SUBMITTED on \_\_\_\_\_, 20\_\_.

BIDDER: \_\_\_\_\_

BY: \_\_\_\_\_

TITLE: \_\_\_\_\_

STATE CONTRACTOR  
LICENSE NO. \_\_\_\_\_

ADDRESS: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

PHONE: \_\_\_\_\_

Seal: (if bid by a Corporation)

**END OF SECTION**

Division	Section Title
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**SPECIFICATIONS**

**DIVISION 26 - ELECTRICAL**

260519	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
260526	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
260529	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
260533	RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS
260553	IDENTIFICATION FOR ELECTRICAL SYSTEMS
262419	MOTOR-CONTROL CENTERS
262726	WIRING DEVICES
262816	ENCLOSED SWITCHES AND CIRCUIT BREAKERS
262913.06	SOFT-START MOTOR CONTROLLERS
262923	VARIABLE-FREQUENCY MOTOR CONTROLLERS

END OF TABLE OF CONTENTS



## SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Copper building wire rated 600 V or less.
2. Connectors, splices, and terminations rated 600 V and less.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.

### PART 2 - PRODUCTS

#### 2.1 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Standards:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  2. RoHS compliant.
  3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- D. Conductor Insulation:
1. Type THHN. Comply with UL 83.

#### 2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

### PART 3 - EXECUTION

#### 3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper.
- B. Branch Circuits: Copper.

#### 3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- D. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

#### 3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

#### 3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

END OF SECTION 260519





## SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes grounding and bonding systems and equipment, plus the following special applications:
  - 1. Underground distribution grounding.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
  - 1. Plans showing as-built, dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
    - a. Ground rods.
  - 2. Instructions for periodic testing and inspection of grounding.
    - a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.

#### ~~1.4 QUALITY ASSURANCE~~

- ~~A. Testing Agency Qualifications: Certified by NETA.~~

### PART 2 - PRODUCTS

#### 2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

## 2.2 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
  - 1. Solid Conductors: ASTM B 3.
  - 2. Stranded Conductors: ASTM B 8.

## 2.3 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Conduit Hubs: Mechanical type, terminal with threaded hub.

## 2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel, sectional type; 5/8 by 120 inches.

## PART 3 - EXECUTION

### 3.1 APPLICATIONS

- A. Conductors: Install solid conductor unless otherwise indicated.
- B. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Underground Connections: Welded connections.
  - 3. Connections to Structural Steel: Welded connectors.

### 3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

### 3.3 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.

### 3.4 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
  - 1. Feeders and branch circuits.
  - 2. Lighting circuits.
  - 3. Receptacle circuits.
  - 4. Three-phase motor circuits.

### 3.5 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
  - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.

### 3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
  - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
  - 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal and at individual ground rods. Make tests at ground rods before any conductors are connected.
    - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    - b. Perform tests by fall-of-potential method according to IEEE 81.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

- E. Report measured ground resistances that exceed the following values:
  - 1. Power Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
- F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

## SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Steel slotted support systems.
2. Conduit and cable support devices.
3. Mounting, anchoring, and attachment components including clamps.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.

### PART 2 - PRODUCTS

#### 2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
  2. Material for Channel, Fittings, and Accessories: Galvanized steel.
  3. Channel Width: Selected for applicable load criteria.
  4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  5. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Conduit and Cable Support Devices: Clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

### PART 3 - EXECUTION

#### 3.1 APPLICATION

- A. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- B. Maximum support spacing as required by NFPA 70.

- C. Multiple Raceways or Cables: Install supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  - 1. Secure raceways and cables to these supports with single-bolt conduit clamps.

### 3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

END OF SECTION 260529

## SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
1. Metal conduits and fittings.
  2. Nonmetallic conduits and fittings.
  3. Boxes and enclosures.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.

### PART 2 - PRODUCTS

#### 2.1 METAL CONDUITS AND FITTINGS

- A. Metal Conduit:
1. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. GRC: Comply with ANSI C80.1 and UL 6.
  3. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- B. Metal Fittings: Comply with NEMA FB 1 and UL 514B.
1. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Fittings, General: Listed and labeled for type of conduit, location, and use. with overlapping sleeves protecting threaded joints.
- C. Joint Compound for GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

#### 2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. Nonmetallic Conduit:
- B. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.



1. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
2. LFNC: Comply with UL 1660.

C. Nonmetallic Fittings:

1. Fittings, General: Listed and labeled for type of conduit, location, and use.
2. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
3. Fittings for LFNC: Comply with UL 514B.
4. Solvents and Adhesives: As recommended by conduit manufacturer.

### 2.3 BOXES AND ENCLOSURES

- A. General Requirements for Boxes and Enclosures: Boxes and enclosures installed in wet locations shall be listed for use in wet locations.
- B. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy Type FD, with gasketed cover.

## PART 3 - EXECUTION

### 3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
  1. Exposed Conduit: GRC.
  2. Underground Conduit: RNC Type EPC-40-PVC, direct buried.
  3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
  4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Minimum Raceway Size: 3/4-inch trade size.
- C. Raceway Fittings: Compatible with raceways and suitable for use and location.
  1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
  2. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

### 3.2 INSTALLATION

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

- B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- C. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- D. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- E. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- F. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- G. Support conduit within 12 inches of enclosures to which attached.
- H. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- I. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- J. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 36 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

### 3.3 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
  - 1. Excavate trench bottom to provide firm and uniform support for conduit.
  - 2. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction.
  - 3. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment.
    - a. Couple steel conduits to ducts with adapters designed for this purpose.
  - 4. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 PROTECTION

A. Protect coatings and finishes from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION 260533

## SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Color and legend requirements for conductors and warning labels.
2. Labels.
3. Tapes and stencils.

#### 1.2 ACTION SUBMITTALS

- ##### A. Product Data: For each type of product.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- ##### A. Comply with ASME A13.1.
- ##### B. Comply with 29 CFR 1910.144 for color identification of hazards; 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs and tags.
- ##### C. Signs, labels, and tags required for personnel safety must comply with the following standards:
1. Product Safety Signs and Labels: NEMA Z535.4.
- ##### D. Comply with NFPA 70.
- ##### E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, must comply with UL 969.
- ##### F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

#### 2.2 COLOR AND LEGEND REQUIREMENTS

- ##### A. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
1. Color must be factory applied or field applied for sizes larger than 8 AWG.
  2. Colors for 208Y/120 V Circuits:

- a. Phase A: Black.
  - b. Phase B: Red.
  - c. Phase C: Blue.
3. Colors for 480Y/277 V Circuits:
- a. Phase A: Brown.
  - b. Phase B: Orange.
  - c. Phase C: Yellow.
4. Color for Neutral: White.
5. Color for Equipment Grounds: Green.

## 2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
- B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.
- C. Self-Adhesive Wraparound Labels: Preprinted, 3 mil thick, polyester flexible label with acrylic pressure-sensitive adhesive.
  1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over legend. Labels sized such that clear shield overlaps entire printed legend.
- D. Self-Adhesive Labels: Polyester, thermal, transfer-printed, 3 mil thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
  1. Minimum Nominal Size:
    - a. 1-1/2 by 6 inch for raceway and conductors.
    - b. 3-1/2 by 5 inch for equipment.
    - c. As required by authorities having jurisdiction.

## 2.4 TAPES AND STENCILS

- A. Underground-Line Warning Tape:
  1. Tape:
    - a. Recommended by manufacturer for method of installation and suitable to identify and locate underground electrical utility lines.
    - b. Printing on tape must be permanent and may not be damaged by burial operations.
    - c. Tape material and ink must be chemically inert and not be subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
  2. Color and Printing:

- a. Comply with APWA Uniform Color Code using NEMA Z535.1 safety colors.
- b. Inscriptions for Red Tapes: "CAUTION BURIED ELECTRIC LINE BELOW, HIGH VOLTAGE".

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

#### 3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Verify identity of item before installing identification products.
- C. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- D. Underground Line Warning Tape:
  1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inch below finished grade. Use multiple tapes where width of multiple lines installed in common trench exceeds 16 inch overall.
  2. Install underground-line warning tape for direct-buried cables and cables in raceways.
  3. Unless otherwise indicated, provide single line of text with 1/2 inch high letters on minimum 1-1/2 inch high sign; where two lines of text are required, use signs minimum 2 inch high.
- E. Laminated Acrylic or Melamine Plastic Signs:
  1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
  2. Unless otherwise indicated, provide single line of text with 1/2 inch high letters on 1-1/2 inch high sign; where two lines of text are required, use labels 2 inch high.

#### 3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- D. Equipment Identification Labels:
  - 1. Indoor Equipment: Self-adhesive label.
  - 2. Outdoor Equipment: Laminated acrylic or melamine sign 4 inch high.

END OF SECTION 260553

## SECTION 262419 - MOTOR-CONTROL CENTERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes MCCs for use with ac circuits rated 600 V and less, with combination controllers and having the following factory-installed components:
1. Automatic power transfer.
  2. Feeder-tap units.
  3. Measurement and control.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each MCC, manufacturer's approval drawings as defined in UL 845. In addition to requirements specified in UL 845, include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    - a. Each installed unit's type and details.
    - b. Factory-installed devices.
    - c. Enclosure types and details.
    - d. Nameplate legends.
    - e. Short-circuit current (withstand) rating of complete MCC, and for bus structure and each unit.
    - f. Features, characteristics, ratings, and factory settings of each installed controller and feeder device, and installed devices.
    - g. Specified optional features and accessories.
  2. Schematic Wiring Diagrams: For power, signal, and control wiring for each installed controller.
  3. Nameplate legends.
  4. Vertical and horizontal bus capacities.
  5. Features, characteristics, ratings, and factory settings of each installed unit.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Standard Drawings: For each MCC, as defined in UL 845.



- B. Seismic Qualification Data: Certificates, for MCCs, accessories, and components, from manufacturer.
- C. Product Certificates: For each MCC.
- D. Source quality-control reports.
- E. Field quality-control reports.
- F. Load-Current and Overload Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- G. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.
- H. Sample Warranty: For special warranty.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace MCC and SPD that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Schneider Electric (Square D)
- B. Eaton (Cutler-Hammer)
- C. Rockwell Automation (Allen-Bradley)

#### 2.2 SYSTEM DESCRIPTION

- A. NEMA Compliance: Fabricate and label MCCs to comply with NEMA ICS 18.
- B. Ambient Environment Ratings:
  - 1. Ambient Temperature Rating: Not less than 0 deg F and not exceeding 104 deg F, with an average value not exceeding 95 deg F over a 24-hour period.

2. Ambient Storage Temperature Rating: Not less than minus 4 deg F and not exceeding 140 deg F
  3. Humidity Rating: Less than 95 percent (noncondensing).
  4. Altitude Rating: Not exceeding 6600 feet, or 3300 feet if MCC includes solid-state devices.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.3 PERFORMANCE REQUIREMENTS

### A. Capacities and Characteristics:

#### 1. MCC Enclosure and Assembly:

- a. Nominal System Voltage: 480 V.
- b. Service Equipment Rated: No.
- c. Enclosure: NEMA 250, Type 3R.
- d. Integrated Short-Circuit Rating for MCC:
  - 1) Fully rated; 65 kA.
- e. Integrated Short-Circuit Rating for Each Unit:
  - 1) Fully rated; 65 kA.
- f. Bus:
  - 1) Horizontal Bus: 800 A.
  - 2) Neutral Bus: None.

#### 2. Main Disconnect Device:

- a. Main Disconnect: MCCB, UL 489, three-pole, 800 A
- b. SPD: UL 1449, Type 1.

#### 3. Magnetic Controllers:

- a. Tag Number: as indicated on drawings.
  - 1) Classification by Starting Method: FVNR.
  - 2) Controller Size: as indicated on drawings complying with NEMA ICS 2.

#### 4. VFCs:

- a. Tag Number: as indicated on drawings.
  - 1) Bypass Mode: Field selectable, manual or automatic.
  - 2) Bypass Style: Two contactor style.
  - 3) Bypass Contactor Classification: Reduced-voltage autotransformer, open transition.
  - 4) Overload Relays: Bimetallic. Class 10.
  - 5) Isolated Overload Alarm Contact: NC.

5. Controller-Mounted Auxiliary Devices:
  - a. Push Buttons and Selector Switches: Heavy-duty type.
  - b. Feeder Tap Units: Main Disconnect: MCCB, UL 489, three-pole.
6. Panelboards: Tag Number as indicated on drawings.
  - a. Mains: Main lugs only, 3-phase, 208Y/120V, 100 A.
  - b. Bolt-on circuit breakers.
7. Transformer(s): As indicated on drawings kVA, 480 V primary, 208 V secondary.
  - a. Primary Circuit Breaker: MCCB, As indicated on drawings A.

## 2.4 ENCLOSURES

- A. Indoor Enclosures: Freestanding steel cabinets unless otherwise indicated. NEMA 250, Type 12 unless otherwise indicated to comply with environmental conditions at installed location.
- B. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
  1. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.
  2. Space-Heater Power Source: Transformer, factory installed in MCC.
- C. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- D. Outdoor Enclosures: Type 3R.
  1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
  2. Enclosure: Flat roof; bolt-on rear covers for each section, with provisions for padlocking.
  3. Doors: Personnel door at each end of aisle, minimum width of 30 inches]; opening outwards; with panic hardware and provisions for padlocking.
  4. Accessories: Fluorescent lighting fixtures, ceiling mounted; wired to a three-way light switch at each end of aisle; GFCI duplex receptacle; emergency battery pack lighting fixture installed on wall of aisle midway between personnel doors.
  5. Power for Space Heaters, Ventilation, Lighting, and Receptacle: Include a CPT within the switchboard. Supply voltage shall be 120/208-V ac.
  6. Power for space heaters, ventilation, lighting, and receptacle supplied from a remote source.

## 2.5 ASSEMBLY

- A. Structure:
  1. Comply with UL requirements for service entrance equipment.

2. Units up to and including Size 3 shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
  3. Units in Type B and Type C MCCs shall have pull-apart terminal strips for external control connections.
  4. Pull Boxes:
    - a. Include provisions for ventilation to maintain temperature in pull box within same limits as the MCC.
    - b. Set the box back from front to clear circuit-breaker removal mechanism.
    - c. Covers: Removable covers forming top, front, and sides.
    - d. Insulated bottom of fire-resistive material with separate holes for cable drops into MCC.
    - e. Cable Supports: Arranged to facilitate cabling and adequate to support cables, including supports for future cables.
    - f. When equipped with barriers, supply with access to check bus bolt tightness.
- B. Compartments: Modular; individual doors with concealed hinges and quick-captive screw fasteners.
1. Interlock compartment door to require that the disconnecting means is "off" before door can be opened or closed, except by operating a concealed release device.
  2. Compartment construction shall allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC.
  3. The same-size compartments shall be interchangeable to allow rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.
- C. Bus Transition and Incoming Pull Sections: Included and aligned with the structure of the MCC.
- D. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC; same-size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.
- E. Wiring Spaces:
1. Vertical wireways in each vertical section for vertical wiring to each unit compartment; supports to hold wiring in place.
  2. Horizontal wireways in bottom and top of each vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.
- F. Provisions for Future:
1. Compartments marked "future" shall be bused, wired and equipped with guide rails or equivalent, and ready for insertion of drawout units.
  2. Compartments marked "spare" shall include provisions for connection to the vertical bus.

G. Integrated Short-Circuit Rating:

1. Short-Circuit Current Rating for Each Unit: Fully rated; 65kA.
2. Short-Circuit Current Rating of MCC: Fully rated with its main overcurrent device; 65kA.

H. Control Power:

1. 120-V ac, supplied centrally from a CPT.
2. 120-V ac; obtained from CPT integral with controller; with primary and secondary fuses. The CPT shall be of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
  - a. CPT Spare Capacity: 100 VA.

I. Factory-Installed Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

1. Wiring Class: NEMA ICS 18, Class I Type A.
2. Control and Load Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

J. Bus:

1. Main Horizontal and Equipment Ground Buses: Uniform capacity for entire length of MCC's main and vertical sections.
2. Vertical Phase and Equipment Ground Buses: Uniform capacity for entire usable height of vertical sections, except for sections incorporating single units.
3. Bus Material: Hard-drawn copper of 98 percent minimum conductivity or tin-plated alloy, with compression connectors for outgoing conductors.
4. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for ground conductors, minimum size 1/4-by-2 inches. Equip with compression connectors for outgoing conductors.
5. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch copper bus, arranged to connect neutral bus to ground bus.
6. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Insulation temperature rating shall not be less than 105 deg C.

2.6 MAIN DISCONNECT AND OVERCURRENT PROTECTIVE DEVICE(S)

A. MCCB (to 1600 A): Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.

1. MCCB shall have quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, its position shall be shown by the position of the handle, and manual push-to-trip push button.

2. Solid-state monitoring and tripping system to show system status monitoring, adjustable time-current protection, and shunt trip.
    - a. Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
    - b. Trip-setting dials or interchangeable plugs to establish the continuous trip of the circuit breaker. Plugs shall not be interchangeable between frames, and the breaker may not be closed without the plug. With neutral ground-fault sensor.
    - c. Time-current adjustments to achieve protective-device coordination as follows:
      - 1) Adjustable long-time delay.
      - 2) Adjustable short-time setting and delay to shape the time-current curve.
      - 3) Adjustable instantaneous setting.
      - 4) Individually adjustable ground-fault setting and time delay.
    - d. Built-in connector to test the long-time delay, instantaneous, and ground-fault functions of the breaker.
    - e. Built-in digital ammeter display, showing load current and tripping cause.
  3. Switch operator power shall be from control power specified in "Assembly" Article.
- B. Surge Suppression: Factory installed as an integral part of the incoming feeder, complying with UL 1449, SPD Type 1.

## 2.7 MAGNETIC CONTROLLERS

- A. Controller Units: Combination controllers.
- B. Disconnects:
  1. MCP:
    - a. UL 489, with interrupting capacity complying with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
    - b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
    - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
    - d. NC alarm contact that operates only when MCP has tripped.
    - e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
  2. MCCB:
    - a. UL 489, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
    - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
    - c. Lockable Handle: For three padlocks and interlocks with cover in closed position.
    - d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.

- e. NC alarm contact that operates only when MCCB has tripped.
  - C. Controllers: Comply with UL 508.
    - 1. Full-Voltage Magnetic Controllers: Electrically held, full voltage, NEMA ICS 2, general purpose, Class A.
      - a. Classification: Nonreversing.
  - D. Overload Relays:
    - 1. Melting-Alloy Overload Relays:
      - a. Inverse-time-current characteristic.
      - b. Class 10 tripping characteristic.
      - c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
- 2.8 VFC
- A. Controller Units: Combination controllers, consisting of variable-frequency power converter that is factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged for self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency. Comply with NEMA ICS 7, NEMA ICS 61800-2, UL 508C, and UL 508E.
    - 1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
    - 2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
    - 3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
    - 4. Listed and labeled for single-phase use by an NRTL acceptable to authorities having jurisdiction.
  - B. Disconnects:
    - 1. MCP:
      - a. UL 489, with interrupting capacity complying with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
      - b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
      - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
      - d. NC alarm contact that operates only when MCP has tripped.
      - e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

2. MCCB:

- a. UL 489, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
  - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  - c. Lockable Handle: For three padlocks and interlocks with cover in closed position.
  - d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
  - e. NC alarm contact that operates only when MCCB has tripped.
3. Disconnect Rating: Not less than 115 percent of VFC input current rating.
  4. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
  5. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
  6. NC alarm contact that operates only when circuit breaker has tripped.

C. Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 3 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: 97 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
6. Overload Capability:
  - a. For variable-torque controllers, 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
  - b. For constant-torque controllers, 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
7. Starting Torque: Minimum of 100 percent of rated torque from 3 to 60 Hz.
8. Speed Regulation: Plus or minus 5 percent.
9. Output Carrier Frequency: Field selectable.
10. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
11. Internal Adjustability Capabilities:
  - a. Minimum Speed: 5 to 25 percent of maximum rpm.
  - b. Maximum Speed: 80 to 100 percent of maximum rpm.
  - c. Acceleration: 0.1 to 999.9 seconds.
  - d. Deceleration: 0.1 to 999.9 seconds.
  - e. Current Limit: 30 to a minimum of 150 percent of maximum rating.
12. Self-Protection and Reliability Features:
  - a. Input surge protection by means of SPDs for three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
  - b. Loss of Input Signal Protection: Selectable response strategy including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.



- c. Under- and overvoltage trips.
  - d. Inverter overcurrent trips.
  - e. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved and listed and labeled by an NRTL.
  - f. Critical frequency rejection, with three selectable, adjustable deadbands.
  - g. Instantaneous line-to-line and line-to-ground overcurrent trips.
  - h. Loss-of-phase protection.
  - i. Reverse-phase protection.
  - j. Short-circuit protection.
  - k. Motor overtemperature fault.
13. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
  14. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

D. Operator Station:

1. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.
2. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
3. Panel-mounted, manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
  - a. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
  - b. Security Access: Electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

E. Displays:

1. Historical Logging Information and Displays:
  - a. Real-time clock with current time and date.
  - b. Running log of total power versus time.
  - c. Total run time.
  - d. Fault log, maintaining last four faults with time and date stamp for each.
2. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters including the following:
  - a. Output frequency (Hz).
  - b. Motor speed (rpm).
  - c. Motor status (running, stop, fault).
  - d. Motor current (amperes).

- e. Motor torque (percentage).
- f. Fault or alarming status (code).
- g. PID feedback signal (percentage).
- h. DC-link voltage (V dc).
- i. Set-point frequency (Hz).
- j. Motor output voltage (V ac).

F. Bypass Systems:

1. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes, and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
2. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.
3. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.
4. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller.
  - a. Bypass Contactor: Load-break, IEC-rated contactor.
  - b. Output Isolating Contactor: Non-load-break, IEC-rated contactor.
  - c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
5. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.
  - a. Bypass Contactor: Load-break, IEC-rated contactor.
  - b. Input and Output Isolating Contactors: Non-load-break, IEC-rated contactors.
  - c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
6. Bypass Contactor Classification: Reduced-voltage autotransformer, closed transition type.
7. NORMAL/BYPASS selector switch.
  - a. HAND/OFF/AUTO selector switch.
  - b. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
  - c. Contactor Coils: Pressure-encapsulated type.

- 1) Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
  - 2) Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
8. Overload Relays: NEMA ICS 2.
- a. Melting-Alloy Overload Relays:
    - 1) Inverse-time-current characteristic.
    - 2) Class 10 tripping characteristic.
    - 3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
  - b. NC isolated overload alarm contact.
  - c. External overload reset push button.
- G. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
- H. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
- I. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

## 2.9 CONTROLLER-MOUNTED AUXILIARY DEVICES

- A. Control-Circuit and Pilot Devices: Factory installed in controller enclosure cover unless otherwise indicated. Comply with NEMA ICS 5.
1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.
    - a. Push Buttons: Covered types; momentary contact unless otherwise indicated.
    - b. Pilot Lights: LED types.
    - c. Selector Switches: Rotary type.
- B. Elapsed-Time Meters: Heavy duty with digital readout in hours; nonresettable.
- C. Meters: Panel type, 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy, with selector switches having an off position.
- D. Auxiliary Dry Contacts: NC and NO.

## 2.10 MEASUREMENT AND CONTROL DEVICES

- A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1.
  
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
  - 1. Listed or recognized by a nationally recognized testing laboratory.
  - 2. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
  - 3. Switch-selectable digital display of the following values with the indicated maximum accuracy tolerances:
    - a. Phase Currents, Each Phase: Plus or minus 1 percent.
    - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
    - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
    - d. Three-Phase Real Power (Megawatts): Plus or minus 2 percent.
    - e. Three-Phase Reactive Power (Megavars): Plus or minus 2 percent.
    - f. Power Factor: Plus or minus 2 percent.
    - g. Frequency: Plus or minus 0.5 percent.
    - h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
    - i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
    - j. Contact devices to operate remote impulse-totalizing demand meter.
  - 4. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
  
- C. Watt-Hour Meters and Wattmeters:
  - 1. Comply with ANSI C12.1.
  - 2. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.
  - 3. Suitable for connection to three- and four-wire circuits.
  - 4. Potential indicating lamps.
  - 5. Adjustments for light and full load, phase balance, and power factor.
  - 6. Four-dial clock register.
  - 7. Integral demand indicator.
  - 8. Contact devices to operate remote impulse-totalizing demand meter.
  - 9. Ratchets to prevent reverse rotation.
  - 10. Removable meter with drawout test plug.
  - 11. Semiflush mounted case with matching cover.
  - 12. Appropriate multiplier tag.
  
- D. Control Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

## 2.11 FEEDER TAP UNITS

- A. MCCBs (to 1200 A): Fixed mounted, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger. Comply with UL 489, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
  - 1. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  - 2. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
    - a. Instantaneous trip.
    - b. Long- and short-time pickup levels.
    - c. Long- and short-time time adjustments.
    - d. Ground-fault pickup level, time delay, and  $I^2t$  response.

## 2.12 SOURCE QUALITY CONTROL

- A. MCC Testing: Test and inspect MCCs according to requirements in NEMA ICS 18.
- B. MCCs will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. NEMA Industrial Control and Systems Standards: Comply with parts of NEMA ICS 2.3 for installation and startup of MCCs.
- B. Floor Mounting: Install MCCs on 4-inch nominal-thickness concrete base.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in control circuits if not factory installed.
- E. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- G. Comply with NECA 1.
- H. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification of MCC, MCC components, and control wiring.

1. Identify field-installed conductors, interconnecting wiring, and components.
2. Install required warning signs.
3. Label MCC and each cubicle with engraved nameplate.
4. Label each enclosure-mounted control and pilot device.

### 3.2 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers and remote.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control selection devices where applicable.
  1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
  2. Connect selector switches within enclosed controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

### 3.3 CONNECTIONS

- A. Comply with requirements for installation of conduit in Section 260533 "Raceways and Boxes for Electrical Systems."
- B. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

### 3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.
- B. Acceptance Testing Preparation:
  1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
  2. Test continuity of each circuit.
- C. Tests and Inspections:
  - ~~1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.~~
  2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  4. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multipole enclosed

controller. Remove front panels so joints and connections are accessible to portable scanner.

- b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multipole enclosed controller 11 months after date of Substantial Completion.
  - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Submit calibration record for device.
5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
  6. Mark up a set of manufacturer's drawings with all field modifications incorporated during construction and return to manufacturer for inclusion in Record Drawings.
- D. MCCs will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

### 3.5 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload relay pickup and trip ranges.
- B. Adjust overload relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Owner before increasing settings.
- D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage, solid-state controllers.
- E. Program microprocessors in VFCs for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- F. Set field-adjustable circuit-breaker trip ranges.

### 3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers, and to use and reprogram microprocessor-based, solid-state controllers.

END OF SECTION 262419

## SECTION 262726 - WIRING DEVICES

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. GFCI receptacles, 125 V, 20 A.
2. Toggle switches, 120/277 V, 15 A.
3. Wall plates.

#### 1.2 ACTION SUBMITTALS

- ##### A. Product Data: For each type of product.

### PART 2 - PRODUCTS

#### 2.1 GENERAL WIRING-DEVICE REQUIREMENTS

- ##### A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- ##### B. Comply with NFPA 70.
- ##### C. RoHS compliant.
- ##### D. Comply with NEMA WD 1.
- ##### E. Device Color: Gray.

#### 2.2 GFCI RECEPTACLES, 125 V, 20 A

##### A. Duplex GFCI Receptacles, 125 V, 20 A:

1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two-pole, three-wire, and self-grounding.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Type: Feed through.
4. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

#### 2.3 TOGGLE SWITCHES, 120/277 V, 15 A

- ##### A. Single-Pole Switches, 120/277 V, 15 A:



1. Standards: Comply with UL 20 and FS W-S-896.

## 2.4 WALL PLATES

- A. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Device Installation:
  1. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
  2. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- C. Receptacle Orientation:
  1. Install ground pin of vertically mounted receptacles down.

END OF SECTION 262726

## SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Nonfusible switches.
2. Molded-case circuit breakers (MCCBs).
3. Enclosures.

#### 1.2 DEFINITIONS

- A. GFEP: Ground-fault circuit-interrupter for equipment protection.
- B. GFLS: Ground-fault circuit-interrupter for life safety.
- C. SPDT: Single pole, double throw.

#### 1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

#### 1.6 WARRANTY

- A. Special Installer Extended Warranty: Installer warrants that fabricated and installed enclosed switches and circuit breakers perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain products from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

### 2.2 NONFUSIBLE SWITCHES

- A. Type HD, Heavy-Duty, Three Pole, Single-Throw Nonfusible Switch: 600 V(ac), 30, 60, and 100A; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

### 2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Circuit breakers must be constructed using glass-reinforced insulating material. Current carrying components must be completely isolated from handle and accessory mounting area.
- B. Circuit breakers must have toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. Circuit-breaker handle must be over center, be trip free, and reside in tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon must be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with push-to-trip button, located on face of circuit breaker to mechanically operate circuit-breaker tripping mechanism for maintenance and testing purposes.
- C. Maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings must be clearly marked on face of circuit breaker.
- D. MCCBs must be equipped with device for locking in isolated position.
- E. Standard: Comply with UL 489 with required interrupting capacity for available fault currents.
- F. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

- G. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- H. Electronic Trip Circuit Breakers: Field-replaceable rating plug, RMS sensing, with the following field-adjustable settings:
  - 1. Instantaneous trip.
  - 2. Long- and short-time pickup levels.
  - 3. Long- and short-time time adjustments.
  - 4. Ground-fault pickup level, time delay, and I-squared t response.
- I. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- J. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- K. GFLS Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6 mA trip).
- L. GFEP Circuit Breakers: With Class B ground-fault protection (30 mA trip).
- M. Features and Accessories:
  - 1. Standard frame sizes, trip ratings, and number of poles.

## 2.4 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, UL 50E, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: Enclosure must be a brush finish on Type 304 stainless steel (UL 50E Type 4-4X stainless steel).
- C. Conduit Entry: UL 50E Types 4, 4X, and 12 enclosures may not contain knockouts. UL 50E Types 7 and 9 enclosures must be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: Circuit-breaker operating handle must be externally operable with operating mechanism being integral part of box, not cover. Cover interlock mechanism must have externally operated override. Override may not permanently disable interlock mechanism, which must return to locked position once override is released. Tool used to override cover interlock mechanism must not be required to enter enclosure in order to override interlock.
- E. Enclosures designated as UL 50E Type 4, 4X stainless steel, 12, or 12K must have dual cover interlock mechanism to prevent unintentional opening of enclosure cover when circuit breaker is ON and to prevent turning circuit breaker ON when enclosure cover is open.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
  - 1. Commencement of work will indicate Installer's acceptance of areas and conditions as satisfactory.

#### 3.2 SELECTION OF ENCLOSURES

- A. Indoor, Dry and Clean Locations: UL 50E, Type 1.
- B. Outdoor Locations: UL 50E, Type 4X.
- C. Other Wet or Damp, Indoor Locations: UL 50E, Type 4X.
- D. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E, Type 12.

#### 3.3 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  - 1. Notify Architect no fewer than seven days in advance of proposed interruption of electric service.
  - 2. Indicate method of providing temporary electric service.
  - 3. Do not proceed with interruption of electric service without Architect's written permission.
  - 4. Comply with NFPA 70, NFPA 70E, NECA 1.
- C. Coordinated layout and installation of switches with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

#### 3.4 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved metal or laminated-plastic nameplate.

### 3.5 FIELD QUALITY CONTROL

#### A. Tests and Inspections for Switches:

##### 1. Visual and Mechanical Inspection:

- a. Inspect physical and mechanical condition.
- b. Inspect anchorage, alignment, grounding, and clearances.
- c. Verify that unit is clean.
- d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
- e. Verify that fuse sizes and types match the Specifications and Drawings.
- f. Verify that each fuse has adequate mechanical support and contact integrity.
- g. Inspect bolted electrical connections for high resistance using one of the following methods:
  - 1) Use low-resistance ohmmeter.
    - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
  - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
    - a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.
- h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on Drawings.
- i. Verify correct phase barrier installation.
- j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

##### 2. Electrical Tests:

- a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
- b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

- c. Perform ground fault test in accordance with NETA ATS Section 7.14 "Ground Fault Protection Systems, Low-Voltage."

B. Tests and Inspections for Molded-Case Circuit Breakers:

1. Visual and Mechanical Inspection:

- a. Verify that equipment nameplate data are as described in the Specifications and shown on Drawings.
- b. Inspect physical and mechanical condition.
- c. Inspect anchorage, alignment, grounding, and clearances.
- d. Verify that unit is clean.
- e. Operate circuit breaker to ensure smooth operation.
- f. Inspect bolted electrical connections for high resistance using one of the following methods:
  - 1) Use low-resistance ohmmeter.
    - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
  - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
    - a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.
- g. Inspect operating mechanism, contacts, and chutes in unsealed units.
- h. Perform adjustments for final protective device settings in accordance with coordination study.

2. Electrical Tests:

- a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
- b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
- c. Perform contact/pole resistance test. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.

- d. Perform insulation resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values may be no less than 2 M  $\Omega$ .
  - e. Determine the following by primary current injection:
    - 1) Long-time pickup and delay. Pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - 2) Short-time pickup and delay. Short-time pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - 3) Ground-fault pickup and time delay. Ground-fault pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - 4) Instantaneous pickup. Instantaneous pickup values must be as specified and within manufacturer's published tolerances.
  - f. Test functionality of trip unit by means of primary current injection. Pickup values and trip characteristics must be as specified and within manufacturer's published tolerances.
  - g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of shunt trip and close coils must be as indicated by manufacturer.
  - h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset trip logs and indicators. Investigate units that do not function as designed.
  - i. Verify operation of charging mechanism. Investigate units that do not function as designed.
3. Test and adjust controls, remote monitoring, and safeties.
- C. Nonconforming Work:
1. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
  2. Remove and replace defective units and retest.
- D. Collect, assemble, and submit test and inspection reports.
1. Test procedures used.
  2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
  3. List deficiencies detected, remedial action taken, and observations after remedial action.
- E. Manufacturer Services:
1. Engage factory-authorized service representative to support field tests and inspections.

END OF SECTION 262816





## SECTION 262913.06 - SOFT-START MOTOR CONTROLLERS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes soft-start motor controllers that are designed for reduced-voltage start and full-voltage run duty.
  - 1. Enclosed soft-start controllers.
  - 2. Enclosures.
  - 3. Accessories.
  - 4. Identification.

#### 1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. FLA: Full-load current.
- C. MCCB: Molded-case circuit breaker.
- D. MCP: Motor circuit protector.
- E. NC: Normally closed.
- F. NO: Normally open.
- G. OCPD: Overcurrent protective device.
- H. SCCR: Short-circuit current rating.
- I. SCPD: Short-circuit protective device.
- J. SCR: Silicon-controlled rectifier.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For each type of controller.
  1. Include plans, elevations, sections, and mounting details.
  2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
  3. Wire Termination Diagrams and Schedules: Include diagrams for signal and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
  4. Include features, characteristics, ratings, and factory settings of individual OCPD and auxiliary components.
- C. Product Schedule: For each enclosed controller.
  1. Each installed soft-start controller type.
  2. NRTL listing.
  3. Factory-installed accessories.
  4. Nameplate legends.
  5. SCCR of integrated unit.
    - a. For each combination soft-start controller, include features, characteristics, ratings, and factory setting of the SCPD and OCPD.
      - 1) Listing document proving Type 2 coordination.
    - b. For each series-rated combination, state the listed integrated SCCR (withstand) of SCPDs and OCPDs by an NRTL acceptable to authorities having jurisdiction.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For soft-start controllers to include in operation and maintenance manuals. Include the following:
  1. Routine maintenance requirements for soft-start controllers and installed components.
  2. Manufacturer's written instructions for testing and adjusting circuit-breaker and MCP trip settings.
  3. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage soft-start controllers.

4. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate FLAs.
5. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
  3. Indicating Lights: Two of each type and color installed.
  4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
  5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

#### ~~1.8 QUALITY ASSURANCE~~

- ~~A. Testing Agency Qualifications. Accredited by NETA.
  - ~~1. Testing Agency's Field Supervisor. Certified by NETA to supervise on-site testing.~~~~

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store soft-start controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect soft-start controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, cover soft-start controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers.

#### 1.10 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  1. Ambient Temperature: Not less than 32 deg F and not exceeding 104 deg F, humidity noncondensing.

## PART 2 - PRODUCTS

### 2.1 MOTOR CONTROLLER PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. UL Compliance: Fabricate and label enclosed controllers to comply with UL 508.

### 2.2 ENCLOSED SOFT-START MOTOR CONTROLLERS

- A. Description: Controllers designed for reduced-voltage start, full-voltage run, and optional soft stop. The controller shall be an integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and user interface module, run-bypass contactor, and overload relay(s); suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.
  - 1. Run-Bypass Contactor: Magnetic contactor in parallel with the SCR of the soft-start controller, bypassing the SCR when full voltage is achieved.
- B. Manufacturers:
  - 1. ABB
  - 2. Eaton
  - 3. Rockwell Automation
  - 4. Siemens Industry
  - 5. Square D; Schneider Electric
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration: Standard duty.
  - 1. At least two SCRs per phase to control the starting and stopping of the motor.
  - 2. Bypass Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Soft-start controller protective features and deceleration controls shall remain active when this contactor is in the bypass mode.
  - 3. Power Electronics Disconnect Contactor. Where indicated, installed ahead of the power electronics equipment, and shall open automatically when the motor is stopped, or a controller fault is detected, or when an SCR shorts.
  - 4. Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.
  - 5. Surge Protection: Comply with NEMA ICS 2 requirements for surge suppression.
- E. Control Power:
  - 1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.

