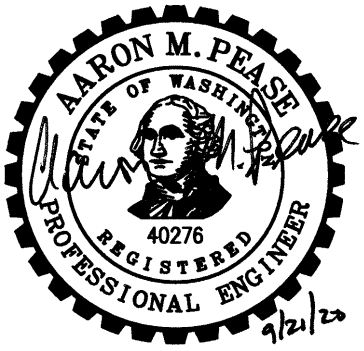
ADDENDUM 3
TO THE CONTRACT PROVISIONS AND CONTRACT PLANS

FOR

CITY OF SOUTH BEND
WATER TREATMENT PLAN UPGRADE AND EXPANSION

G&O #15286



ISSUED THIS DATE: **MONDAY, SEPTEMBER 21, 2020**

BID OPENING: **11:00 AM (LOCAL TIME) ON WEDNESDAY SEPTEMBER 23, 2020 CITY OF SOUTH BEND 1102 WEST 1st STREET SOUTH BEND, WASHINGTON, 98586**

Bidder shall acknowledge receipt of this Addendum on Page 1 of the Bid Form.

TO PROSPECTIVE BIDDERS:

The attention of all prospective bidders on the above project is directed to the following additions and modifications to the Contract Provisions and Contract Plans.

I. ADDITIONS, MODIFICATIONS, AND/OR DELETIONS TO THE TECHNICAL SPECIFICATIONS

ITEM 1:

Page iii, Technical Specifications Table of Contents

Under Division 16, Electrical, **ADD** the following:

"16442 Control Centers 16442-1
16460 Low Voltage Transformers ..... 16460-1"

ITEM 2:

Page 01200-4, Specification Section 01200-1.4 A. 5. b., Payment

REVISE as shown below (added text is italicized, deleted text is shown as strike out):

"b. Payment: The lump sum contract price for WATER TREATMENT PLANT UPGRADES shall include all costs for labor, materials, and equipment required to furnish, install, and test the raw water pumps, finished water pumps, neutralization pumps, and ~~magnetic flow meter~~ *compressed air system,* as shown on the Plans and as indicated in Sections 11211, 11212, ~~11313~~ *and 11213,* and 15210."

ITEM 3:

Page 01200-5, Specification Section 01200-1.4 A. 12. b., Payment

REVISE as shown below (added text is italicized, deleted text is shown as strike out):

"b. Payment: The lump sum contract price for *BUILDING* PIPING, VALVES, AND APPURTENANCES shall include all costs for the labor, materials, and equipment to *furnish and* install piping, valves, and appurtenances including, but not limited to installation of pipe, ~~conduit,~~ fittings, valves, control valves, ~~magnetic flowmeters, analyzers, level sensors,~~ pipe supports, plumbing, painting, chemical feed lines, chemical injection points, and instrumentation *installation,* as well as disinfection and testing, as shown on the Plans and as specified herein."

ITEM 4:

Page 01200-7, Specification Section 01200-1.4 B. 1. b., Payment

REVISE as shown below (added text is italicized, deleted text is shown as strike out):

"b. Payment: The lump sum contract price for GENERATOR AND ATS SWITCH shall include all costs for the labor, materials, and equipment to furnish and install a new generator, generator pad, automatic transfer switch, *service disconnect breaker [01 SDB 01], molded case breaker [01 MCCB 01], and pullbox [01 PBOX 01], and their associated conduits and wiring,* as shown on the Plans and as specified herein."

ITEM 5:

Page 11242-1, Specification Section 11242-1.2, EQUIPMENT LIST

DELETE the following from the Equipment List:

"Sodium Bisulfite Tank 1 CHT-870"

ITEM 6:

Page 16130-20, Specification Section 16130-3.2 A., PVC-COATED RGS CONDUIT APPLICATIONS

REVISE subsection 5 as shown below (added text is italicized, deleted text is shown as strike out):

"5. All portions of RGS elbows, bends, straight pipes, couplings, and fittings exposed *and within 10 feet of chemical storage tanks* ~~in Chemical rooms (reference Definitions)~~ shall be PVC-Coated."

ITEM 7:

DELETE Specification Section 16420 in its entirety and **REPLACE** it with the attached Section 16420.

ITEM 8:

ADD Specification Section 16442 in its entirety.

ITEM 9:

ADD Specification Section 16460 in its entirety.

III. ADDITIONS, MODIFICATIONS, AND/OR DELETIONS TO THE CONTRACT PLANS

ITEM 1:

SHEET E-13, NETWORK CONFIGURATIONS

DELETE Sheet E-13 in its entirety and **REPLACE** with the attached revised Sheet E-13.

ITEM 2:

SHEET E1-1, EAST TREATMENT PLANT UPGRADE AND EXPANSION

REMOVE Conduit call-out "C0105" in the SW corner of the sheet.

ITEM 3:

SHEET E1-3, WATER TREATMENT PLANT EXISTING AND MODIFIED ELECTRICAL SERVICE DETAILS

ADD the following Notes to the sheet:

"7. NOT ALL CONTROL CONDUITS ARE SHOWN. CONDUITS C0121A, C0121B AND C0121C ARE NOT SHOWN.

8. JUNCTION BOX JC0121 IS NOT SHOWN. PROVIDE AS A NEMA 4X 316L STAINLESS STEEL SIZED AND INSTALLED PER THE NEC WITHIN A CODE COMPLIANT LOCATION."

ITEM 4:

SHEET E2-1, WEST WTP MODIFIED ELECTRICAL PLAN

DELETE Sheet E2-1 in its entirety and **REPLACE** with the attached revised Sheet E2-1.

SECTION 16420

MOTOR CONTROLLERS

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section includes AC motor controllers rated 600 volts and less that are supplied as enclosed units within motor control centers or as individual units mounted in equipment specified under other sections.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Section	Items
13451	Programmable Logic Controller (PLC) Programming
16050	Basic Electrical Materials and Methods
16120	Conductors and Cables
16410	Enclosed Switches, Fuses, and Circuit Breakers
16442	Motor Control Equipment
16910	PLC Hardware and Software Procurement
16940	Control Panels

1.3 DEFINITIONS

A. ANALOG AMMETER

A dial-type, d'Arsenval movement, analog meter measuring motor ampacity, either directly or indirectly from a current transformer connected to one of the motor leads.

B. COMPLETE COMBINATION STARTER

The terms STARTER, MOTOR STARTER, COMBINATION MOTOR STARTER, and COMBINATION STARTER are all equivalent to COMPLETE COMBINATION STARTER as described here.

A Complete Combination Starter consists of all power, control, and communication devices required to completely and safely operate a motor in HAND control. It consists of a lockable Overcurrent Protective Device (OCPD) such as a circuit breaker or a fused disconnect, a Power Module (RVSS, VFD, or Magnetic) for controlling/applying power to the motor, Motor Overload Protection (MOP) circuits, and other ancillary circuits for complete control and protection of the motor and starter power devices. It

includes an enclosure with operator interface control and monitoring devices.

C. FST (FIELD SERVICE TECHNICIAN)

A Field Service Technician (FST) is defined as a "hands-on" field representative qualified and authorized to perform technical start-up and trouble-shooting work on the manufacturer's motor starters including drive programming and configuration.

D. FVNR BYPASS CONTACTOR

In RVSS starter power circuits, an FVNR rated BYPASS CONTACTOR is one whose current rating is sufficiently high to allow direct across-the-line motor starting in an FVNR mode (RVSS failure).

See RUN RATED BYPASS CONTACTOR in this section.

In VFD starter power circuits, the function of the FVNR BYPASS CONTACTOR is to provide across-the-line motor control in the event that the VFD fails. This CONTACTOR must have a current rating that is sufficiently high to allow direct across-the-line motor starting in an FVNR operating mode (VFD failure).

E. FVNR (FULL VOLTAGE NON REVERSING) STARTER

FVNR starters operate motors in only one direction. These starters instantly apply full line voltage to the motor terminals through a contactor relay.

See MAGNETIC STARTER.

F. FVR (FULL VOLTAGE REVERSING) STARTER

FVR starters operate motors in both forward and reverse directions. These starters instantly apply full line voltage to the motor terminals through two separate (one forward and one reverse) contactor relays.

See MAGNETIC STARTER.

G. HIM (HUMAN INTERFACE MODULE)

HIM units are programmable human interfaces to RVSS and VFD drives and are used to configure the drive protection and control options. These

devices are typically provided with programming/operating buttons and visual displays.

H. IGBT (Insulated Gate Bipolar Transistors)

IGBTs are embedded devices used to provide power switching in the DC-to-AC inverter section of VFD power modules.

I. MAGNETIC MOTOR STARTER

Because FVNR and FVR starters use an electromagnetic contactor relay to transfer power to the motor, these devices are a part of the MAGNETIC STARTER family of motor starters.

See FVNR, FVR.

J. POINT OF ANALYSIS

The Point of Analysis is a point indicated on the electrical one line diagram(s) where the contractor is responsible to comply with the Total Harmonic Current Distortion (THDC) limits of the IEEE-519, 2014 standard. By defining this point, the Engineer is providing all manufacturers a common point to calculate their THDC values.

The "available short circuit current" (I_{SC}) value required for IEEE-519 calculation shall be taken from the electrical one line diagram(s) of the Plans as the BOLTED FAULT CURRENT at the Point of Analysis.

The "average maximum demand current" (I_L) value required for IEEE-519 calculation shall be taken from the UTILITY LOAD DEMAND column of the LOAD SUMMARY table on the electrical one line diagram(s) of the Plans. Only loads "downstream" of the Point of Analysis shall be utilized in the calculation of I_L.

K. RAMP RATE, RVSS

The RVSS ramp rate is defined as the time, in seconds, for the RVSS to increase motor speed from zero to full speed or decrease motor speed from full speed to zero.

L. RAMP RATE, VFD

The VFD ramp rate is defined as the time, in seconds, for the VFD to increase its output frequency from 0 Hz to 60 Hz or decrease its output frequency from 60 Hz to 0 Hz.

M. RUN-RATED BYPASS CONTACTOR

In RVSS starter power circuits, a run rated BYPASS CONTACTOR is one whose current rating is limited to the RVSS current rating. This type of bypass contactor cannot be used to directly start the motor across-the-line.

See FVNR BYPASS CONTACTOR in this section.