2. Spare CPT Capacity: As indicated on Drawings, available in increments of 100 VA, from 100 to 500 VA.
- F. Controller Diagnostics and Protection:
1. Microprocessor-based thermal-protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
  2. Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and under-load conditions; and line frequency over or under normal.
  3. Input isolation contactor that opens when the controller diagnostics detect a faulted soft-start component or when the motor is stopped.
- G. Cover mounted-controller status panel with LED lights or alphanumeric display to show the following:
1. Starter Status: "Ready," "starting," "stopping," or "run."
  2. Motor current in amperes.
  3. Faults:
    - a. Motor overcurrent trip.
    - b. Motor thermal overload.
    - c. Starter thermal fault.
    - d. Low line voltage.
    - e. Loss of a phase.
    - f. Phases reversed.
    - g. Maximum starting time exceeded.
    - h. Serial communications error.
- H. Interface Panel: Mounted on controller door.
1. Guarded adjustable set points, not readily accessible.
    - a. Motor FLA, adjustable from 40 to 110 percent of the controller's rating.
    - b. Current limitation on starting, adjustable from 200 to 500 percent of FLA, typically set at 300 percent.
    - c. NEMA ICS 2 overload class. Selections shall include the following tripping classes: Class 5, Class 10, Class 15, Class 20, and Class 30.
  2. Adjustable set points, readily accessible, password protected.
    - a. Linear acceleration, adjustable from 1 to 60 s.
    - b. Maximum start time, adjustable from 1 to 250 s.
    - c. Selector switch; select coast to stop or soft stop.
    - d. Linear deceleration, adjustable from 1 to 60 s.
- I. Remote Output Features. All outputs shall be prewired to terminal blocks.
1. Analog output for field-selectable assignment of motor operating characteristics; 0- to 10-V dc.
  2. Form C status contacts that change state when controller is running.

3. Form C alarm contacts that change state when a fault condition occurs.

## 2.3 ENCLOSURES

- A. Comply with NEMA 250, Type designations as indicated on Drawings, to comply with environmental conditions at installed location.
- B. Construction of the enclosures shall comply with NEMA ICS 6.
- C. Controllers in hazardous (classified) locations shall comply with UL 1203.

## 2.4 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
  1. Push Buttons, Pilot Lights, and Selector Switches: Standard duty, except as needed to match enclosure type. Heavy-duty or oil-tight where indicated in the controller schedule.
    - a. Push Buttons: As indicated in the controller schedule.
    - b. Pilot Lights: As indicated in the controller schedule.
  2. Meters: Panel type, 2-1/2-inch minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy. Where indicated, provide selector switches with an off position.
- B. Breather assemblies, to maintain interior pressure and release condensation in Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

## 2.5 IDENTIFICATION

- A. Controller Nameplates: Laminated acrylic or melamine plastic signs, as described in Section 260553 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.
- B. Arc-Flash Warning Labels:
  1. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a 3-1/2-by-5-inch self-adhesive equipment label for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.
    - a. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD" .
    - b. Labels shall be machine printed, with no field-applied markings.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

### 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wall-Mounted Controllers: Install controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on slotted support systems complying with Section 260529 "Hangers and Supports for Electrical Systems," and bolted to wall.
- C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- D. Control Wiring: Separate control wiring from power wiring. Where unavoidable, use twisted pair cabling or shielded cables for control wiring.
- E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- F. Setting of Overload Relays: Select and set overloads on the basis of FLA rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for high-torque, high-efficiency, and so on motors.

### 3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.4 FIELD QUALITY CONTROL

- ~~A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.~~
- B. Tests and Inspections:
  - 1. Comply with provisions of NFPA 70B, Chapter "Testing and Test Methods."
  - 2. Visual and Mechanical Inspection:
    - a. Compare equipment nameplate data with Drawings and the Specifications.
    - b. Inspect physical and mechanical condition.
    - c. Inspect anchorage, alignment, and grounding.
    - d. Verify that the unit is clean.



- e. Ensure that vent path openings are free from debris and that heat-transfer surfaces are clean.
  - f. Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.
  - g. Inspect Contactors:
    - 1) Verify mechanical operation.
    - 2) Verify that contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
  - h. Motor-Running Protection:
    - 1) Verify that motor FLA is at, or under, the controller current rating.
    - 2) Verify that overload element setting is correct for its application.
    - 3) Apply minimum- and maximum-speed set points. Verify that set points are within limitations of the load coupled to the motor.
    - 4) If motor-running protection is provided by fuses, verify correct fuse rating.
  - i. Inspect bolted electrical connections for high resistance using one of the following two methods:
    - 1) Use a low-resistance ohmmeter. Compare bolted-connection-resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
  - j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
3. Electrical Tests:
- a. For the contactor and circuit breaker, perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS, Table 100.1. In the absence of manufacturer's published data, use Table 100.5. Values of insulation resistance less than this table or manufacturer's written instructions shall be investigated and corrected.
  - b. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
  - c. Test motor protection devices according to manufacturer's published data.
  - d. Test circuit breakers as follows:
    - 1) Operate the circuit breaker to ensure smooth operation.
    - 2) For adjustable circuit breakers, adjust protective device settings according to the coordination study. Comply with coordination study recommendations.

- e. Test the electronic motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.
  - f. Test the following parameters according to NETA relay calibration procedures, or as recommended by manufacturer:
    - 1) ANSI No. 49R, Overtemperature Protection:
      - a) Determine time delay at 300 percent of setting.
      - b) Determine a second point on the operating curve.
      - c) Determine pickup.
    - 2) ANSI No. 47, Input Phase Loss and Reversed Phases Protection:
      - a) Determine positive sequence voltage to close the NO contact.
      - b) Determine positive sequence voltage to open the NC contact (undervoltage trip).
      - c) Verify negative sequence trip.
      - d) Determine time delay to close the NO contact with sudden application of 120 percent of pickup.
      - e) Determine time delay to close the NC contact on removal of voltage when previously set to rated system voltage.
    - 3) ANSI No. 81, Over-frequency Protection:
      - a) Verify frequency set points.
      - b) Determine time delay.
      - c) Determine undervoltage cutoff.
    - 4) Fault Alarm Outputs: Verify that each relay contact performs its intended function in the control scheme including breaker trip tests, close inhibit tests, lockout tests, and alarm functions.
  - g. Perform operational tests by initiating control devices.
4. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove all necessary covers prior to the inspection.
- a. Comply with recommendations of NFPA 70B, Chapter "Testing and Test Methods," Article "Infrared Inspection."
  - b. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of each motor controller.
  - c. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each motor controller 11 months after date of Substantial Completion.
  - d. Report of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used, and lists the following results:
    - 1) Description of equipment to be tested.
    - 2) Discrepancies.
    - 3) Temperature difference between the area of concern and the reference area.
    - 4) Probable cause of temperature difference.

- 5) Areas inspected. Identify inaccessible and unobservable areas and equipment.
  - 6) Identify load conditions at time of inspection.
  - 7) Provide photographs and thermograms of the deficient area.
  - 8) Recommended action.
- e. Equipment: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C. The equipment shall detect emitted radiation and convert detected radiation to a visual signal.
  - f. Act on inspection results, recommended action, and considering recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.
- C. Motor controllers will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.5 SYSTEM FUNCTION TESTS

- A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality-control tests have been completed and all components have passed specified tests.
1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
  2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
  3. Verify the correct operation of sensing devices, alarms, and indicating devices.
- B. Motor controllers will be considered defective if they do not pass the system function tests and inspections.
- C. Prepare test and inspection reports.

### ~~3.6 DEMONSTRATION~~

- ~~A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor controllers.~~

END OF SECTION 262913.06

## SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

#### 1.2 DEFINITIONS

- A. CE: Conformance Europeene (European Compliance).
- B. CPT: Control power transformer.
- C. DDC: Direct digital control.
- D. EMI: Electromagnetic interference.
- E. LED: Light-emitting diode.
- F. NC: Normally closed.
- G. NO: Normally open.
- H. OCPD: Overcurrent protective device.
- I. PID: Control action, proportional plus integral plus derivative.
- J. RFI: Radio-frequency interference.
- K. VFC: Variable-frequency motor controller.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type and rating of VFC indicated.
  - 1. Include dimensions and finishes for VFCs.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For each VFC indicated.
  - 1. Include mounting and attachment details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  1. Required working clearances and required area above and around VFCs.
  2. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements.
  3. Show support locations, type of support, and weight on each support.
  4. Indicate field measurements.
- B. Qualification Data: For testing agency.
- C. Harmonic Analysis Report: Provide Project-specific calculations and manufacturer's statement of compliance with IEEE 519.
- D. Source quality-control reports.
- E. Field quality-control reports.
- F. Sample Warranty: For special warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals.
  1. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
  3. Indicating Lights: Two of each type and color installed.

#### ~~1.7 QUALITY ASSURANCE~~

- ~~A. Testing Agency Qualifications: Accredited by NETA.~~

- ~~1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on site testing.~~

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and connect factory-installed space heaters to temporary electrical service.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

## 1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 SYSTEM DESCRIPTION

- A. General Requirements for VFCs:
  - 1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508A.
- B. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
  - 1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
  - 2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
  - 3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
- C. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

- D. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
- E. Unit Operating Requirements:
  - 1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
  - 2. Input AC Voltage Unbalance: Not exceeding 3 percent.
  - 3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
  - 4. Minimum Efficiency: 97 percent at 60 Hz, full load.
  - 5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
  - 6. Minimum Short-Circuit Current (Withstand) Rating: 22kA.
  - 7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.
  - 8. Humidity Rating: Less than 95 percent (noncondensing).
  - 9. Altitude Rating: Not exceeding 3300 feet.
  - 10. Vibration Withstand: Comply with NEMA ICS 61800-2.
  - 11. Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
  - 12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
  - 13. Speed Regulation: Plus or minus 5 percent.
  - 14. Output Carrier Frequency: Selectable; 0.5 to 15kHz.
  - 15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- F. Self-Protection and Reliability Features:
  - 1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.
  - 2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
  - 3. Under- and overvoltage trips.
  - 4. Inverter overcurrent trips.
  - 5. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
  - 6. Critical frequency rejection, with three selectable, adjustable deadbands.
  - 7. Instantaneous line-to-line and line-to-ground overcurrent trips.
  - 8. Loss-of-phase protection.
  - 9. Reverse-phase protection.
  - 10. Short-circuit protection.
  - 11. Motor-overtemperature fault.
- G. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
- H. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

- I. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- J. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- K. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- L. Integral Input Disconnecting Means and OCPD: UL 489, instantaneous-trip circuit breaker with pad-lockable, door-mounted handle mechanism.
  - 1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
  - 2. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
  - 3. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
  - 4. NC alarm contact that operates only when circuit breaker has tripped.

## 2.2 CONTROLS AND INDICATION

- A. Status Lights: Door-mounted LED indicators displaying the following conditions:
  - 1. Power on.
  - 2. Run.
  - 3. Overvoltage.
  - 4. Line fault.
  - 5. Overcurrent.
  - 6. External fault.
- B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
  - 1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
  - 2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
    - a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.
- C. Historical Logging Information and Displays:
  - 1. Real-time clock with current time and date.
  - 2. Running log of total power versus time.
  - 3. Total run time.
  - 4. Fault log, maintaining last four faults with time and date stamp for each.



- D. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
1. Output frequency (Hz).
  2. Motor speed (rpm).
  3. Motor status (running, stop, fault).
  4. Motor current (amperes).
  5. Motor torque (percent).
  6. Fault or alarming status (code).
  7. PID feedback signal (percent).
  8. DC-link voltage (V dc).
  9. Set point frequency (Hz).
  10. Motor output voltage (V ac).
- E. Control Signal Interfaces:
1. Electric Input Signal Interface:
    - a. A minimum of two programmable analog inputs.
    - b. A minimum of six multifunction programmable digital inputs.
  2. Pneumatic Input Signal Interface: 3 to 15 psig.
  3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:
    - a. 0- to 10-V dc.
    - b. 4- to 20-mA dc.
    - c. Potentiometer using up/down digital inputs.
    - d. Fixed frequencies using digital inputs.
  4. Output Signal Interface: A minimum of one programmable analog output signal(s) which can be configured for any of the following:
    - a. Output frequency (Hz).
    - b. Output current (load).
    - c. DC-link voltage (V dc).
    - d. Motor torque (percent).
    - e. Motor speed (rpm).
    - f. Set point frequency (Hz).
  5. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
    - a. Motor running.
    - b. Set point speed reached.
    - c. Fault and warning indication (overtemperature or overcurrent).
    - d. PID high- or low-speed limits reached.
- F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: Two.
- G. Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFC settings shall be retained within VFC's nonvolatile memory.
1. Hardwired Points:
    - a. Monitoring: On-off status
    - b. Control: On-off operation
  2. Communication Interface: Comply with ASHRAE 135. Communication shall interface with DDC system for HVAC to remotely control and monitor lighting from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the DDC system for HVAC.

### 2.3 LINE CONDITIONING AND FILTERING

- A. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.

### 2.4 BYPASS SYSTEMS

- A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
- B. Bypass Mode:
1. Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor, and retransfer shall only be allowed with the motor at zero speed.
  2. Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic-control system feedback.
- C. Bypass Controller:
1. Two-Contactor-Style Bypass: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller.
    - a. Bypass Contactor: Load-break, NEMA-rated contactor.
    - b. Output Isolating Contactor: Non-load-break, NEMA-rated contactor.
    - c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and

de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

2. Three-Contactor-Style Bypass: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller arranged to isolate the power converter input and output and permit safe testing of the power converter, both energized and de-energized, while motor is operating in bypass mode.
  - a. Bypass Contactor: Load-break, NEMA-rated contactor.
  - b. Input and Output Isolating Contactors: Non-load-break, NEMA-rated contactors.
  - c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

D. Bypass Contactor Configuration: Reduced-voltage (autotransformer) type.

1. NORMAL/BYPASS selector switch.
2. HAND/OFF/AUTO selector switch.
3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
4. Contactor Coils: Pressure-encapsulated type.
  - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
  - b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
  - a. CPT Spare Capacity: 100 VA.
6. Overload Relays: NEMA ICS 2.
  - a. Melting-Alloy Overload Relays:
    - 1) Inverse-time-current characteristic.
    - 2) Class 10 tripping characteristic.
    - 3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
  - b. Bimetallic Overload Relays:
    - 1) Inverse-time-current characteristic.
    - 2) Class 10 tripping characteristic.
    - 3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
    - 4) Ambient compensated.

- 5) Automatic resetting.
- c. Solid-State Overload Relays:
    - 1) Switch or dial selectable for motor-running overload protection.
    - 2) Sensors in each phase.
    - 3) Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
    - 4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
    - 5) Analog communication module.
  - d. NC isolated overload alarm contact.
  - e. External overload, reset push button.

## 2.5 OPTIONAL FEATURES

- A. Multiple-Motor Capability: VFC suitable for variable-speed service to multiple motors. Overload protection shuts down VFC and motors served by it, and generates fault indications when overload protection activates.
  1. Configure to allow two or more motors to operate simultaneously at the same speed; separate overload relay for each controlled motor.
  2. Configure to allow two motors to operate separately; operator selectable via local or remote switch or contact closures; single overload relay for both motors; separate output magnetic contactors for each motor.
  3. Configure to allow two motors to operate simultaneously and in a lead/lag mode, with one motor operated at variable speed via the power converter and the other at constant speed via the bypass controller; separate overload relay for each controlled motor.
- B. Damper control circuit with end-of-travel feedback capability.
- C. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFC resumes normal operation.
- D. Motor Preheat Function: Preheats motor when idle to prevent moisture accumulation in the motor.
- E. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.
- F. Remote digital operator kit.
- G. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer.

## 2.6 ENCLOSURES

- A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.
  2. Outdoor Locations: Type 4X.
  3. Other Wet or Damp Indoor Locations: Type 4X.
  4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
- B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

## 2.7 ACCESSORIES

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
1. Push Buttons: Covered.
  2. Pilot Lights: Push to test.
  3. Selector Switches: Rotary type.
  4. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- B. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.
- C. Supplemental Digital Meters:
1. Elapsed-time meter.
  2. Kilowatt meter.
  3. Kilowatt-hour meter.
- D. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- E. Cooling Fan and Exhaust System: For NEMA 250, Type 12; UL 508 component recognized: Supply fan, with stainless steel intake and exhaust grills; 120-V ac; obtained from integral CPT.
- F. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
- G. Spare control-wiring terminal blocks.

## 2.8 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
  - 1. Test each VFC while connected to its specified motor.
  - 2. Verification of Performance: Rate VFCs according to operation of functions and features specified.
- B. VFCs will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.
- B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."
- B. Floor-Mounting Controllers: Install VFCs on 4-inch nominal thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
  - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.
  1. Structural-steel channels are specified in Section 260529 "Hangers and Supports for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.
- F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- G. Comply with NECA 1.

### 3.3 CONTROL WIRING INSTALLATION

- A. Install wiring between VFCs and remote devices.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control devices where applicable.
  1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
  2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

### 3.4 IDENTIFICATION

- A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
  1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  2. Label each VFC with engraved nameplate.
  3. Label each enclosure-mounted control and pilot device.
- B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

~~3.5 FIELD QUALITY CONTROL~~

~~A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.~~

B. Acceptance Testing Preparation:

1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation.
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Owner before starting the motor(s).
5. Test each motor for proper phase rotation.
- ~~6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.~~
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:
  - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
  - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
  - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. VFCs will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

~~3.6 STARTUP SERVICE~~

~~A. Engage a factory-authorized service representative to perform startup service.~~



- ~~1. Complete installation and startup checks according to manufacturer's written instructions.~~

### 3.7 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Owner before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers.
- E. Set field-adjustable pressure switches.