N. RVSS (REDUCED VOLTAGE, SOFT START)

The RVSS is the manufacturer's integrated power module package without additional starter components, and consists of embedded electronic power switching devices for acceleration and deceleration, associated "firing" control circuitry, and an embedded microprocessor for power circuit firing control and motor/module protection. It is one of the key components that make up a COMPLETE COMBINATION RVSS STARTER.

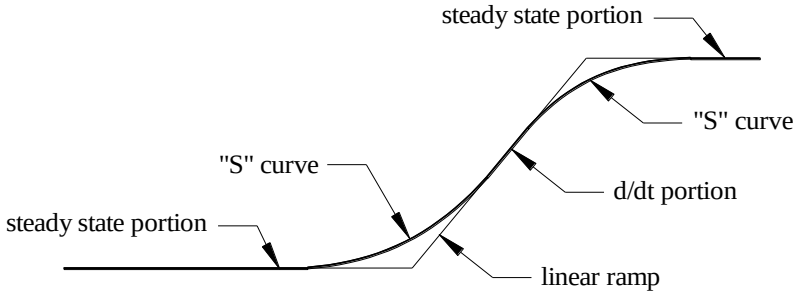
The RVSS power module may or may not include a RUN-RATED BYPASS CONTACTOR.

O. SCRS (SILICON CONTROLLED RECTIFIERS)

SCRs are GE's trade name for a thyristor (a four-layer unidirectional switching device). SCRs are triggered by the application of a gate current and are shut off at a zero-voltage crossover.

P. "S" CURVES

A modified linear-ramp curve with rounded edges between portions of the curve that are changing (d/dt portions) and portions of the curve that are not changing (steady state).



Q. THD (TOTAL HARMONIC DISTORTION)

THD is defined as the ratio of the sum of the levels of all harmonic components to the level of the fundamental frequency.

Values are limited by the IEEE 519, 1992 standard developed to minimize power problems related to non-linear loads, such as VFDs.

R. VFD

The VFD is the manufacturer's integrated power module package without additional starter components, and consists of an embedded AC-to-DC converter, a DC link, and a DC-to-AC inverter, associated inverter "firing" control circuitry, and a microprocessor for power circuit firing control and motor/module protection. It is one of the key components that make up a COMPLETE COMBINATION VFD STARTER.

1.4 SUBMITTALS

Do not submit motor starters under a separate 16420 submittal. Submit motor starters under the MCC submittal, 16442.

Submit under the provisions of Section 01300.

Submit a complete Bill of Materials (BOM) for each motor starter.

Submit drawings showing schematics for each motor starter. Schematics shall include all physical devices and connections of power and control circuits. Schematics shall include diagrams or descriptions clearly describing internal VFD logic where applicable. All devices on the schematics shall be tagged with their associated BOM number.

Submit drawings of door-mounted devices with associated BOM numbers.

Submit the name and phone number of the technical person that will be made available to the Engineer/Integrator for support of PLC networking to the manufacturer's networked devices.

Submit the name and phone number of the technical person that will be made available to the Engineer/Integrator for support of internal drive programming and configuration.

Submit Manufacturer's product data for motor controllers and accessories specified in this Section.

Submit maintenance data for tripping devices to include in the operation and maintenance manual specified in Section 16050.

Submit compiled load current and overload relay list after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.5 QUALITY ASSURANCE

See Section 16050.

1.6 COORDINATION

The Contractor shall acquire the full and complete nameplate data for each motor and document this data for insertion into the O&M Manual. This data shall be made available during FIELD TESTING AND COMMISSIONING work as described in Section 3.5.

Coordinate the sizing and settings of each starter's Overcurrent Protective Device (OCPD) and Motor Overload Protection (MOP) device with associated motor's nameplate data.

1.7 EXTRA MATERIALS

Reference Specification Section 16050 for spare parts.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. AVAILABLE MANUFACTURERS

Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include the following:

1. Allen-Bradley Co.; Industrial Control Group.

2. Eaton Corp.; Westinghouse & Cutler-Hammer Products.

3. Square-D.

When motor starters are integrated into Motor Control Centers (MCCs), the starters shall be fabricated, tested, and UL labeled by the MCC manufacturer.

2.2 PRODUCT SHIPMENT AND STORAGE

A. PRODUCT SHIPMENT

The motor starters shall be delivered to the project's System Integrator (reference specification 16940) for temporary connection and integrated testing with the site PLC prior to being delivered to the jobsite. This testing will be coordinated by the System Integrator and combined into a complete witness test of both the PLC and motor starter controls. All hardwire connections between the PLC(s) and the motor starters shall be tested during the witness test. For the test, all motor starters (whether FVNR, FVR, RVSS, or VFD) shall be powered at their full operational voltage and shall be connected and tested against a voltage-rated AC squirrel cage motor. Allow for the Owner and Engineer to witness these tests. Provide a minimum of 15 days' notice prior to the test.

The System Integrator shall be responsible for repackaging and shipping to the jobsite. The Contractor is responsible for unloading the shipment.

B. PRODUCT STORAGE

Motor starters, whether in MCCs or stand alone, shall be packaged, covered, and protected from weather and physical damage during storage before final installation.

2.3 COMBINATION MOTOR STARTERS, GENERAL

A. ENCLOSURES

1. For Starters Internal to MCCs

For starters internal to MCCs, reference Section 16442 (Control Centers) and reference the MCC NEMA rating(s) on the Plans.