### 3.8 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.
- B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

### ~~3.9 DEMONSTRATION~~

- ~~A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.~~

END OF SECTION 262923

# FY2020 WASTEWATER TREATMENT FACILITY UPGRADES

## FOR THE CITY OF WAYCROSS

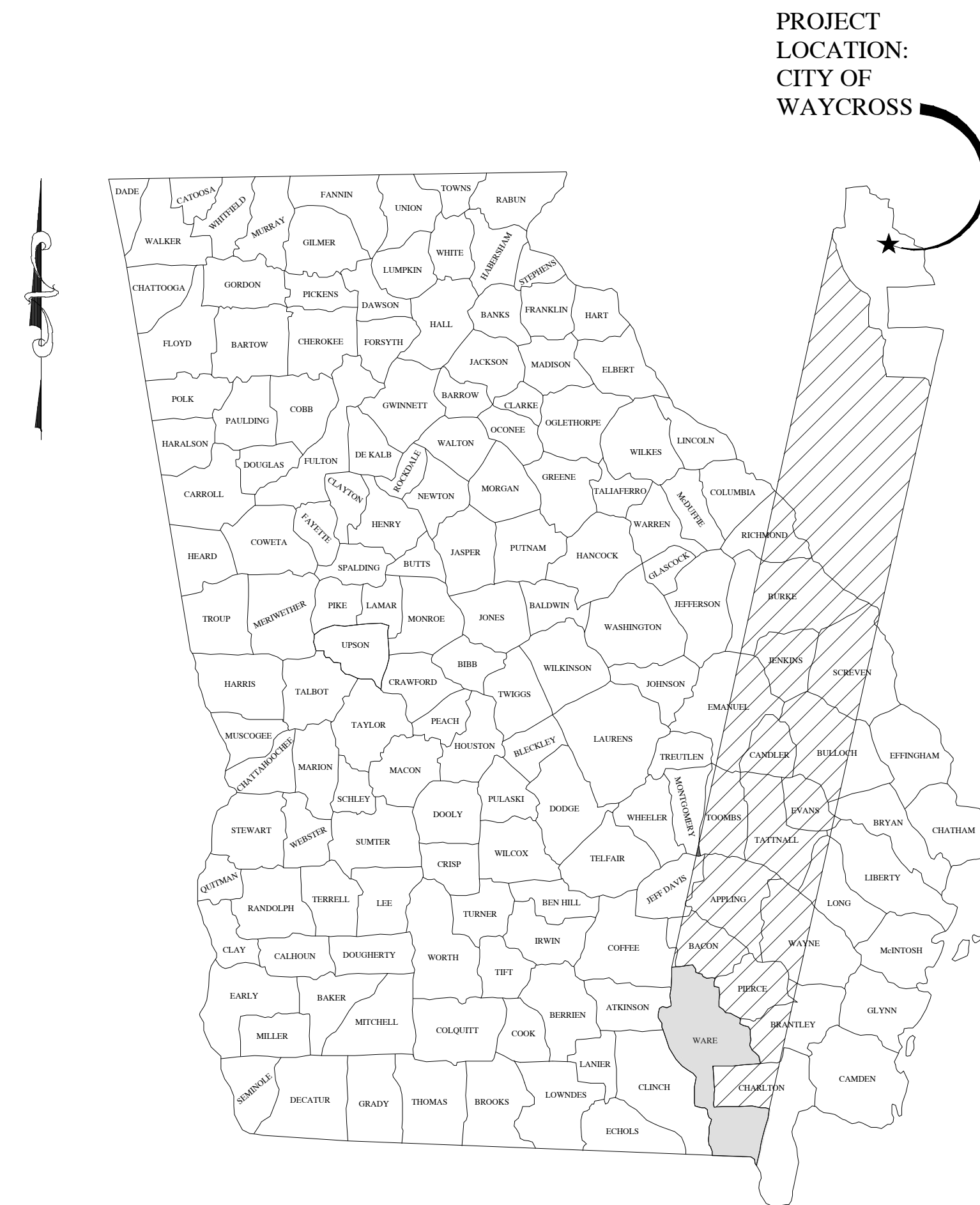
WARE COUNTY, GA

JUNE 2022

### INDEX TO DRAWINGS

#### CITY COUNCIL

DR. MICHAEL-ANGELO JAMES	MAYOR
DAVID EDDINS	INTERIM CITY MANAGER
NORMAN E. DAVIS, SR.	DISTRICT 1 COMMISSIONER
SHEINITA BENNETT	DISTRICT 2 COMMISSIONER
KATRENA FELDER	DISTRICT 3 COMMISSIONER
DIANE L. HOPKINS	DISTRICT 4 COMMISSIONER
HENRY STRICKLAND	DISTRICT 5 COMMISSIONER



LOCATION MAP

SHEET NO.	TITLE
1 C0.0	COVER SHEET
C0.1	GENERAL NOTES AND LOCATION MAP
C1.1	WWTP SITE EXISTING PROCESS FLOW PLAN
C1.2	WWTP SITE EXISTING PIPING PLAN AND VALVE SCHEDULE
P1.1	PRIMARY CLARIFIERS PLAN
P1.2	PRIMARY CLARIFIERS SECTIONS
P1.3	PRIMARY CLARIFIERS DETAILS
P1.4	PRIMARY SLUDGE LINE REHAB
P2.1	PRIMARY SPLITTER BOX AND SURGE TANK MODIFICATIONS
P3.1	EFFLUENT PUMP STATION PLAN & SECTION
P4.1	DIGESTER & HEAD HOUSE DEMOLITION PLAN
P4.2	DIGESTER & HEAD HOUSE DEMOLITION SECTIONS
P4.3	DIGESTER & HEAD HOUSE PIPING PLAN
P4.4	DIGESTER & HEAD HOUSE PLANS & SECTIONS
P4.5	DIGESTER BUILDING PIPING SECTIONS
P4.6	DIGESTER BELT PRESS FEED PIPING
P4.7	DIGESTER AERATION EQUIPMENT PLAN AND SECTIONS
P4.8	DIGESTER AERATION PIPING SECTIONS
P4.9	DIGESTER MIXING AND INSTRUMENTATION DETAILS
P4.10	DIGESTER MIXING SYSTEM INSTALLATION DETAILS
1 P4.11 - P4.12	DIGESTER AERATION SYSTEM INSTALLATION DETAILS
P5.1	WAS PUMP REPLACEMENT
P6.1 - P6.2	CONSTRUCTION NOTES AND DETAILS
S1.1	GENERAL NOTES AND DETAILS
S1.2	TYPICAL DETAILS
S2.1 - S2.2	AERATION CARROUSEL REPAIRS
S4.1 - S4.3	BLOWER PAD AND POLE BARN
S4.4 - S4.5	NEW HEAD HOUSE STAIR
1 E0.1	LEGEND AND GENERAL NOTES
1 ES1.1	ELECTRICAL SITE PLAN - WWTP
E1.1	PRIMARY CLARIFIERS DEMOLITION PLAN
E1.2	PRIMARY CLARIFIERS PLAN
E3.1	EFFLUENT PUMP STATION DEMOLITION AND PROPOSED PLAN AND SECTION
E4.1	DIGESTER AND HEAD HOUSE DEMOLITION PLAN
E4.2	DIGESTER HEAD HOUSE DEMOLITION AND PLANS
E4.3	POLE BARN PLAN
1 E5.1	WAS PUMP REPLACEMENT
E6.1	ONE LINE DIAGRAM - DEMOLITION
E6.2 - E6.2A	ONE LINE DIAGRAM - NEW WORK
E6.3	MCC-8 ELEVATIONS AND ONE LINE
E6.4	MCC-8 NAMEPLATE SCHEDULE
E6.5	PANELBOARD SCHEDULES
E7.1	POLE BARN EQUIPMENT CONTROLS

NO.	DESCRIPTION	DATE
1	ADDENDUM #3	07/15/22

BID SET



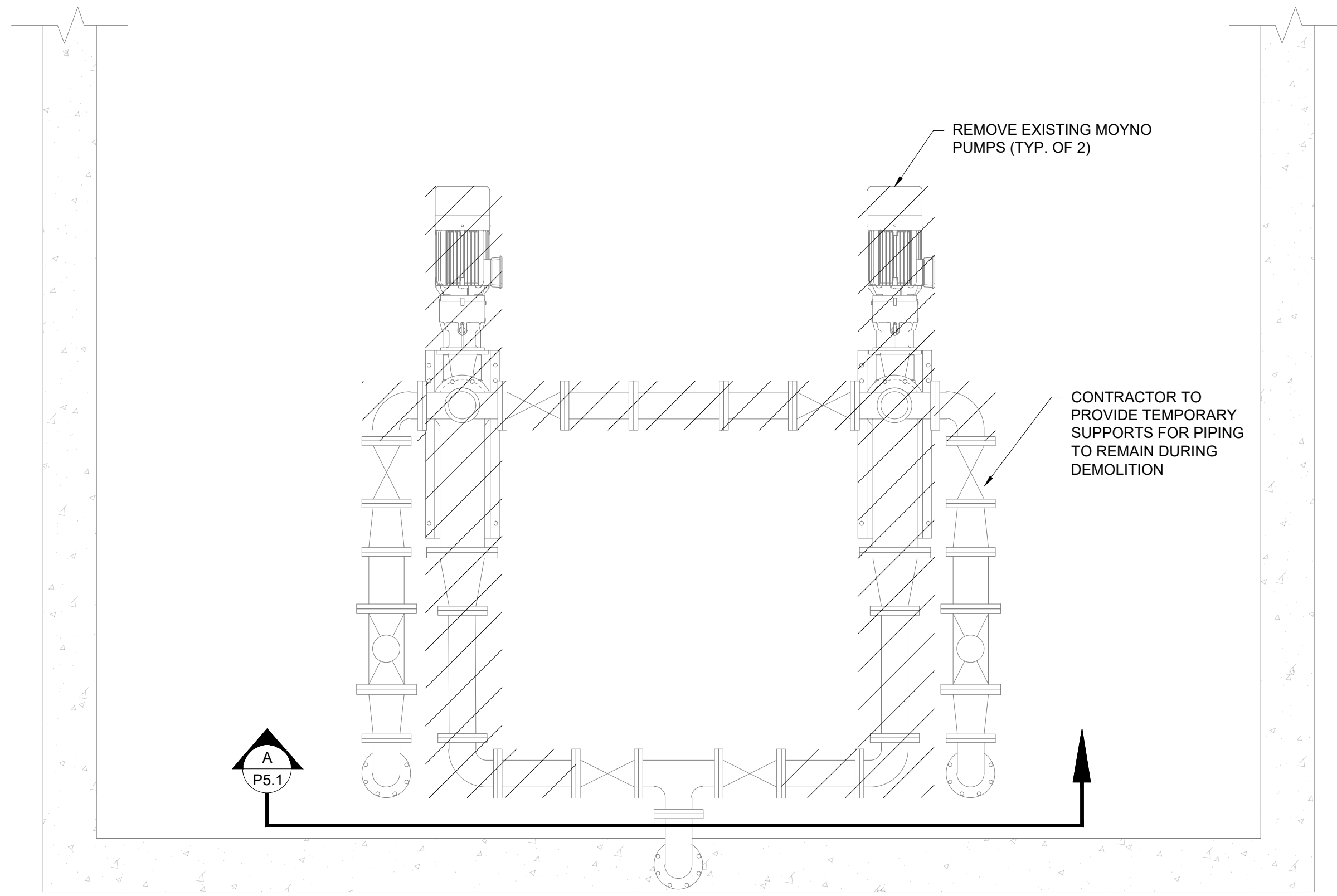
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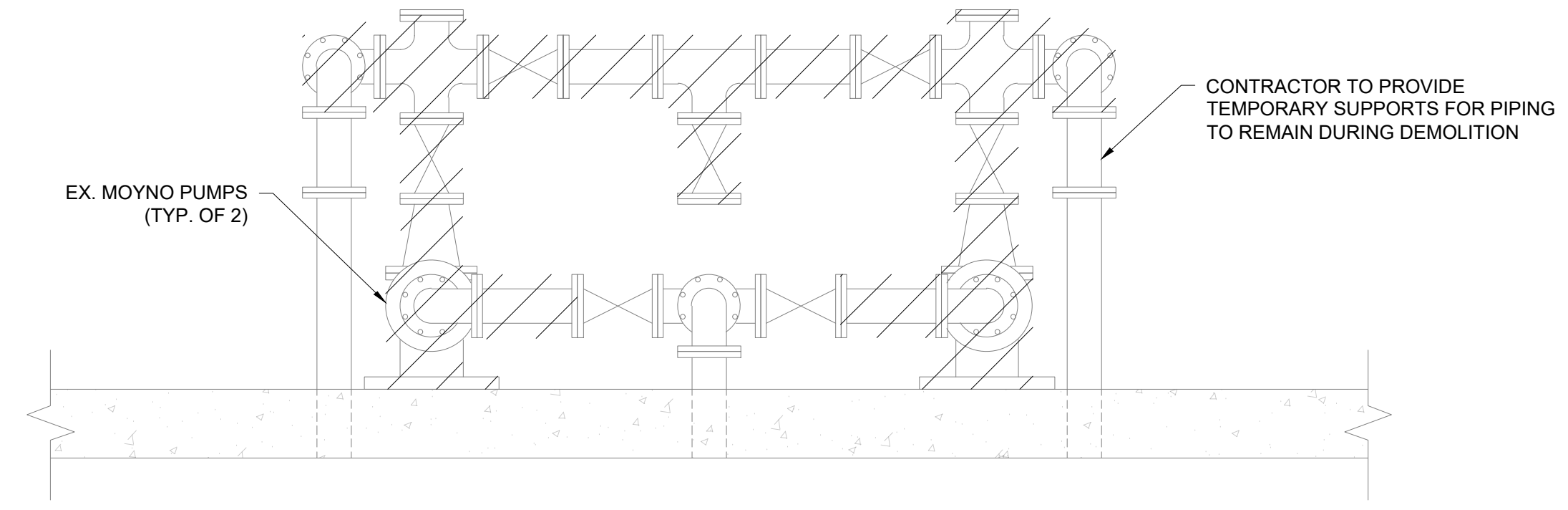
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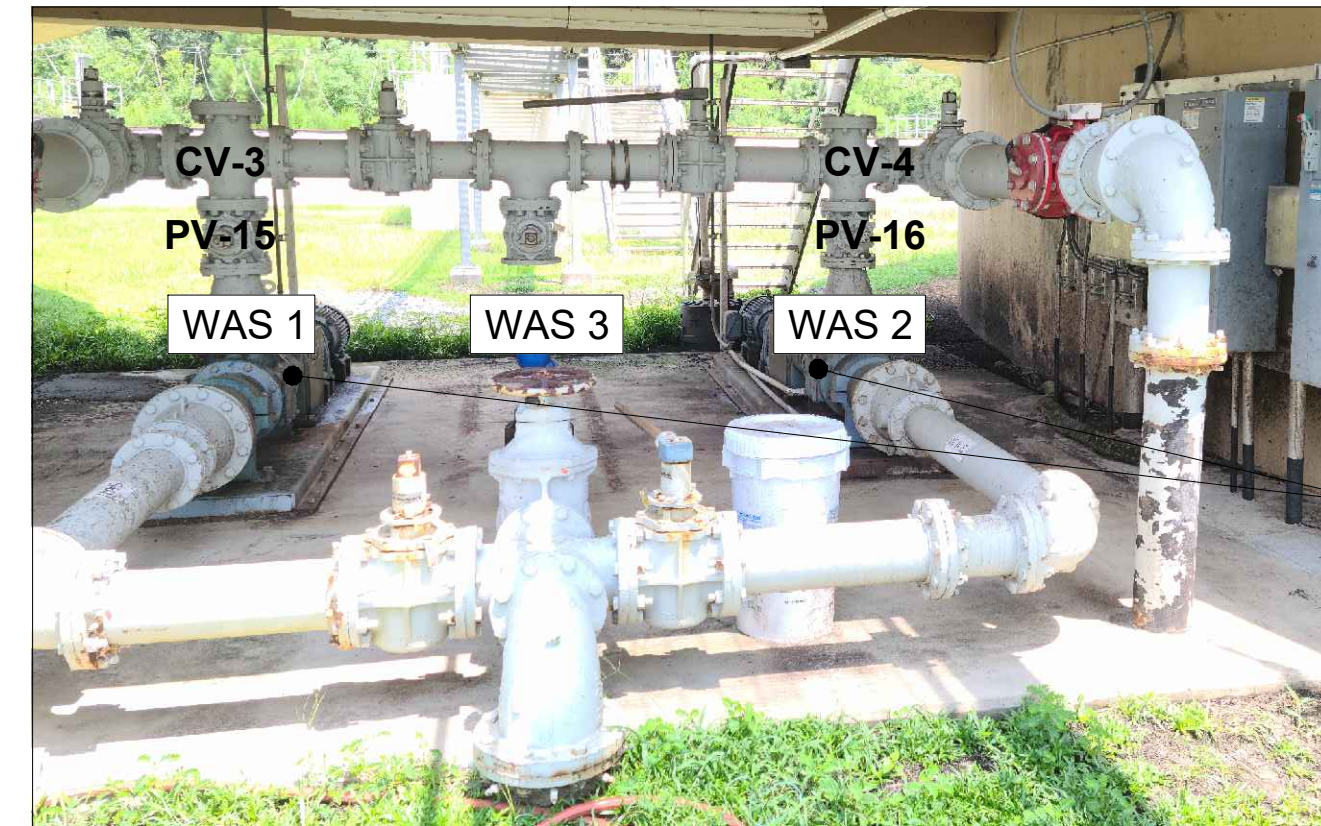
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**EXISTING WAS DEMOLITION PLAN**  
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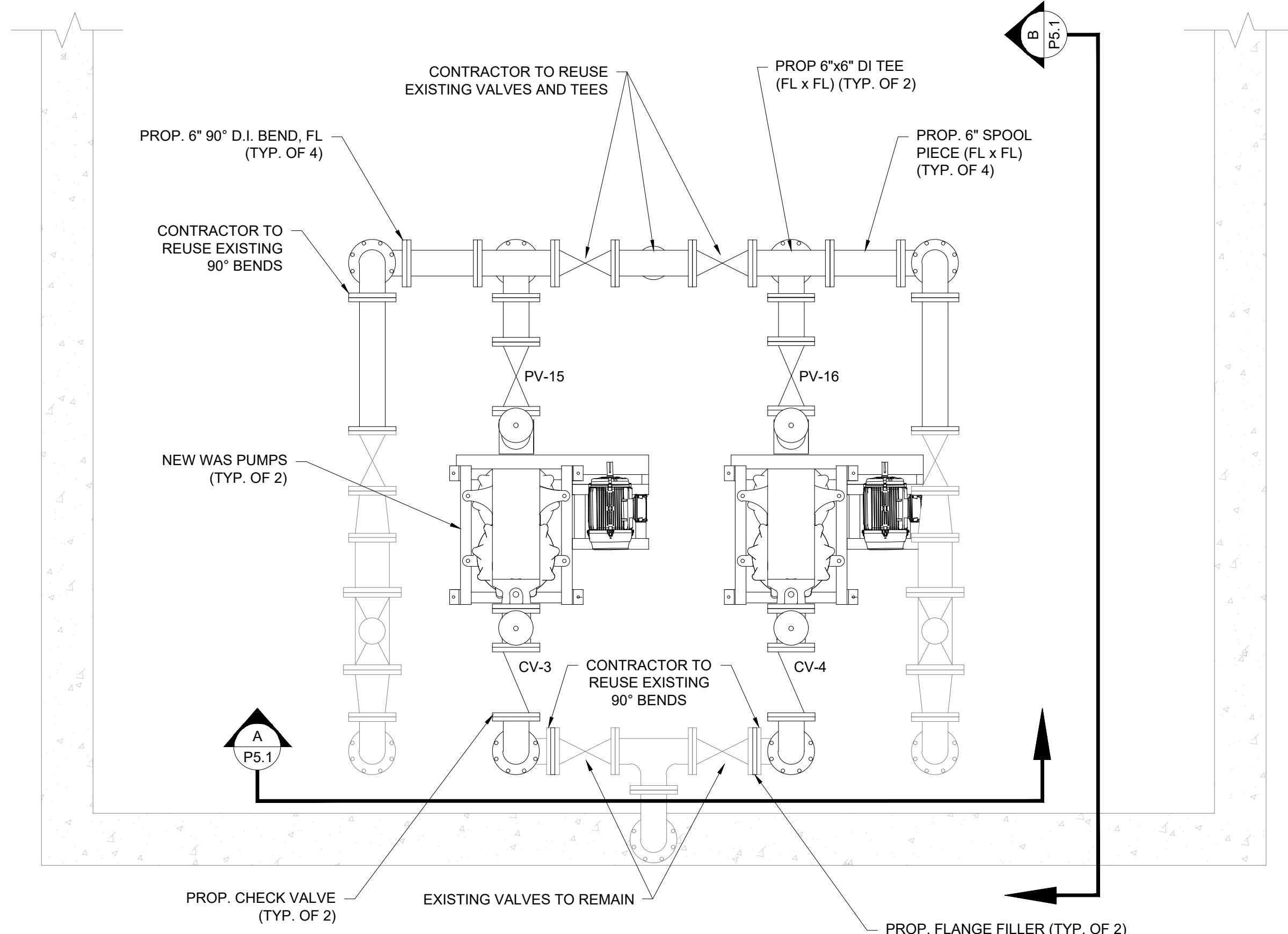