B. COMPLIANCE

1. Standards

Motor starters shall be Underwriter's Laboratory (UL) listed and labeled, and comply with the latest applicable standards of ANSI, IEEE, and the National Electrical Code.

C. GENERAL DEVICES AND COMPONENTS

All combination motor starters shall include the following devices:

1. Overcurrent Protective Device (OCPD).

    a. The OCPD shall be a NEMA AB 1, motor circuit breaker protector, magnetic only, with field-adjustable short-circuit trip-coordinated with motor locked-rotor amperes for the specific motor being powered.

    b. The OCPD shall be lockable in the OPEN position and shall include an auxiliary Form A contact that is open when the OCPD is electrically tripped or manually opened.

    c. The OCPD shall be lockable from the front panel, without the operator having to open the panel door.

    d. The OCPD shall be sized by the motor controller manufacturer for the motor being served and shall be selectively coordinated with OCPDs upstream as per Section 16410.

2. Control Devices (reference Specification 16940)

    The following minimum requirements apply:

    a. Provide surge protective devices across each AC and DC relay coil.

    b. Provide control and timing relays per Section 16940.

    c. Provide LED “push-to-test” indicating lights.

    d. Provide combination electromechanical motor start counter and motor run time (elapsed time) meters per Section 16940. Battery backed LCD displays will not be accepted.

    e. Provide Phase Monitor Relays that monitor phase loss, phase imbalance, phase reversal, under-voltage, and over-voltage, with a Form A contact that is active on any of these conditions.

Exception:

- *Programmable starters that provide the Phase Monitor Relay functions as described above do not require an additional discrete phase monitor relay.*

f. Door-Mounted Devices

Provide door-mounted devices as specifically shown on the Plans.

Door-mounted devices, such as elapsed time meters, motor start counters, indicating lights, ammeters, selector switches, reset pushbuttons, etc., shall not be replaced with electronic panel functions.

g. Devices Mounted Internal to the Enclosure

Motor starters shall include all components and devices necessary to provide the electrical control functionality shown on the Motor Starter Elementary Wiring Diagrams on the Plans.

Electromechanical relays and timers shall not be replaced with electronic logic functions.

Exception to 2:

- *Unless specifically approved by the Engineer.*

3. Control Circuit Requirements

a. Control functions shall match those shown on the Motor Starter Elementary Diagrams including manual requirements by the operators.

Provide additional circuits and devices as required by the starter manufacturer for power circuit isolation; however, these additions shall not change the features or functionality of the intended design.

b. Provide additional fusing or device protection as required to protect the drive's electronic power and control circuits and to comply with UL requirements.

c. Motor starters shall be provided with independent fused "control power" circuits. A fault in one motor control circuit shall only disable that associated motor.

i. Motor starter control circuits shall be 120 volts AC.

ii. If motor power is derived from voltage configurations that directly provide 120 volts AC line-to-neutral (240/120 volts AC or 208/120 volts AC systems), then each control circuit shall be provided with an individual fuse protective device at 120 volts AC.

NOTE:
Motor starters operating from a 240/120 Vac, 3-phase power source shall be provided with an internal label as shown here:

CAUTION: B PHASE HAS 208 VOLTS TO GROUND

Motor starters operating from a 240/120 Vac, 3-phase power source shall not have their motor starter control power be derived from Phase B and neutral.

iii. If motor power is derived from 480 Vac, then each control circuit shall be provided with an independent control transformer with a 120-volt AC fused secondary. The fuse shall be factory mounted to the top of the transformer.

iv. Motor starter control circuits may include remote panel heaters, motorized dampers, blower enclosure cooling fans, or other small power devices. Size the control transformers and fuses to handle all connected loads shown on the Plans plus an additional 25 percent.

D. SPECIAL POWER CIRCUITS

Some motor starters require "special power circuits" as listed below. These circuits are not included in the G&O Motor Elementary Wiring Diagrams. If required, the manufacturer shall provide the power

contactors and control circuits. Special Power Circuits include the following functions and are applicable to motor starter types as listed below:

Function	VFD	RVSS	FVNR
Line Filter Switching	X		
Isolation Contactor	X	X	
Bypass Contactor, Start-Rated (FVNR)	X	X	
Bypass Contactor, Run-Rated		X	
Power Factor Caps		X	X

These functions shall be provided as described on the Plans and within these Specifications.

E. WORK BY MANUFACTURER

1. All starters

   a. The manufacturer shall provide motor controls as defined in these specifications and as shown on the Motor Starter Wiring Diagrams in the Plans.

   b. The manufacturer shall provide complete combination motor starters as described in this section of this specification.

   c. The manufacturer shall provide all physical (external) control relays and timers per Motor Starter Wiring Diagrams in the Plans. These devices shall <u>not</u> be integrated into programmable starter devices (VFDs, RVSSs, Smart Overload Relays, Extended I/O, etc.).

   d. The manufacturer shall provide additional internal controls and external relays/contactors for "special power circuits" as required for drive protection and manufacturer's warranty.

2. Starters with Programmable Devices

   Motor starters containing programmable devices (VFDs, RVSSs, Smart Overload Relays, Extended I/O modules, etc.) shall be configured as follows:

   a. The manufacturer shall provide internal fault logic for protection of motors and starter power devices. These are

the manufacturer's programmed conditions as required to warrant the system. A relay "FAULT" output will be programmed true on these fault conditions.

b. The manufacturer shall provide HIM programming as follows:

i. HIM Display:

(1) The HIM will always display the "fault code" if faulted.