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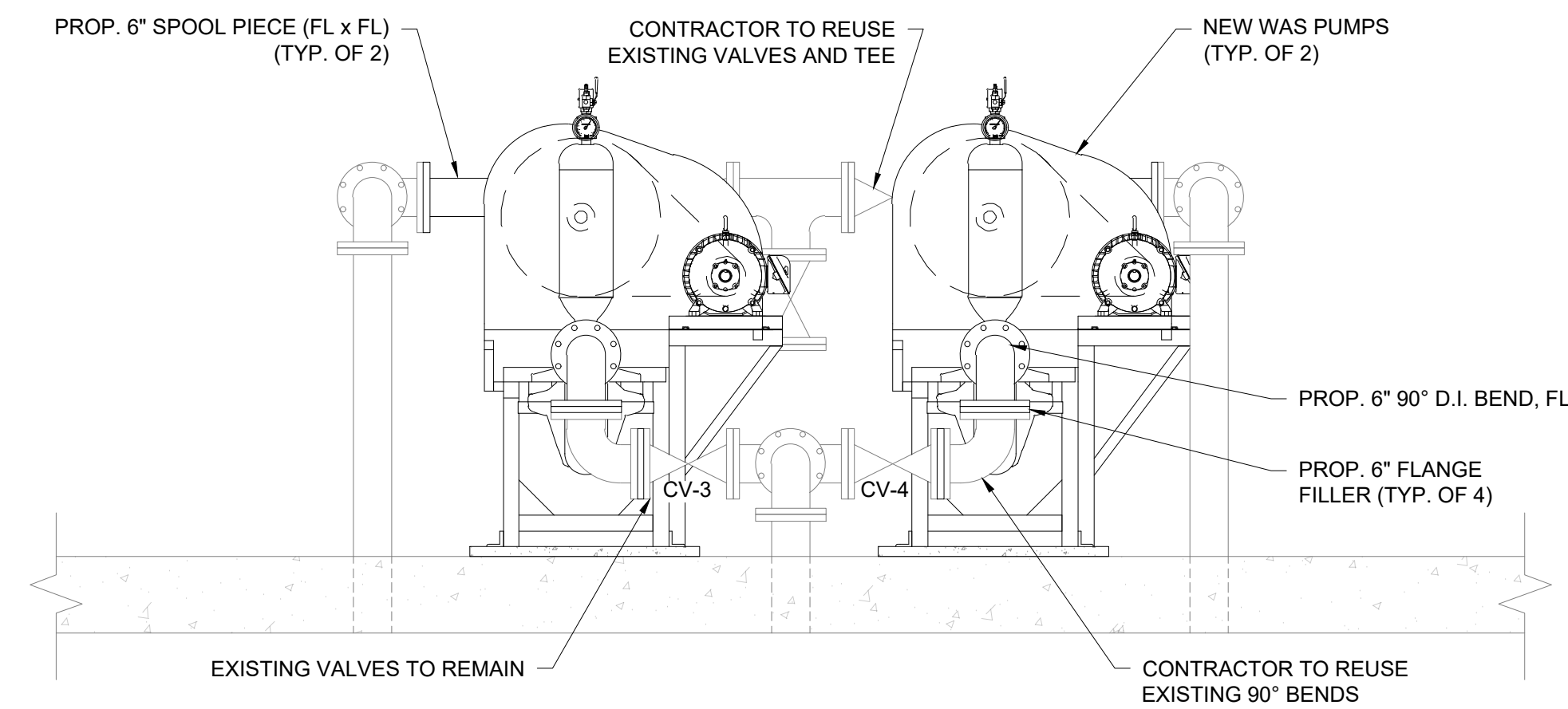


**WAS PUMPS**  
N.T.S.

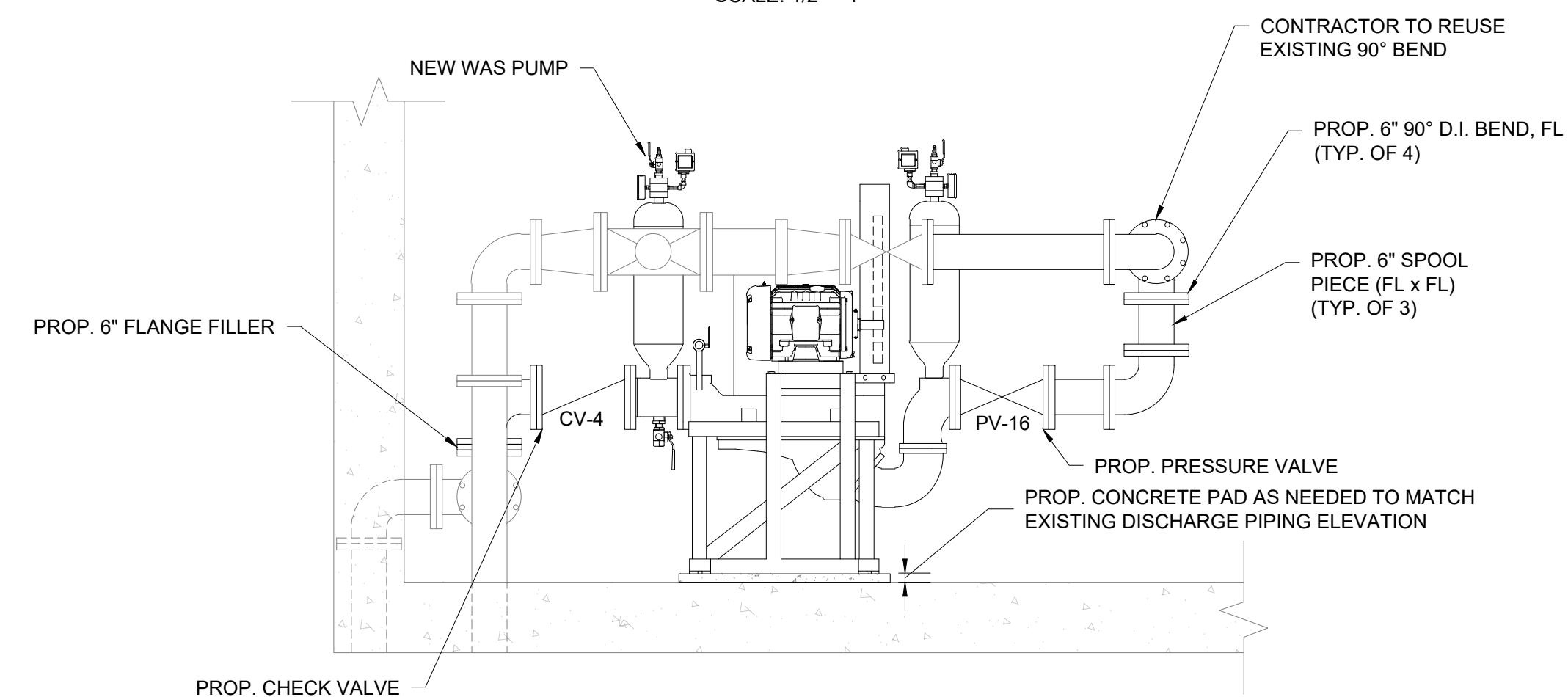
ISOLATE PUMP UTILIZING EXISTING INLET AND OUTLET VALVES. REPLACE EXISTING WAS #1 AND #2 PUMP WITH NEW POSITIVE DISPLACEMENT PUMP. COORDINATE PUMP DOWN TIMES WITH PLANT OPERATORS. ONE WAS PUMP MUST REMAIN IN SERVICE AT ALL TIMES.



**PROPOSED WAS PLAN**  
SCALE: 1/2" = 1'



**PROPOSED WAS SECTION A**  
SCALE: 1/2" = 1'

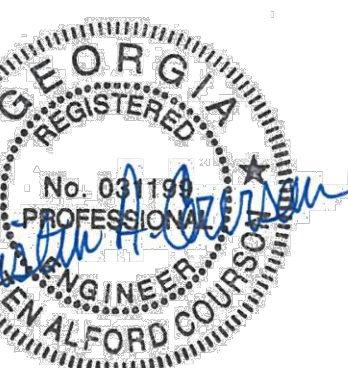


**PROPOSED WAS SECTION B**  
SCALE: 1/2" = 1'

**SHUTDOWN NOTES:**  
ONLY ONE WAS PUMP IS CURRENTLY OPERATIONAL. THE WORKING WAS PUMP IS UTILIZED 4 TO 5 DAYS A WEEK FOR SLUDGE PRESSING OPERATIONS. THE CONTRACTOR SHALL PROCEED WITH PIPING WORK AND NEW PUMP INSTALLATION IN THE NON-OPERATIONAL PUMP POSITION FIRST WHILE LEAVING THE OPERATIONAL PUMP IN SERVICE. COORDINATE ELECTRICAL DOWNTIME WITH PLANT OPERATORS AND THE ENGINEER. ONCE THE FIRST NEW PUMP IS SUCCESSFULLY PLACED IN OPERATION (PUMPING DIGESTER) THE ALTERNATIVE WAS PUMP MAY BE TAKEN OFF LINE FOR REPLACEMENT.

REVISIONS	NO.	DESCRIPTION	DATE
	A	ADDENDUM #3	07/15/22

**BID SET**

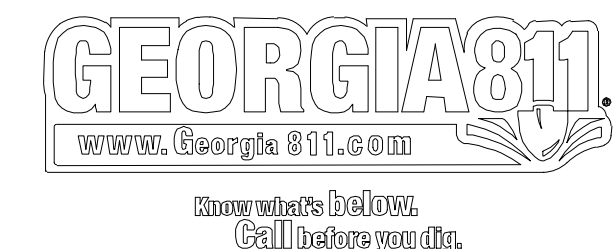


**DRAWN BY:** JDM  
**CHECKED BY:** KAC  
**DATE:** JUN 2022  
**SCALE:** N.T.S.

**CONTENT:**  
**WAS PUMP REPLACEMENT**

**SHEET NO:**

**P5.1**



# ELECTRICAL LEGEND

SYMBOL		DESCRIPTION
LIGHTING AND POWER DEVICES		
EXISTING	PROVIDE	
		DUPLEX CONVENIENCE RECEPTACLE, 15 A, 125 VAC, MOUNT 18" AFF UON. "WP" INDICATES WEATHERPROOF.
		DUPLEX CONVENIENCE RECEPTACLE WITH INTERNAL GROUND FAULT PROTECTION. 15 A, 125 VAC. MOUNT 48" AFF OR 6" ABOVE BACKSPLASH OR COUNTER TOP.
		RECEPTACLE AS NOTED ABOVE BUT, MOUNT 48" AFF OR 6" ABOVE BACKSPLASH OR COUNTER TOP WHERE COUNTER IS INDICATED.
		QUADRUPLEX CONVENIENCE RECEPTACLE MOUNTED IN TWO-GANG OUTLET BOX - EACH RATED 20A, 125 VOLTS WITH SINGLE COVER PLATE, MOUNT 18" AFF, UON
		LIGHTING PHOTOCELL; BASIS OF DESIGN IS INTERMATIC NIGHT FOX EK4536 WITH INTERMATIC K122 LOCKING RECEPTACLE.
		S SINGLE POLE SINGLE THROW SWITCH. "WP" INDICATES WEATHERPROOF.
EQUIPMENT CONNECTIONS		
		MOTOR CONNECTION AS INDICATED
		JUNCTION BOX
		DISCONNECT SWITCH. 600 V IN NEMA 1 ENCLOSURE UON 3P = NO. OF POLES, 60 = SWITCH RATING, 40 = FUSE RATING (NF INDICATES NON-FUSIBLE) (SEE LEGEND NOTE 5)
		ENCLOSED CIRCUIT BREAKER 480V IN NEMA 1 ENCLOSURE 14 KAIC UON 3P = NO. OF POLES, 100 = FRAME RATING, 40 = TRIP RATING (SEE LEGEND NOTE 5)
		DISCONNECT SWITCH PROVIDED INTEGRAL WITH EQUIPMENT.
		MAGNETIC MOTOR CONTROLLER (CONTROLLER FURNISHED WITH EQUIPMENT)
		MANUAL MOTOR CONTROLLER (CONTROLLER FURNISHED WITH EQUIPMENT)
		VARIABLE FREQUENCY DRIVE CONNECTION (DRIVE FURNISHED WITH EQUIPMENT)
		[MOTOR RATED SWITCH] [MANUAL MOTOR STARTER SWITCH] WITH OVERLOADS, MOUNT 48" AFF UON.
		SWITCH WITH PILOT LIGHT, MOUNT 48" AFF UON.
		PUSH BUTTON
DISTRIBUTION		
		PANELBOARD - 208Y/120V
		PANELBOARD - 480Y/277V
		DRY TYPE TRANSFORMER, SIZE AS INDICATED.
		UGP UNDERGROUND POWER
		INDICATES CONDUIT RUN EXPOSED
		INDICATES CONDUIT RUN CONCEALED IN CEILING, WALL, FLOOR, OR ABOVE SUSPENDED CEILING
GENERAL		
		DEMOLITION NOTE REFERENCE NUMBER
		NOTE REFERENCE NUMBER
		REMOVE TO THIS POINT.
		POINT OF CONNECTION NEW-TO-EXISTING (SEE LEGEND NOTE 3)

# ABBREVIATIONS

A	AMPERE	KCMIL	THOUSAND CIRCULAR MILS
A/C	AIR CONDITIONING	KWH	KILOWATT HOUR
AF	AMPERE FRAME	KVA	KILOVOLT AMPERE
AFG	ABOVE FINISHED FLOOR	L/P	LIGHT POLE
AT	ABOVE FINISHED GRADE	MCB	MAIN CIRCUIT BREAKER
ATS	AMPERE TRIP	MH	MANHOLE
AWG	AUTOMATIC TRANSFER SWITCH	MLO	MAIN LUG ONLY
BG	AMERICAN WIRE GAUGE	MT	MOUNT
BLDG	BELOW GRADE	MTD	MOUNTED
BRKR	BUILDING	MTG HT	MOUNTING HEIGHT
C	BREAKER	NF	NON-FUSED
CB	CONDUIT	NEU	NEUTRAL
CBS	CIRCUIT BREAKER	NIC	NOT IN CONTRACT
CKT	CONCRETE BLOCK STRUCTURE	P	POLE
CONC.	CIRCUIT	P/P	POWER POLE
DISC SW	CONCRETE	PH	PHASE
DWG	DISCONNECT SWITCH	PNL	PANEL
EC	DRAWING	PVC	POLY VINYL CHLORIDE
EHH	EMPTY CONDUIT	QTY	QUANTITY
EMH	ELECTRICAL HANDHOLE	RECEPT	RECEPTACLE
EMT	ELECTRICAL MANHOLE	REQ'D	REQUIRED
EQUIP	ELECTRICAL METALLIC TUBING	RMC	RIGID METAL CONDUIT
EWH	EQUIPMENT	S/N	SOLID NEUTRAL
EXIST	ELECTRIC WATER HEATER	SPD	SURGE PROTECTION DEVICE
EXP	EXISTING	SW	SWITCH
FACP	INDICATES EXPLOSION PROOF EQUIPMENT	UG	UNDERGROUND
FLA	FIRE ALARM CONTROL PANEL	UON	UNLESS OTHERWISE NOTED
GEN	FULL LOAD AMPS	UPS	UNINTERRUPTIBLE POWER SUPPLY
GFI	GENERATOR	V	VOLTS
GND	GROUND FAULT INTERRUPTER	VAC	VOLTS ALTERNATING CURRENT
HH	GROUND	VDC	VOLTS DIRECT CURRENT
KAIC	HANDHOLE	VFD	VARIABLE FREQUENCY DRIVE
	THOUSAND AMP INTERRUPTING CAPACITY	W	WIRE
	RMS SYMMETRICAL	WP	INDICATES WEATHERPROOF EQUIPMENT
		XFMR	TRANSFORMER