(2) If not faulted, then the HIM will display motor speed or motor amps (owner selection).

ii. HIM Key Pad:

(1) The system can be placed in the PROGRAMMING mode only through password entry. The password shall be provided to the owner.

(2) START, STOP, RESET, HAND, OFF, AUTO keys are inactive (locked out) unless in the programming mode.

3. Networked Starters.

a. For VFD motor starters the manufacturer shall provide internal logic for control of "RUN", and "SPEED REFERENCE"functionality per the Motor Starter Wiring Diagrams in the Plans. If different pin assignments are used by the manufacturer, then these shall match the external and internal logic connections as shown in the plans and shall be clearly documented during submittal. Extended I/O modules (EIOMs) shall be added as required to meet these conditions.

For non-VFD motor starters, the manufacturer shall provide internal logic for control of "RUN" and "PUMP SET OK" functionality per the Motor Starter Wiring Diagrams in the Plans. If different pin assignments are used by the manufacturer, then these shall match the external and internal logic connections as shown in the plans and shall

be clearly documented during submittal. Extended I/O modules (EIOMs) shall be added as required to meet these conditions.

b. The manufacturer shall configure and program the internal logic functions and HIM unit, as described in these specifications and on the Plans.

c. The manufacturer shall provide all drive digital inputs to be readable by the PLC over the network.

d. The manufacturer shall provide full support to the PLC programmer for the acquisition and transfer of networked I/O.

F. WORK BY INTEGRATOR OR FST

1. General

The manufacturer shall allow for field adjustments by a qualified FST and shall support the efforts of the FST during the panel shop witness testing and during startup and commissioning as defined in this specification. Reference Section 3.5.

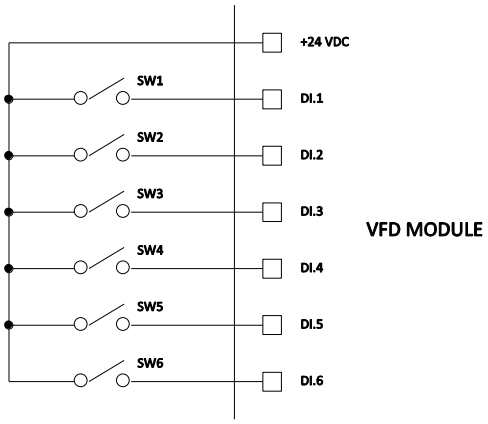
The manufacturer shall provide the FST directly or authorize the FST work to be performed by the Integrator. If authorized to be performed by the Integrator, then

a. Such adjustments and settings shall not affect the manufacturer's warranty or transfer the manufacturer's liability to the Integrator, and

b. Such work by the Integrator shall be financially compensated for by the manufacturer.

2. Witness Testing

The FST shall demonstrate complete functionality of internal logic functions for "RUN", and "SPEED REFERENCE" functionality during shop witness testing.



Example of a 6-input test switch bank

To do this, the FST shall provide a simple 6-bit switch harness similar to that shown above for testing output functions with up to six digital inputs. The FST shall disconnect the starter wiring to selected inputs, verify the output against all possible input combinations using the switches, document the result, and reconnect the starter wiring. This example shows a 6-input test (64 possible combinations). The FST shall prepare a logic table showing input status against the resulting output.

If the internal logic operates properly, then the entire starter will be tested for proper operation with both internal and external controls functioning as unit.

If corrections need to made as a result of the test, then the manufacturer shall support the changes either directly or by authorizing the Integrator to perform this work as the FST.

3. Settings Specific to the Application:

The FST shall provide drive module configuration settings as listed below. These changes shall not affect the manufacturer's warranty or reduce the manufacturer's liability.

a. Current limit settings,

b. Motor protection settings,

c. Final settings for the fixed maximum and minimum speeds,

d. Providing frequency notch (avoidance) bands,

e. Final settings for the fixed acceleration and deceleration ramp rates,

f. Others with approval.

2.4 MAGNETIC MOTOR STARTERS

NEMA ICS 2, Class A, full voltage, reversing or non-reversing (FVR or FVNR respectively), across the line.

Reference section COMBINATION MOTOR STARTERS, GENERAL

A. THE POWER CIRCUIT

1. Overcurrent Protective Device (OCPD).

   Reference GENERAL DEVICES AND COMPONENTS, Section 2.3C.

2. Magnetic Contactor.

   The magnetic contactor shall be NEMA rated, Size 1 minimum. IEC contactors will not be permitted.

3. Motor Overload Protection (MOP).

   a. Intelligent Overload Relay Protection

      Where motor starters are shown on the Plans to be networked together or to a PLC, either directly or through network switches, such combination motor starters shall include Intelligent Overload Relays complete with communication equipment and protocols compatible with the approved system control PLC.

      Overload Relays shall be powered from the communication network or from the combination motor starter's 120 Vac control power supply and shall feature ambient temperature compensation, visible trip indication, selectable trip Classes of 10, 15, 20, and 30, selectable manual/auto-manual reset, and a minimum of four discrete 120 Vac inputs and two Form C contacts rated at 1.5 amps at 240 volts AC minimum. One of the contacts shall be programmable for motor shutdown.

Provide additional distributed I/O modules and associated power supplies, as required, to meet the data transfer networking requirements and shown on the Motor Starter Elementary Wiring Diagrams on the Plans.

Exception to A:

- *Unless specifically shown otherwise on the Plans or unless specifically approved by the Engineer.*

B. THE CONTROL CIRCUIT

Reference GENERAL DEVICES AND COMPONENTS, Section 2.3C.

2.5 VFD MOTOR STARTERS

A. GENERAL

The drive is designed to provide variable speed control of a standard NEMA MG 1, Design B, 3-phase, induction motor by adjusting output voltage and frequency. Output power is of suitable capacity and wave form to provide step-less speed control of the specified 3-phase motor throughout a continuous speed range under variable or constant load (as applicable) not exceeding the motor's full load rating.

Controller is suitable for and coordinated with the thermal, electrical, and mechanical characteristics of the motor actually furnished to which it is connected.

Coordinate the drive capability with the torque characteristics (variable or constant torque) of the actual equipment furnished, which is driven by the motor to which the drive is connected.

B. THD NOISE IMMUNITY AND COMPLIANCE WITH IEEE 519

1. THD levels shall meet the recommendations of IEEE-519, 2014 at the "Point of Analysis" (reference definitions). Reference to the location of values for I_{SC} and I_L required for IEEE-519 calculations are described in the definition.

2. During submittal, show the values and calculations used to determine the level and type of line filters being submitted and their assumed compliance with IEEE-519.

C. THE POWER CIRCUIT

1. Technology

a. The Bridge

Power switching devices shall be IGBTs.

VFD motor starters shall be six-pulse, Pulse Width Modulated (PWM).

b. Control Type

Variable Torque Output Rating:

Three-phase, 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

2. Overcurrent Protective Device (OCPD)

Reference GENERAL DEVICES AND COMPONENTS, Section 2.3C.

3. The VFD

a. Capable of sustaining 115 percent of motor rated full load current indefinitely.

b. Operates in an ambient temperature of 0 to 40 degrees C.

c. Maintains displacement power factor of 0.95 or better over the entire speed range.

4. Motor/Drive Protection, Adjustments, and Auto Reset

a. VFD shall include self diagnostics for detection of failed circuitry.

b. Fault detection shall shut down motor operation as shown on the Plans. Upon removal of fault condition, the drive shall automatically reset and attempt to restart.

c. Upon return of power after an outage, the drive shall automatically restart.

d. In addition to other specified standard protective functions the VFD shall provide the following:

i. Drive over-temperature trip.

ii. Short-circuit protection.

iii. Fault current protection of AC to DC rectifier section.

iv. Adjustable current limit of 50 to 110 percent of full-load rating.

v. Stall prevention.

vi. Surge protection from input line AC transients (lightning/surge arrestor).

vii. Electrical isolation between power and logic circuits.

viii. Able to withstand output terminal line-to-line short circuits without component failure.

5. Line and Load Circuit Conditioning

a. Line Filtering

Passive line filtering shall be provided on all VFD starters to assist in compliance to IEEE 519-2014. Line filters may consist of reactors only or may include capacitors and resistors as required to comply with IEEE 519-2014. The minimum line filter shall consist of a 3 percent reactor.

Line filters that include capacitors shall have the capacitors switched off when the motor is not running.

Circuits internal and external to the drive module required to control the application of the capacitors shall be provided by the manufacturer. Extended I/O modules (EIOMs) shall be added as required to meet this requirement.

Line filters may be a separate device or integral to the drive module.

b. Load Filtering

Passive load filtering shall be provided on all VFD starters to reduce motor winding voltage stress, improve drive stability, and assist in drive protection. The filter shall consist of a simple reactor or a passive combination RLC dv/dt filter as described below.

i. For motor lead lengths less than 200 feet

Provide 1.5 percent load reactor.

ii. For motor lead lengths greater than 200 feet

Provide an RLC dv/dt load filter with a 1.5 percent load reactor.

Exception to 5:

- *Line filtering may not be required when using 18-pulse technology or active filters. Requirements to be defined by the manufacturer for compliance to IEEE 519-1992.*

6. VFD Isolation

Circuits internal and external to the drive module required to control the isolation of the VFD module shall be provided by the manufacturer. Extended I/O modules (EIOMs) shall be added as required to meet this requirement.

D. THE CONTROL CIRCUIT

Reference GENERAL DEVICES AND COMPONENTS, Section 2.3C.

E. VFD SPEED CONTROL

VFD motor starters shall be provided with manual and automatic speed control. Automatic speed control may be derived from a signal source remote from the starter and may be hardwired, networked, or both for redundancy.

1. Manual Speed Control

   Manual speed control shall be selected by the VFD as shown in the Motor Starter Wiring Diagrams in the Plans.

   The Manual Speed Reference shall be derived from the drive's Human Interface Module (HIM) or or field-mounted speed potentiometer. Regardless of the manual range setting, the speed shall be limited to values between "minimum speed" and "maximum speed" programmed in the VFD through the HIM.

2. Hardwired Speed Reference

   Remote hardwired speed references shall be from an isolated 4-20 mA analog signal. Four mA shall equate to 0 Hz (0 percent speed). Twenty mA shall equate to 60 Hz (100 percent speed). Regardless of the 4-20 mA signal, the speed shall be limited to values between "minimum speed" and "maximum speed" programmed in the VFD through the HIM.