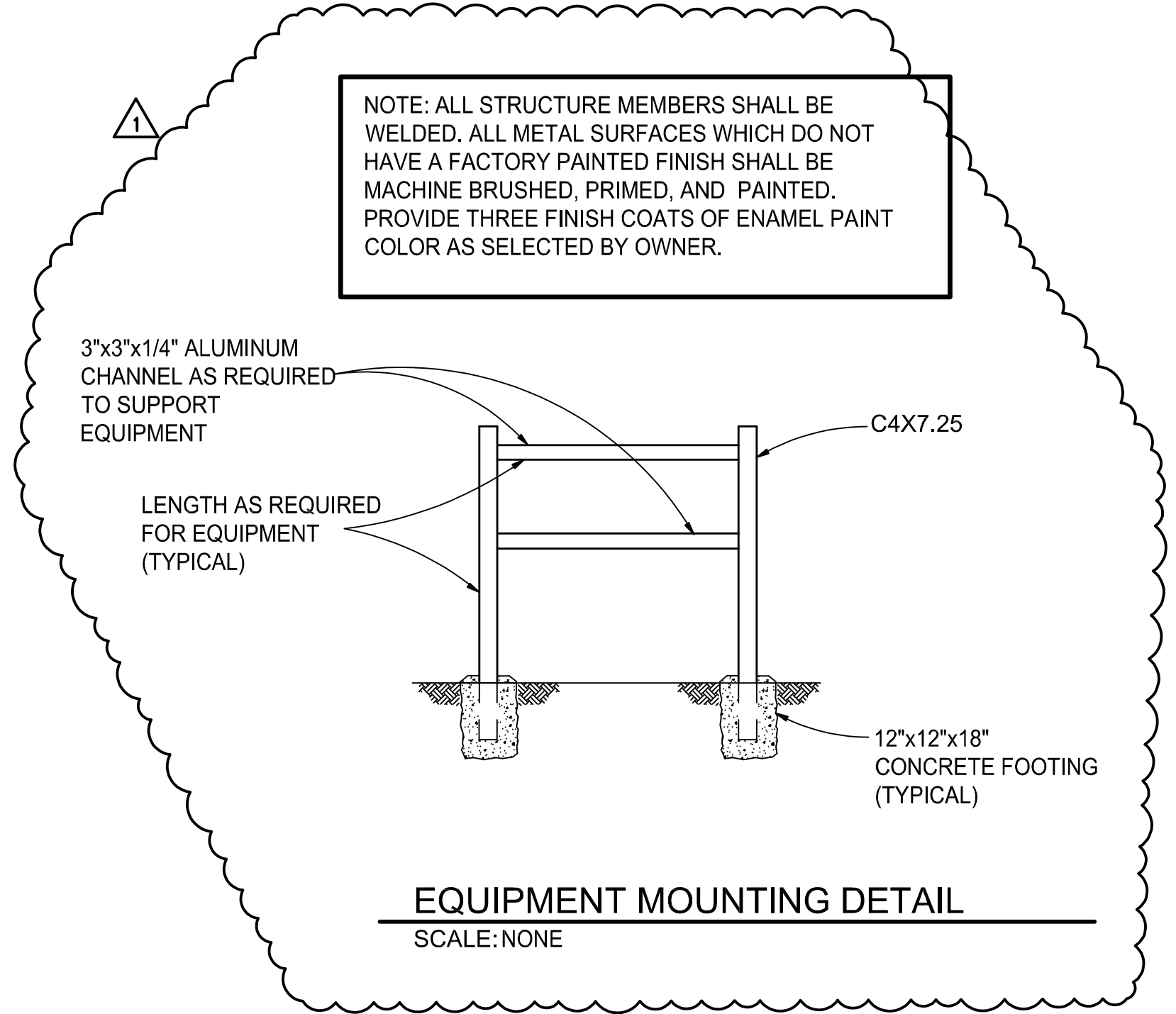
# LEGEND NOTES

- WIRE AND CONDUIT FOR MOTOR AND EQUIPMENT LOADS SHALL BE CONTINUOUS IN SIZE AND COUNT FROM SOURCE TO FINAL CONNECTION. SIZE AND COUNT SHALL BE AS INDICATED ON THE CIRCUIT HOMERUN UNLESS OTHERWISE NOTED.
- WHERE BRANCH CIRCUIT HOMERUNS ARE LABELED "SPLIT CIRCUIT" (SC), THE BRANCH CIRCUIT NUMBER INDICATED HAS BEEN USED ON MORE THAN ONE HOMERUN INDICATOR. INSTALL ONLY ONE CONDUCTOR PER CIRCUIT BREAKER POLE WITHIN THE PANELBOARD ENCLOSURE. SPLICES NECESSARY TO COMPLY WITH THIS REQUIREMENT SHALL BE MADE IN A SEPARATE SPLICE BOX OUTSIDE THE PANELBOARD ENCLOSURE.
- WHERE A NEW-TO-EXISTING CONNECTION IS INDICATED, PROVIDE MATERIALS AND LABOR REQUIRED TO MAKE THE CONNECTION.
- A (\*) IN THE FUSE RATING OR TRIP RATING POSITION FOR THIS SYMBOL INDICATES PROVIDE FUSE OR BREAKER TRIP RATING IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATION.
- WHERE EQUIPMENT OR DEVICES ARE NOTED AS "REMOVE", REMOVE CONDUCTORS ASSOCIATED WITH THESE ITEMS TO THE LAST ACTIVE ITEM ON THE CIRCUIT, OR TO THE BRANCH CIRCUIT BREAKER IF ALL ITEMS ON THE CIRCUIT ARE REMOVED. REMOVE CONDUITS FOR THESE CIRCUITS WHERE THEY RUN EXPOSED OR IN CEILING OR FLOOR PLENUMS. CONDUITS RUN CONCEALED IN WALLS OR FLOOR SLABS SHALL BE CUT OFF FLUSH WITH SURFACE AND ABANDONED. VOIDS IN WALLS OR FLOOR SLABS LEFT BY THE REMOVAL OF ELECTRICAL EQUIPMENT OR CONDUITS SHALL BE FILLED WITH NON-SHRINK GROUT AND FINISHED TO MATCH EXISTING ADJACENT SURFACES

# GENERAL NOTES

- WIRING SHALL BE IN CONDUIT, MINIMUM SIZE THREE-QUARTER (3/4) INCH WITH LARGER SIZES AS INDICATED OR REQUIRED BY N.E.C.
- WIRE AND CABLE SHALL BE #12 AWG MINIMUM.
- FOR PURPOSES OF MOUNTING ELECTRICAL EQUIPMENT OR DEVICES IN AREAS WITH RAISED FLOORING, OR RAISED PLATFORMS, THE TOP OF THE RAISED FLOOR SURFACE SHALL BE CONSIDERED THE FINISHED FLOOR LEVEL.
- EXISTING CONDUCTORS SCHEDULED TO BE REUSED SHALL BE INSPECTED BY ELECTRICIAN TO ENSURE N.E.C. CODE COMPLIANCE. ELECTRICIAN SHALL PERFORM THE FOLLOWING:
  - CHECK UNCOVERED PARTS OF CABLE FOR MATERIAL DAMAGE AND CONDITION OF CABLE JACKET AND INSTALLATION OF THE EXPOSED SECTION.
  - VERIFY THAT THE CONNECTION POINTS MATCH WHAT IS SHOWN ON THE PROJECT'S EXISTING SINGLE-LINE DIAGRAM.
  - PERFORM AN INSULATION RESISTANCE TEST (MEG OHMMETER TEST) ON EACH CONDUCTOR WITH RESPECT TO GROUND AND ADJACENT CONDUCTORS. TEST PERIOD MUST BE FOR 1 MINUTE USING A VOLTAGE ACCORDING TO MANUFACTURER'S PUBLISHED DATA. IF NO LITERATURE FROM THE MANUFACTURER IS AVAILABLE, APPLY 500 VOLTS DC ON 300-VOLT-RATED CABLE AND 1000 VOLTS DC FOR 600 VOLT-RATED CABLE. INSTALLATION RESISTANCE VALUE MUST BE ACCORDING TO THE LINE MANUFACTURER'S PUBLISHED DATA. IF NO DATA FROM MANUFACTURER EXISTS, THE VALUE SHOULD BE LESS THAN 100 MEGAOHMS. PERFORM CONTINUITY TESTS TO ENSURE CORRECT CABLE CONNECTION AND PHASING.
  - PRIOR TO ANY EXCAVATION FOR THE INSTALLATION OF UNDERGROUND ELECTRICAL POWER, ELECTRICAL CONTRACTOR TO CONDUCT AN ELECTROMAGNETIC INDUCTION STUDY OF THE LOCATION BEING EXCAVATED AND DOCUMENT ALL UNDERGROUND EQUIPMENT.
  - ELECTRICIAN TO ENSURE NEW EQUIPMENT DATA PLATE CONCURS WITH PRIOR EQUIPMENT BEING REPLACED, EXISTING DATA PLATE. IF NEW DATA PLATE IS INCONSISTENT, ELECTRICIAN SHALL CONTACT ELECTRICAL ENGINEER FOR ELECTRICAL REQUIREMENTS PRIOR TO INSTALLATION OF NEW EQUIPMENT.
  - PROVIDE UPDATE TYPED PANEL SCHEDULE UPON PROJECT COMPLETION.
  - PRIOR TO ANY EXCAVATION FOR THE INSTALLATION OF UNDERGROUND ELECTRICAL POWER REQUIREMENTS, ELECTRICAL CONTRACTOR SHALL CONDUCT AN ELECTROMAGNETIC INDUCTION STUDY OF THE LOCATION BEING EXCAVATED AND DOCUMENT ALL UNDERGROUND EQUIPMENT.
  - ALL UNDERGROUND CONDUIT SHALL BE SCH-80 PVC. ABOVE GROUND CONDUIT TO BE ALUMINUM.
  - ROUTE UNDERGROUND CONDUIT PARALLEL IN SAME TRENCHES AS OTHER DISCIPLINE PIPING WHEN POSSIBLE.

Sheet List Table	
Sheet Number	Sheet Title
E0.1	LEGEND AND GENERAL NOTES
ES1.1	ELECTRICAL SITE PLAN - WWTP
E1.1	PRIMARY CLARIFIERS DEMOLITION PLAN
E1.2	PRIMARY CLARIFIERS PLAN
E3.1	EFFLUENT PUMP STATION DEMOLITION AND PROPOSED PLAN AND SECTION
E4.1	DIGESTER & HEAD HOUSE DEMOLITION PLANS
E4.2	DIGESTER & HEAD HOUSE PLANS
E4.3	POLE BARN PLAN
E5.1	WAS PUMP REPLACEMENT
E6.1	ONE LINE DIAGRAM - DEMOLITION
E6.2	ONE LINE DIAGRAM - NEW WORK
E6.2A	ONE LINE DIAGRAM - NEW WORK
E6.3	MCC-8 ELEVATIONS AND ONE LINE
E6.4	MCC-8 NAMEPLATE SCHEDULE
E6.5	PANELBOARD SCHEDULES
E7.1	POLE BARN EQUIPMENT CONTROLS



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CONTENT:  
LEGEND AND GENERAL NOTES

SHEET NO:  
**E0.1**

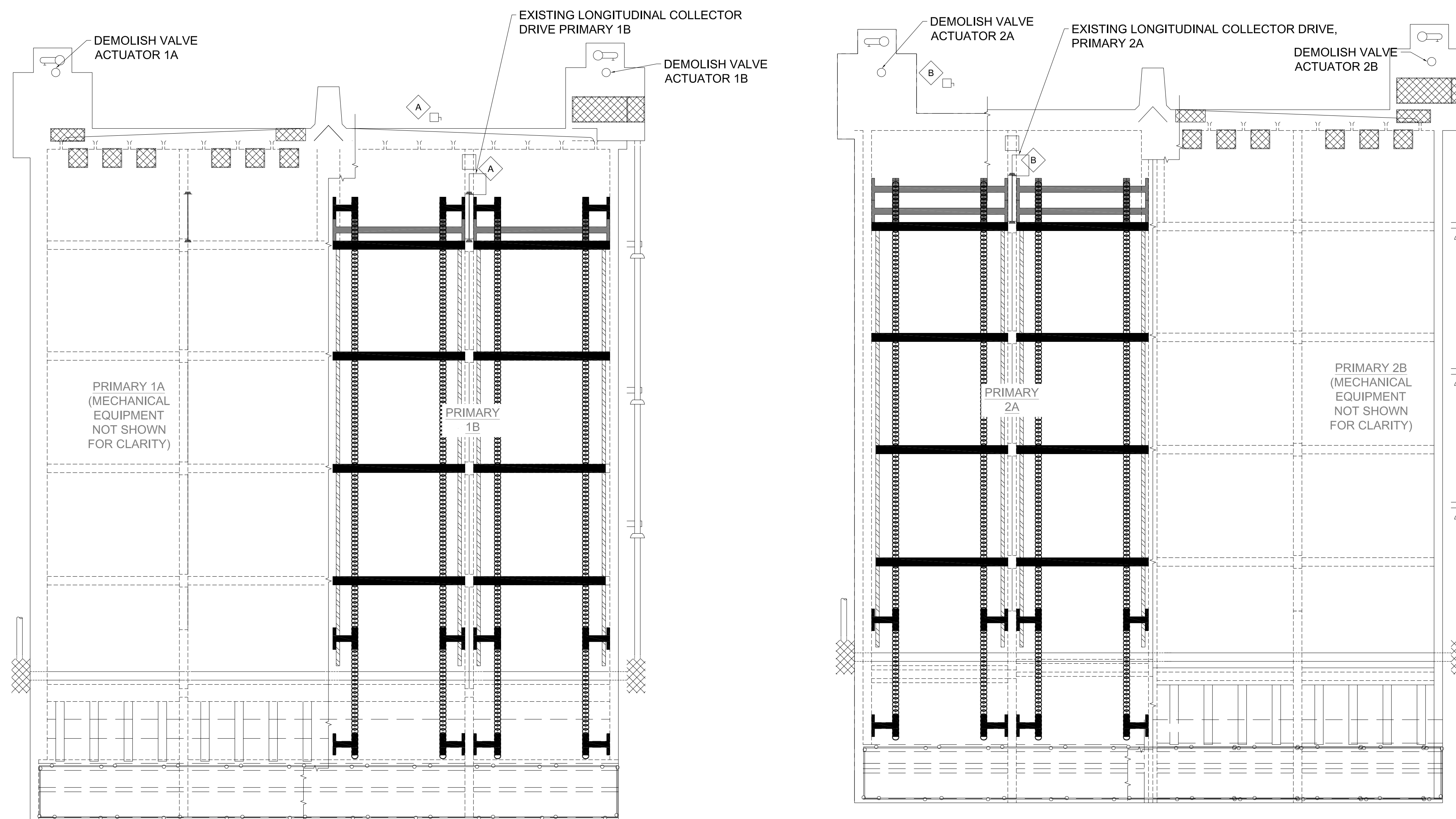
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**GENERAL NOTES**

- A. SEE GENERAL NOTES, SHEET E0.1, PERTAINING TO THE TESTING OF EXISTING ELECTRICAL CONDUCTORS.
- B. SEE GENERAL NOTES, SHEET E0.1, PERTAINING TO THE EXCAVATION OF EARTH FOR NEW UNDERGROUND ELECTRICAL COMPONENTS.
- C. CONTRACTOR/ELECTRICIAN TO FIELD VERIFY LOCATION OF EXISTING EQUIPMENT.
- D. SEE SHEET ES1.1 FOR SITE LOCATION.

**# DEMOLITION NOTES**

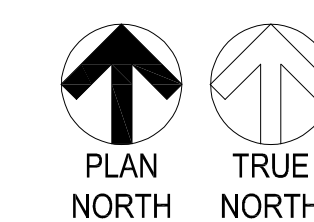
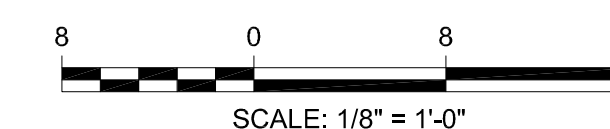
- A. DISCONNECT FEEDER SERVING ELECTRICAL DISCONNECT AND MOTOR THAT SERVES 1/2HP LONGITUDINAL DRIVE LABELED CLARIFIER 1B, AND SLUDGE COLLECTOR 1B. CONDUCTORS TO REMAIN AS-IS FOR RECONNECTION. DISCONNECTS AND MOTORS SHALL BE REMOVED AND REPLACED AS SHOWN ON SHEET E1.2.
- B. DISCONNECT FEEDER SERVING ELECTRICAL DISCONNECT AND MOTOR THAT SERVES 1/2HP LONGITUDINAL DRIVE LABELED CLARIFIER 2A, AND SLUDGE COLLECTOR 2A. CONDUCTORS TO REMAIN AS-IS FOR RECONNECTION. DISCONNECTS AND MOTORS SHALL BE REMOVED AND REPLACED AS SHOWN ON SHEET E1.2.



**1**  
**E1.1** PRIMARY CLARIFIERS DEMOLITION PLAN  
SCALE: 1/8" = 1'-0"

**SHUTDOWN NOTES:**

- 1. TWO PRIMARIES (MINIMUM) OR THREE PRIMARIES (PREFERRED) MUST REMAIN IN SERVICE AT ALL TIMES. COORDINATE ALL ELECTRICAL EQUIPMENT SHUTDOWNS WITH ESG OPERATIONS STAFF AND THE ENGINEER.



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**CONTENT:**  
PRIMARY CLARIFIERS DEMOLITION PLAN

**SHEET NO:**  
**E1.1**

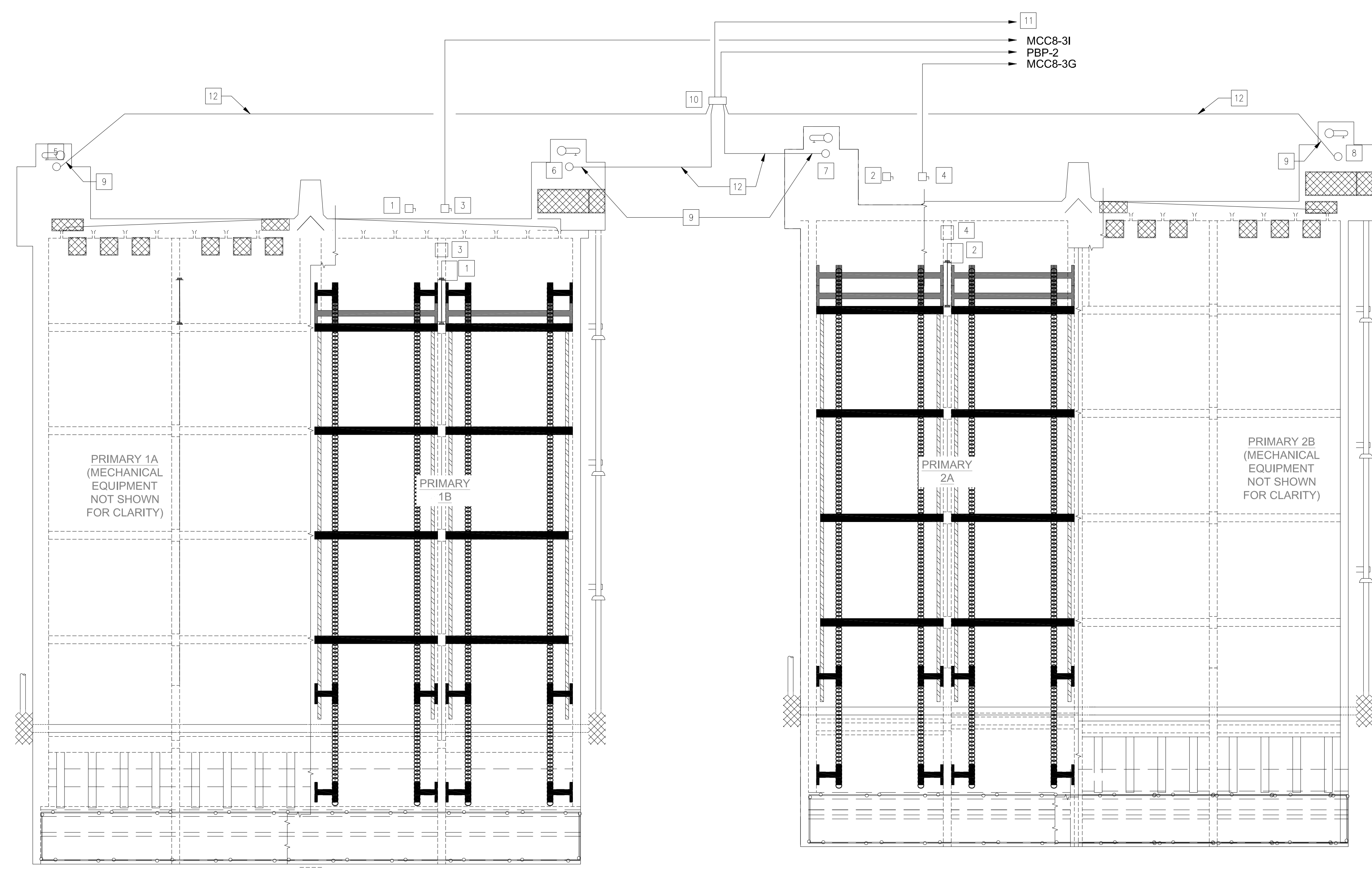
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# GENERAL NOTES

- A. SEE GENERAL NOTES, SHEET E0.1, PERTAINING TO THE TESTING OF EXISTING ELECTRICAL CONDUCTORS.
- B. SEE GENERAL NOTES, SHEET E0.1, PERTAINING TO THE EXCAVATION OF EARTH FOR NEW UNDERGROUND ELECTRICAL COMPONENTS, PRIOR TO ANY EXCAVATION WORK BEING PERFORMED.