3. Networked Speed Reference

   Remote networked speed references shall be transferred over a LAN between the controlling PLC and VFD drive. The range shall be between 0 and 100 percent, where 0 percent shall equate to 0 Hz (0 percent speed) and 100 percent shall equate to 60 Hz (100 percent speed). Regardless of the minimum speed reference sent over the LAN, the speed shall be limited to values between "minimum speed" and "maximum speed" programmed in the VFD through the HIM.

F. VFD DRIVE CONTROL

1. Microprocessor based digital logic control programmable from the HIM.

2. Speed Control

   a. Maximum speed is field adjustable up to the rated 60 Hz motor speed.

   b. Minimum speed is field adjustable from 0 to 75 percent of maximum rpm.

c. The minimum and maximum speeds are independently field adjustable through the HIM. Initial settings shall be preconfigured by the starter manufacturer for each VFD starter as shown in the table below.

d. Speeds shall increase and decrease at a linear ramp rate, independently adjustable for acceleration and deceleration through the HIM. Initial settings shall be preconfigured by the starter manufacturer for each VFD starter as shown in the table below.

		Ramp Rates (0-100% speed) in sec.		**Speed Limits (in % full speed)**	
Tag Number	**Description**	**Accel.**	**Decel.**	**Min.**	**Max.**
[01 MTR 114]	MOTOR, Raw Water Pump No. 3	5	5	40	100
[01 MTR 711]	MOTOR, Finished Water Pump No. 1	5	5	40	100
[01 MTR 712]	MOTOR, Finished Water Pump No. 2	2	5	55	100
[01 MTR 713]	MOTOR, Finished Water Pump No. 3	2	5	55	100

3. In addition to other specified features, provide the following:

a. Low-frequency voltage boost.

b. Coast to rest/stop.

c. Minimum five-cycle logic power carryover during utility loss.

d. Insensitivity to line rotation.

e. Display of fault information.

f. Slip compensation.

g. Programmable “jump frequency.”

G. VFD I/O TERMINALS

The VFD shall include, as a minimum, the I/O connections as shown on the motor starter elementary wiring diagrams on the Plans. Provide extended I/O modules, as required, to meet this objective.

The manufacturer shall make all signals to digital input pins available to the PLC over the network. This transmission of data shall made seamless to the PLC listed in specification 16910.

H. NETWORK COMMUNICATIONS

Where motor starters are shown on the Plans to be networked together or to a PLC, either directly or through network switches, such VFD combination motor starters shall include communications equipment and protocols compatible with the approved system control PLC.

Provide the minimum command and status parameters as shown on the schematic(s) and I/O tables on the Plans.

Provide additional distributed I/O modules and associated power supplies, as required, to meet the data transfer networking requirements listed here and shown on the schematic(s) and I/O tables on the Plans.

The manufacturer shall provide technical assistance to the Integrator as required to create a reliable and clear transfer of data packets between the motor starters and the PLC as identified in specification 16910.

2.6 EXTRA MATERIALS

Reference Specification 16050 for spare parts.

PART 3 EXECUTION

3.1 APPLICATION

Apply motor starters as described on the Plans.

3.2 INSTALLATION

Install independently mounted motor control devices according to manufacturer's written instructions and the NEC.

A. IDENTIFICATION

Identify motor control components and control wiring according to Section 16050.

B. LOCATION AND MOUNTING

Locate controllers as shown on the Plans. Provide the mounting methods for each separate starter enclosure as shown on the Plans. Reference Section 16050.

3.3 WIRING INSTALLATION

A. Install wiring between motor control devices according to Section 16120.

B. Bundle, train, and support wiring in enclosures.

C. Make all control wiring connections to provide a complete and operational system. Provide additional terminals, wire guides, and gutters as required for a safe and protected system.

3.4 CONNECTIONS

Tighten connectors, terminals, bus joints, and mountings. Tighten field-connected connectors and terminals including screws and bolts according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD TESTING AND COMMISSIONING

A. GENERAL TESTING REQUIREMENTS

1. Testing procedures described herein shall apply to all starters associated with the Project.

2. Complete testing of motor starters shall be provided and shall include:

   a. The services of a qualified independent testing agency to perform breaker testing as described below.

   b. The assistance of the starter manufacturer's **Field Service Technician** (FST) as described below. Throughout this contract, the Field Service Technician shall be provided by the manufacturer.

   Special Note:

   Areas of field testing and commissioning where the work responsibilities are shown as "FST/INTEGRATOR" may

be performed by either the manufacturer's FST or the Integrator (if so authorized by the manufacturer and agreed upon by the Integrator). If the work is authorized to be performed by the Integrator, then such work shall not affect the manufacturer's warranty or transfer the manufacturer's liability to the Integrator.

3. Motor starter tests shall also be coordinated with the following representatives:

   a. The System Integrator,

   b. The motor/pump Manufacturer,

   c. The Engineer,

   d. The Owner.

B. TESTING PROCEDURES BEFORE MAKING ELECTRICAL CONNECTIONS TO THE STARTER (FST ASSISTANCE NOT REQUIRED)

1. Megger the motor leads per Specification 16120.

2. If the starter is powered from a separate feeder, then megger the feeder per Specification 16120.

3. For molded case circuit breakers 100 amps and larger, provide independent testing agency to perform circuit breaker tests as stated in NETA ATS, Section 7.6. Certify compliance with test parameters. Provide the Engineer a copy of the test results signed by testing agency.