# # NOTES

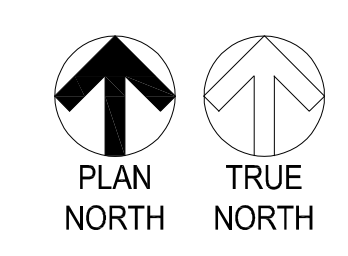
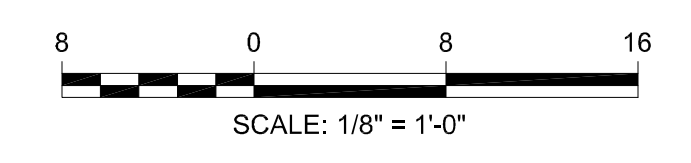
1. PROVIDE 30A/3P/NEMA 4X COMBINATION STARTER/DISCONNECT WITH EXTERIOR ON/OFF/AUTO/RESET CONTROLS AND CONNECT TO NEW MOTOR THAT SERVES 1/2HP LONGITUDINAL DRIVE LABELED CLARIFIER 1B. SLUDGE COLLECTOR 1B. UTILIZE EXISTING CONDUCTORS.
2. PROVIDE 30A/3P/NEMA 4X COMBINATION STARTER/DISCONNECT WITH EXTERIOR ON/OFF/AUTO/RESET CONTROLS AND CONNECT TO NEW MOTOR THAT SERVES 1/2HP LONGITUDINAL DRIVE LABELED CLARIFIER 2A. SLUDGE COLLECTOR 2A. UTILIZE EXISTING CONDUCTORS.
3. PROVIDE 30A/3P/NEMA 4X COMBINATION STARTER/DISCONNECT WITH EXTERIOR ON/OFF/AUTO/RESET CONTROLS. PROVIDE POWER TO NEW CROSS COLLECTOR DRIVES PRIMARY CLARIFIER 1B. PROVIDE UNDERGROUND FEED FROM NEW MCC-8, 480V/3PH, 4#8,#10G;1" C, TO NEW 30A/3P/NEMA 4X COMBINATION STARTER/DISCONNECT, LOCATED ADJACENT TO CROSS COLLECTOR DRIVES. SEE SHEET E4.5 FOR LOCATION OF MCC-8.
4. PROVIDE 30A/3P NEMA 4X COMBINATION STARTER/DISCONNECT WITH EXTERIOR ON/OFF/AUTO/RESET CONTROLS. PROVIDE POWER TO NEW CROSS COLLECTOR DRIVES PRIMARY CLARIFIER 2A. PROVIDE UNDERGROUND FEED FROM NEW MCC-8, 480V/3PH, 4#8,#10G;1" C, TO NEW 30A/3P/NEMA 4X COMBINATION STARTER/DISCONNECT, LOCATED ADJACENT TO CROSS COLLECTOR DRIVES. SEE SHEET ES1.1 AND E4.3 FOR LOCATION OF MCC-8.
5. NEW VALVE ACTUATOR #5 LOCATED NORTHWEST OF PRIMARY 1A. SEE MANUFACTURERS CONTROL TERMINATION SCHEDULE TO SERVE VALVE.
6. NEW VALVE ACTUATOR #6 LOCATED NORTHEAST OF PRIMARY 1B. SEE MANUFACTURERS CONTROL TERMINATION SCHEDULE TO SERVE VALVE.
7. NEW VALVE ACTUATOR #7 LOCATED NORTHEAST OF PRIMARY 2A. SEE MANUFACTURERS CONTROL TERMINATION SCHEDULE TO SERVE VALVE.
8. NEW VALVE ACTUATOR #8 LOCATED NORTHWEST OF PRIMARY 2B. SEE MANUFACTURERS CONTROL TERMINATION SCHEDULE TO SERVE VALVE.
9. ROUTE 8#14 CONTROL CABLES IN 3/4" CONDUIT ON TOP OF EXISTING CONCRETE TO VALVE ACTUATOR. UTILIZE CADDY PYRAMID STANDOFFS MOUNTED @3" O.C. WITH A MINIMUM OF TWO PER ABOVE-GROUND RUN.
10. PROVIDE NEW PRIMARY SLUDGE TRANSFER CONTROL PANEL. NEMA 4X DUPLEX RYSS PANEL WITH PLC AND HMI SHALL CONTROL TWO PRIMARY SLUDGE PUMPS AND FOUR ELECTRICAL ACTUATORS, AND SHALL BE INSTALLED ADJACENT TO PRIMARY CLARIFIER. COORDINATE EXACT LOCATION OF CONTROL PANEL WITH ESG ENGINEERING (KRISTEN COURSON) PRIOR TO ROUGH-IN. COORDINATE CONTROL PANEL WITH GREG MASTERS - 1 (770) 614-7022.
11. REFER TO NOTE 8, SHEET ES1.1, AND NOTE 11, SHEET E4.2, FOR ADDITIONAL INFORMATION ON CONTROL WIRING.
12. PROVIDE 3/4" C FROM SLUDGE PUMP CONTROL PANEL TO VALVE ACTUATOR WITH #18/2 SHIELDED TWISTED PAIR CABLE.



**1**  
E1.2 PRIMARY CLARIFIERS PLAN  
SCALE: 1/8" = 1'-0"

# SHUTDOWN NOTES:

1. TWO PRIMARIES (MINIMUM) OR THREE PRIMARIES (PREFERRED) MUST REMAIN IN SERVICE AT ALL TIMES. COORDINATE ALL ELECTRICAL EQUIPMENT SHUTDOWNS WITH ESG OPERATIONS STAFF AND THE ENGINEER.



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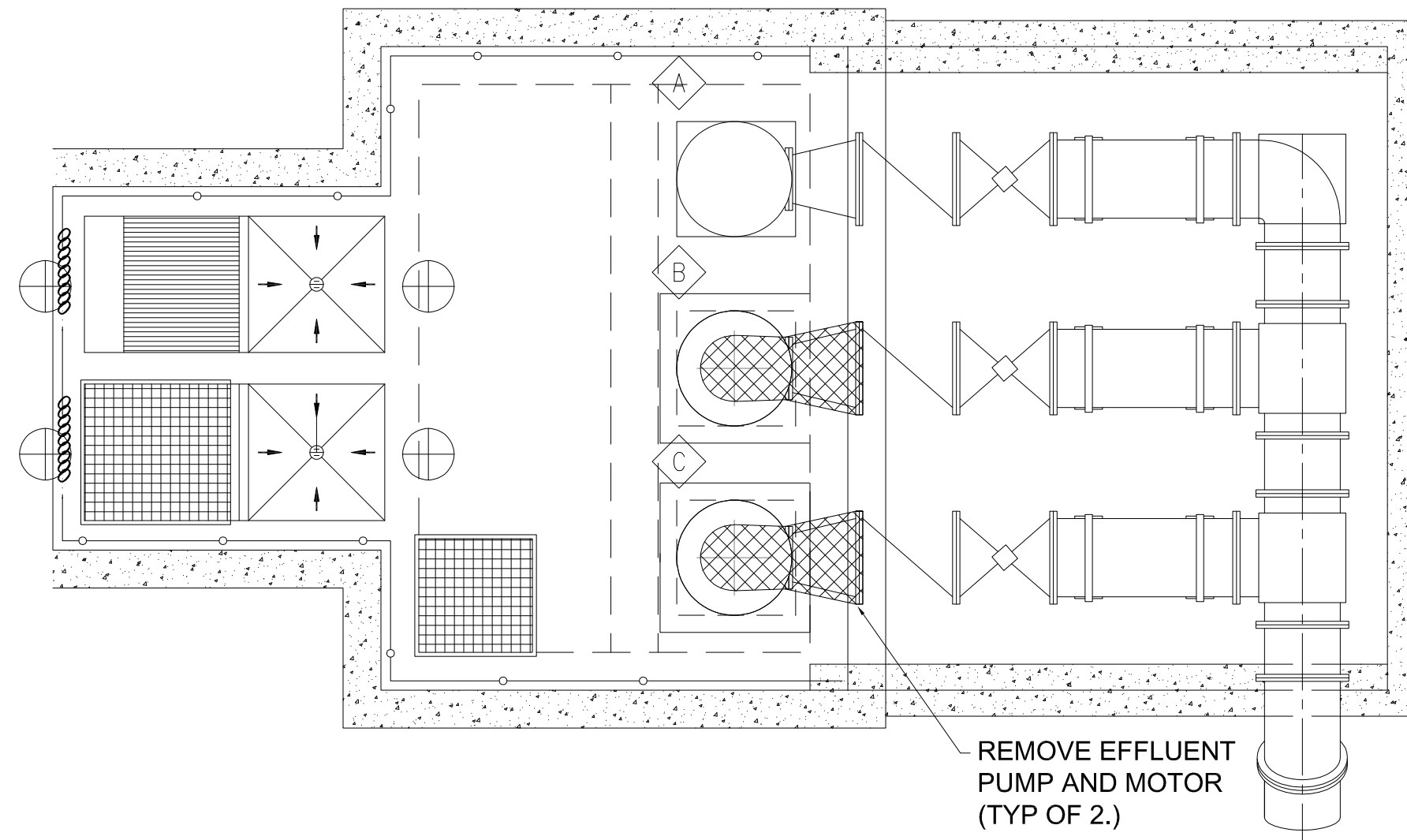


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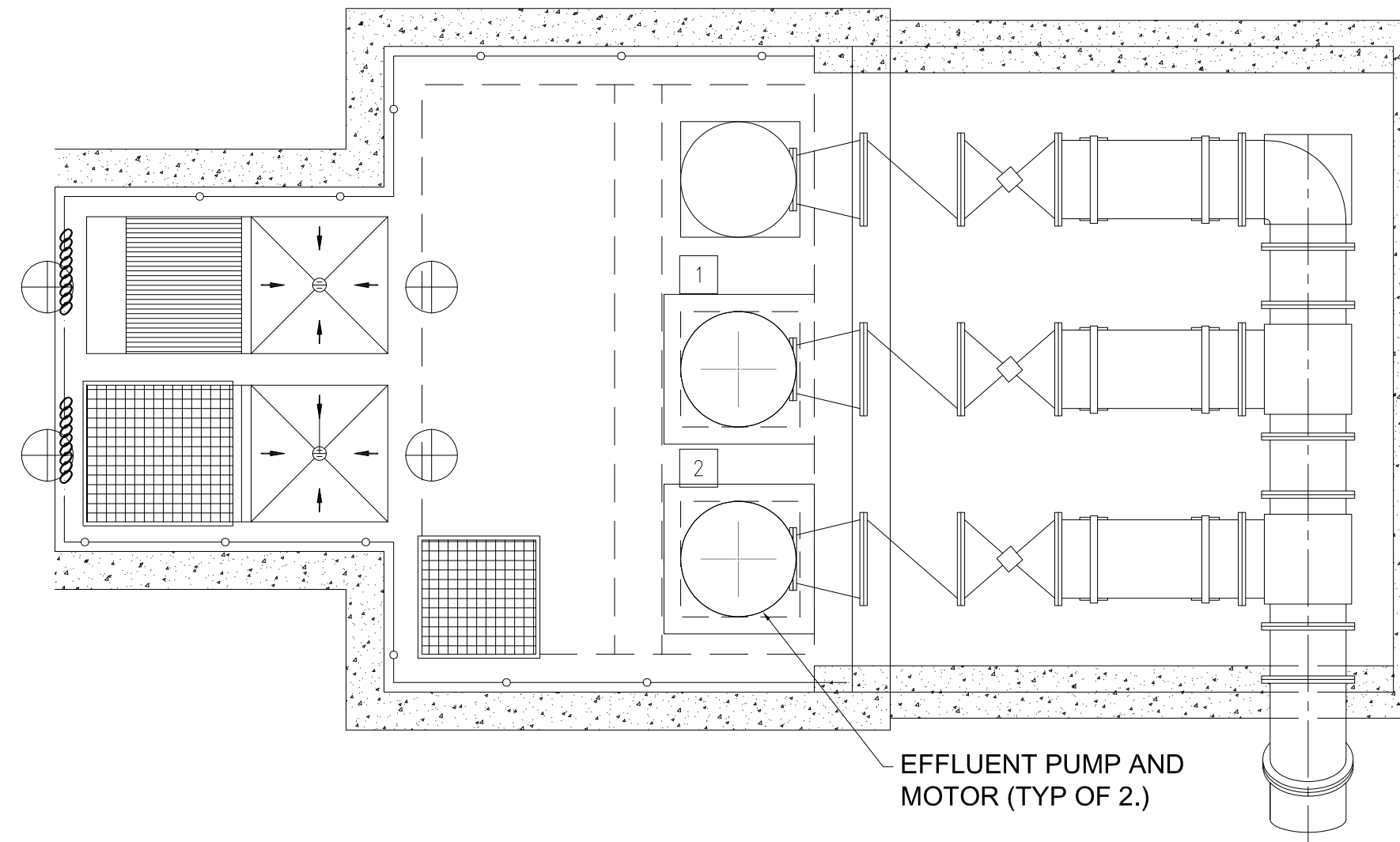
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PRIMARY CLARIFIERS PLAN

**SHEET NO:**  
**E1.2**

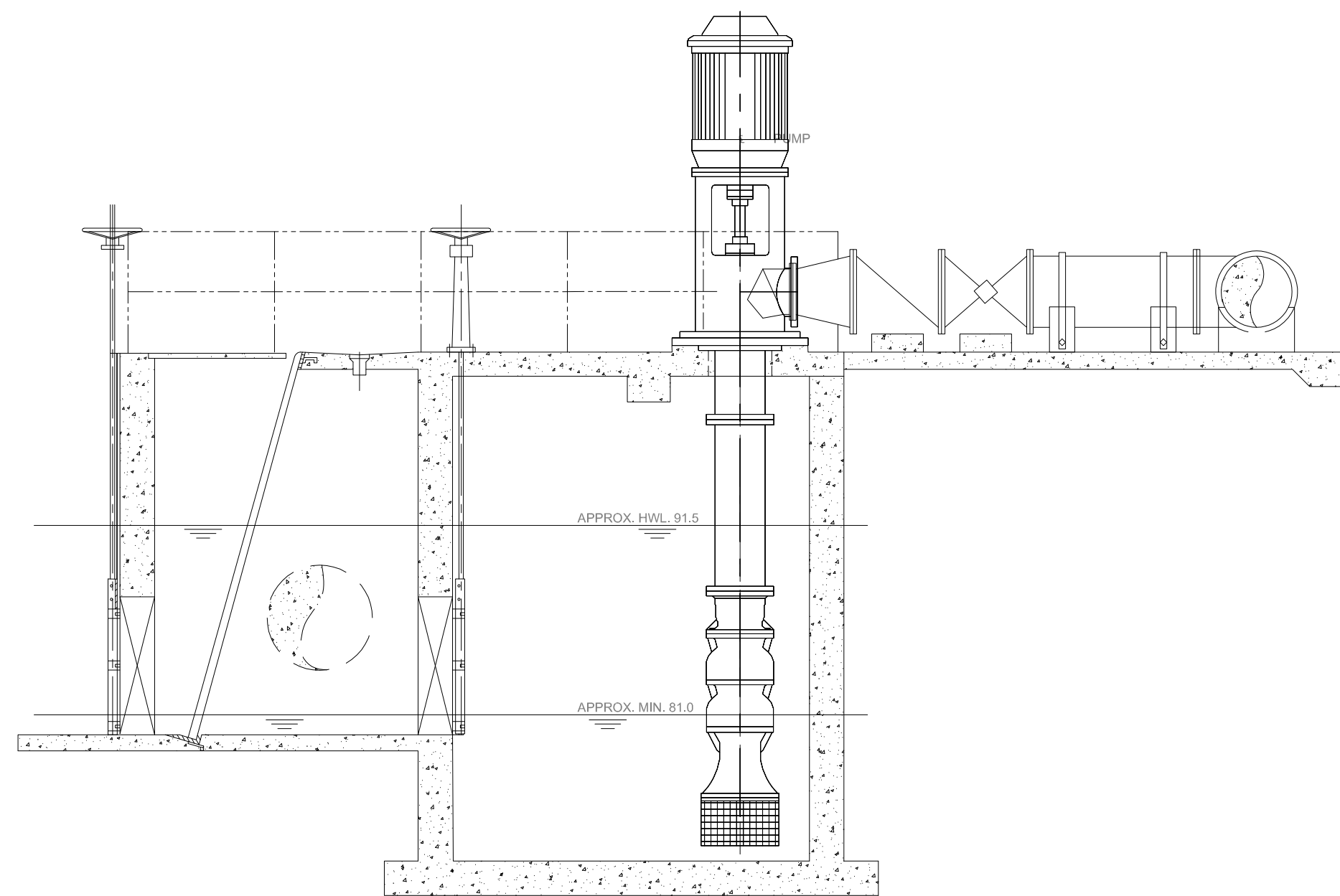
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**1**  
E3.1 EFFLUENT PUMP STATION PLAN - DEMOLITION  
SCALE: 1/4" = 1'-0"



**2**  
E3.1 EFFLUENT PUMP STATION PLAN  
SCALE: 1/4" = 1'-0"



**3**  
E3.1 SECTION A - PROPOSED  
SCALE: 1/4" = 1'-0"

**GENERAL NOTES**

- A. SEE GENERAL NOTES, SHEET E0.1, PERTAINING TO THE TESTING OF EXISTING ELECTRICAL CONDUCTORS.

**DEMOLITION NOTES**

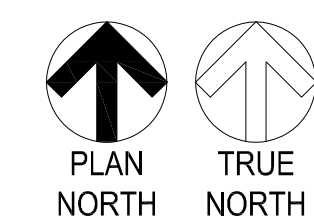
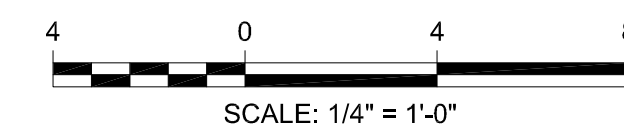
- A. EXISTING EFFLUENT PUMP #1 TO REMAIN.
- B. DISCONNECT EXISTING FEEDERS FROM EFFLUENT PUMP #2. BREAKER IN MCC-7, FEEDER AND CONDUIT TO REMAIN AS IS. STARTER IN MCC-7 IS BEING REPLACED WITH A SOFT STARTER. REFER TO NOTE 1, SHEET ES1.1 FOR ADDITIONAL INFORMATION.
- C. DISCONNECT EXISTING FEEDERS FROM EFFLUENT PUMP #3. BREAKER IN MCC-7, FEEDER AND CONDUIT TO REMAIN AS IS. STARTER IN MCC-7 IS BEING REPLACED WITH A SOFT STARTER. REFER TO NOTE 1, SHEET ES1.1 FOR ADDITIONAL INFORMATION.

**NOTES**

- 1. RECONNECT FEEDER TO NEW EFFLUENT PUMP #2.
- 2. RECONNECT FEEDER TO NEW EFFLUENT PUMP #3.

**SHUTDOWN NOTES:**

- 1. TWO EFFLUENT PUMPS SHALL REMAIN IN SERVICE AT ALL TIMES. SCHEDULE ALL WORK WITH OPERATIONS STAFF AND SEQUENCE WORK SO THAT REPLACEMENT OF ONE PUMP IS COMPLETE (WITH NEW SOFT START) AND OPERATIONAL BEFORE REPLACEMENT OF SECOND PUMP BEGINS.



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EFFLUENT PUMP  
STATION  
DEMOLITION AND  
PROPOSED PLAN AND  
SECTION

**SHEET NO:**  
**E3.1**

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# GENERAL NOTES

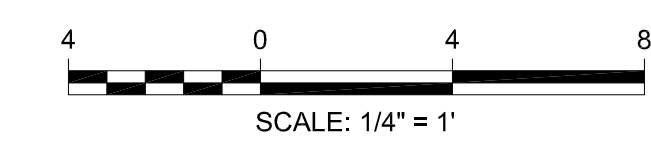
- A. SEE GENERAL NOTES, SHEET E0.1, PERTAINING TO THE TESTING OF EXISTING ELECTRICAL CONDUCTORS.

# DEMOLITION NOTES

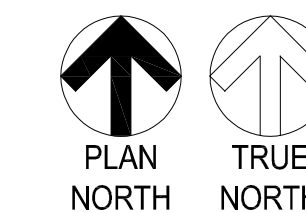
- A. EXISTING 15HP DIGESTER FEED PUMP #1 AND VFD SCHEDULED FOR REPLACEMENT. DEMOLISH EXISTING CONDUCTORS AND CONDUIT/RACEWAY TO MCC BUSS THAT SERVES IT, RELABEL EXISTING BUSS (SPARE).
- B. EXISTING 15HP DIGESTER FEED PUMP #2 AND VFD SCHEDULED FOR REPLACEMENT. DEMOLISH EXISTING CONDUCTORS AND CONDUIT/RACEWAY TO MCC BUSS THAT SERVES IT, RELABEL EXISTING BUSS (SPARE).
- C. EXISTING 15HP DIGESTER FEED PUMP #3 AND VFD SCHEDULED FOR REMOVAL. DEMOLISH EXISTING CONDUCTORS AND CONDUIT/RACEWAY TO MCC BUSS THAT SERVES IT, RELABEL EXISTING BUSS (SPARE).

# SHUTDOWN NOTES:

- 1. PRIMARY SLUDGE PUMP #3 IS CURRENTLY THE ONLY OPERATIONAL PUMP IN THE BASEMENT. THIS PUMP SHALL REMAIN OPERATIONAL WITH THE EXISTING POWER SUPPLY WHILE PUMPS #1 AND #2 ARE REPLACED AND POWERED. PUMP #3 SHALL BE DEMOLISHED ONCE THE NEW PUMPS ARE INSTALLED AND OPERATIONAL.



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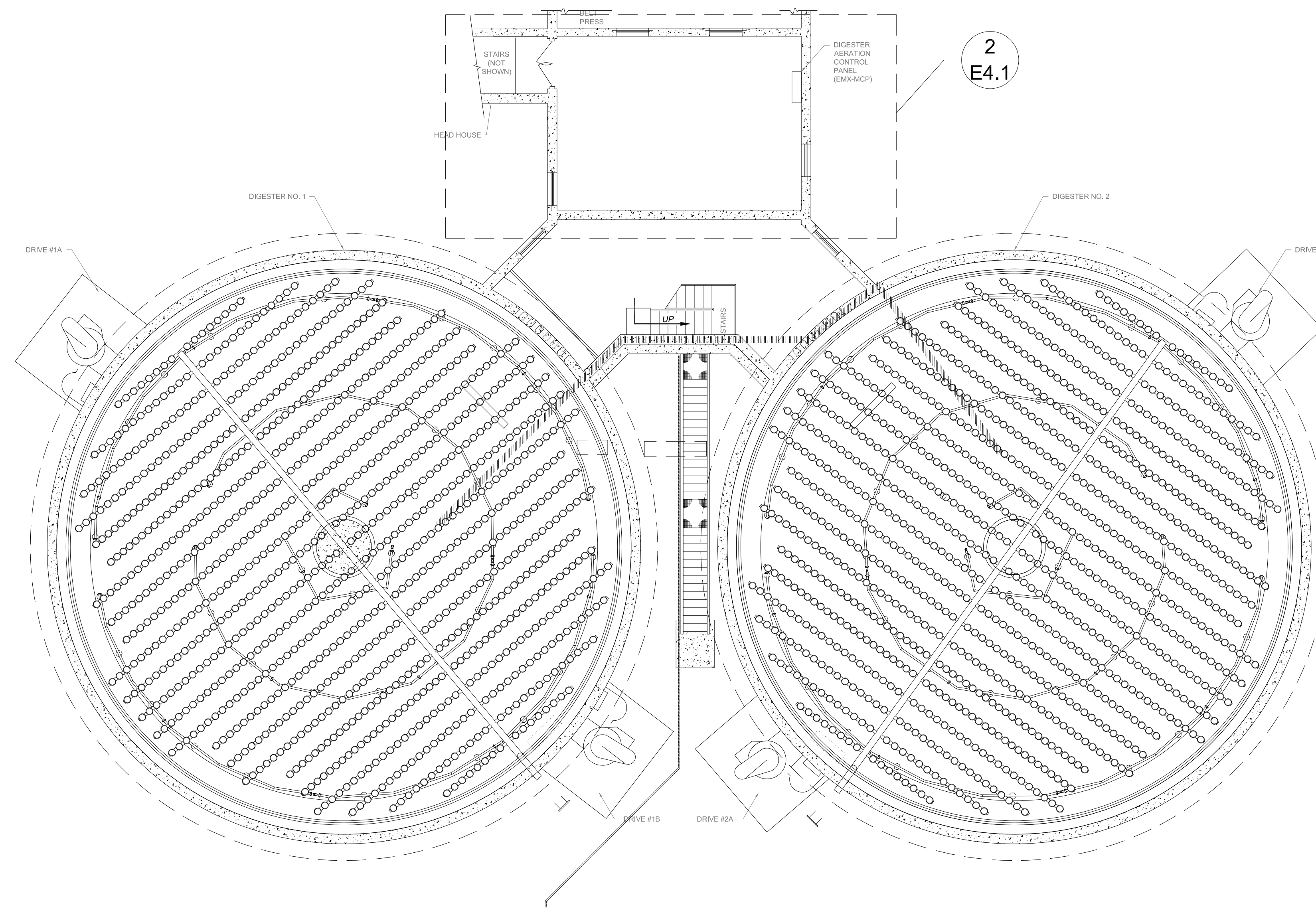


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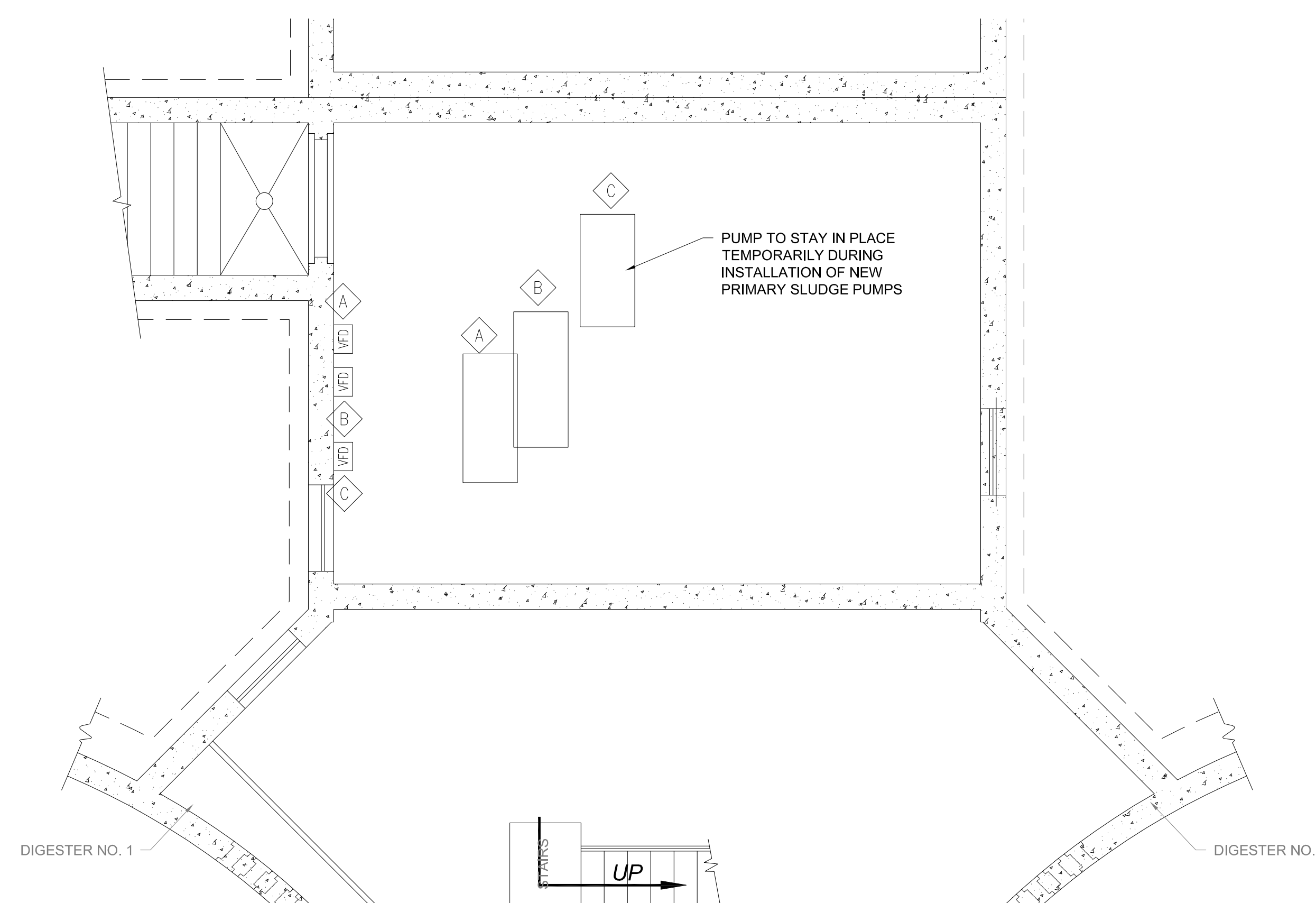
CONTENT:  
DIGESTER & HEAD  
HOUSE DEMOLITION  
PLANS

SHEET NO:

E4.1



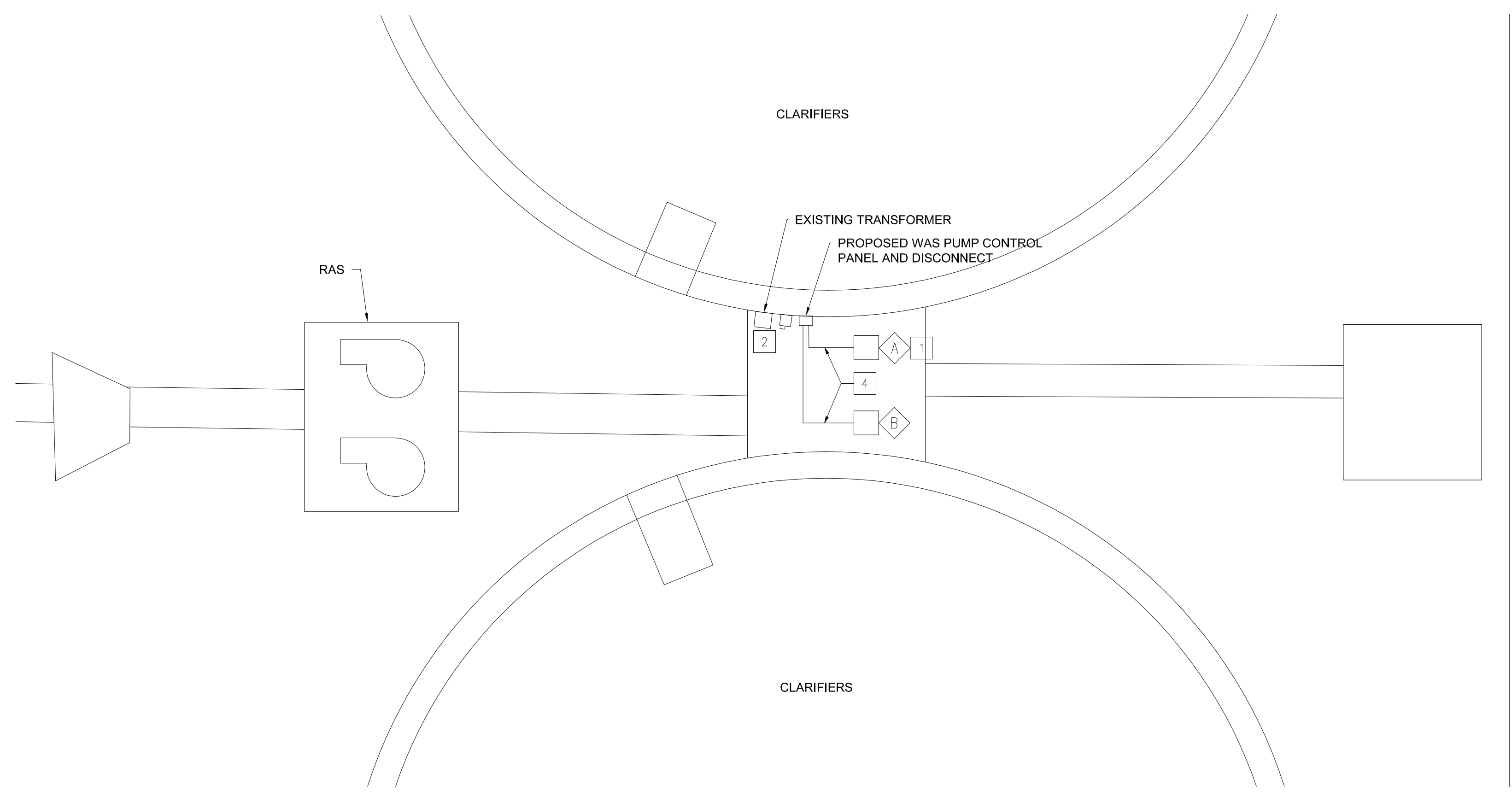
1 DIGESTER & HEAD HOUSE DEMOLITION PLANS  
SCALE: 1/8" = 1'-0"



2 DIGESTER AND HEAD HOUSE  
BASEMENT PLAN - DEMOLITION  
SCALE: 1/4" = 1'-0"

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**1**  
**E5.1** WAS PUMP REPLACEMENT  
SCALE: 1" = 10'

**GENERAL NOTES**

A. SEE GENERAL NOTES, SHEET E0.1, PERTAINING TO THE TESTING OF EXISTING ELECTRICAL CONDUCTORS.

**DEMOLITION NOTES**

A. EXISTING WAS PUMP #1 AND VFD TO BE DISCONNECTED FOR REPLACEMENT. CONDUCTORS TO REMAIN AS IS.  
 B. EXISTING WAS PUMP #2 AND VFD TO BE DISCONNECTED FOR REPLACEMENT. CONDUCTORS TO BE DEMOLISHED TO EXISTING DISCONNECT SERVING WAS PUMP #2.

**NOTES**

1. WAS PUMP #1. REFER TO GENERAL NOTE #1. RECONFIGURE CONNECTION FROM WAS PUMP #1 TRANSFORMER TO SERVE WAS PUMP #1 AND WAS PUMP #2, VIA NEW CONTROL PANEL.
2. EXISTING TRANSFORMER #1 THAT PREVIOUSLY SERVED WAS PUMP #1, SHALL NOW FEED 60A/3P/NEMA 4X DISCONNECT, 60A/3P/NEMA 4X DISCONNECT SHALL SERVE CONTRACTOR-PROVIDED NEW WAS PUMPS CONTROL PANEL N4X VFD DUPLEX PANEL MOUNTED ADJACENT TO WAS PUMP #1. NEW CONTROL PANEL SHALL CONTROL WAS PUMPS #1 AND #2. MOUNT DISCONNECT AND CONTROL PANEL ON WALL ADJACENT TO WAS PUMPS, COORDINATE LOCATION WITH ESG ENGINEERING (KRISTEN COURSON) PRIOR TO ROUGH-IN. COORDINATE CONTROL PANEL N4X VFD DUPLEX WITH GREG MASTERS - 1 (770) 614-7022. RELABEL ELECTRICAL EQUIPMENT TO REFLECT THE NEW ELECTRICAL CONNECTIONS IT SERVES. PROVIDE 4#4, 1#8G; 1-1/4" FROM TRANSFORMER TO DISCONNECT AND FROM DISCONNECT TO CONTROL PANEL.
3. LABEL EXISTING 80A BREAKER IN MCC-5 PREVIOUSLY FOR WAS PUMP #2 AS SPARE. RELABEL EXISTING 80A BREAKER SERVING WAS PUMP 1 TO REFLECT WAS PUMP #1 AND #2, AS WELL AS THE TRANSFORMER PREVIOUSLY SERVING WAS PUMP #1, AS WAS PUMP #1 AND #2. EXISTING WAS TRANSFORMER #2, DISCONNECT SERVED FROM THIS TRANSFORMER SHALL BE LABELED AS SPARE. SEE 1/ES1-1 FOR SITE LOCATION OF MCC-5.
4. ROUTE 8#14 CONTROL CABLES IN 3/4" CONDUIT ON TOP OF EXISTING CONCRETE TO PRESSURE SWITCH. UTILIZE CADDY PYRAMID STANDOFFS MOUNTED @3' O.C. WITH A MINIMUM OF TWO PER ABOVE-GROUND RUN.

**SHUTDOWN NOTES:**

1. ONLY ONE WAS PUMP IS CURRENTLY OPERATIONAL. THE WORKING WAS PUMP IS UTILIZED 4 TO 5 DAYS A WEEK FOR SLUDGE PRESSING OPERATIONS. THE CONTRACTOR SHALL PROCEED WITH PIPING WORK AND NEW PUMP INSTALLATION IN THE NON-OPERATIONAL PUMP POSITION FIRST WHILE LEAVING THE OPERATIONAL PUMP IN SERVICE. COORDINATE ELECTRICAL DOWNTIME WITH PLANT OPERATORS AND THE ENGINEER. ONCE THE FIRST NEW PUMP IS SUCCESSFULLY PLACED IN OPERATION (PUMPING TO DIGESTER) THE ALTERNATE WAS PUMP MAY BE TAKEN OFF LINE FOR REPLACEMENT.

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**FY2020 WASTE WATER TREATMENT FACILITY UPGRADES**  
 FOR THE CITY OF WAYCROSS, GA

REVISIONS	NO.	DESCRIPTION	DATE
A	1	ADDENDUM #3	7/13/22

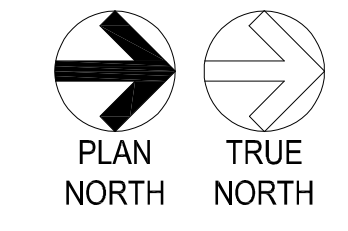
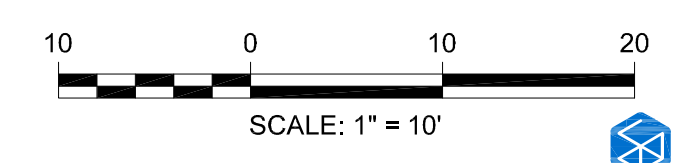
**FOR CONSTRUCTION**



**DRAWN BY:** SJB  
**CHECKED BY:** SPS  
**DATE:** JUNE 3 2022  
**SCALE:** AS NOTED

**CONTENT:**  
 WAS PUMP REPLACEMENT

**SHEET NO:**  
**E5.1**



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