4. Perform visual and mechanical inspection of enclosure and devices. Remove and replace damaged units with new.

5. Connect power, control, instrumentation, and communication conductors to the motor starter. Verify the integrity of all connections.

6. Remove any burrs, filings, or other foreign materials from enclosure.

7. Completely wipe down and vacuum enclosure.

C. ENGAGING THE FST AT THE JOBSITE PRIOR TO ENERGIZATION

Engage an FST to be present when energizing or commissioning motor starters. Under the direction of the FST, the following minimum tests shall be performed, documented, and dated by the FST. These documents will be provided as a part of the MCC or Motor Starter Sections of the O&M Manual.

The FST shall:

1. Check connections and device mounting for proper torque.

2. Check alignment of plug-in devices with stationary parts.

3. Check operating mechanisms for binding, lubrication, etc.

4. Verify that all pilot lights are LED type. Replace if not.

5. Verify that analog meters are scaled roughly two times the motor's FLA.

6. Test the validity of the control, instrumentation, and communication circuits.

7. Test all breakers for proper physical movement and door interlocking. Repair or replace as required.

8. Set the motor protection values for the specific motors being controlled.

9. Verify the drive's initial minimum and maximum speed ranges per the table in Section 2.6F.

10. Set the acceleration and deceleration rates per the tables in Section 2.5 and Section 2.6, FACTORY SETTINGS, for RVSS and VFD units respectively.

11. The FST shall energize the starter.

D. SERVICES OF THE FST/INTEGRATOR AT THE JOBSITE AFTER ENERGIZATION

The FST/INTEGRATOR shall:

1. Verify motor rotation and direction. Coordinate this work with the pump/motor manufacturer. Wiring corrections shall be made by the Contractor.

2. Test the starter protection circuits.

3. Test the starter RESET control.

4. Test the starter for proper operation and functionality per design. Verify manual and automatic speed controls and transfers.

5. In coordination with the pump or blower manufacturer, the Owner, and the Engineer, run VFD-controlled motors through their minimum and maximum speed ranges. Identify the frequencies at which the motor speeds cause excessive resonant frequency vibrations (as determined by the pump/blower manufacturer). Identify the frequencies just above and below the resonant frequency and program the VFD drive to lock out the band of frequencies in between (the "notch frequencies"). Perform this task for each resonant frequency. Document the lower and upper frequencies of the lockout bands.

6. Test the starter network communications and functionality with associated PLC or network controller. Coordinate this work with the System Integrator.

7. Test all starter digital and analog I/O connectivity, functionality, and scaling with the PLC, whether hardwired or networked. Coordinate this work with the System Integrator.

8. Test starter cooling fan circuits.

9. Test minimum and maximum speeds.

10. Correct malfunctioning units on site where possible and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

E. ADJUSTMENTS AND STARTER PERFORMANCE VERIFICATION BY THE FST/INTEGRATOR

1. The FST/INTEGRATOR shall provide adjustments, calibrations, and final settings for RVSS units, VFD drives, and Motor Overcurrent Protective (MOP) devices as required to meet design intent and process requirements and make all necessary adjustments and calibrations as required to provide acceptable motor starting and operational performance. Motor nameplate data shall be provided to the FST by the Contractor.

2. The FST/INTEGRATOR shall provide the final OCPD breaker trip setting for the motor circuit being protected.

3. The FST/INTEGRATOR shall document all such adjustments and calibrations in a table similar to that shown below (as a minimum) and initial and date each final setting. This table shall be submitted to Engineering for approval and acceptance. All Status "As Left" conditions must be checked off as "OK" before completion. The final table shall be provided as a part of the MCC or Motor Starter Sections of the O&M Manual.

Parameter Adjusted		**Value**				
Ref. No.	**Parameter Description**	**As Found**	**As Left**	**Status "As Left"**	**Date/Time**	**Test Performed By (Initials)**

3.6 DEMONSTRATION

A. DEMONSTRATION OF FULLY FUNCTIONAL MOTOR CONTROLLERS

1. Provide all testing required to demonstrate complete functionality for all motor/motor starter systems including speed control, speed notching, manual and auto control, motor acceleration and deceleration, upper and lower speed limits (in manual and auto modes), and motor protection.

2. Cycle power to each starter while their motors are running. Provide a minimum of two cycle tests per motor/starter.

B. TRAINING

1. The FST shall provide basic starter operation training immediately following commissioning.

2. The FST shall provide a minimum of 4 hours of training 30 to 90 days after commissioning (time defined by Owner). The training shall demonstrate FVNR, and VFD controller operation and troubleshooting to the Owner's operators and maintenance personnel. Include training related to equipment operation and maintenance procedures.

3. Schedule training with at least 7 days' advance notice.

3.7 CLEANING

Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally, using methods and materials recommended by manufacturer.

***** END OF SECTION *****

SECTION 16442

MOTOR CONTROL EQUIPMENT

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section consists of motor control equipment rated 600 V and less.

1.2 RELATED WORKS SPECIFIED ELSEWHERE

Section	Item
01300	Submittals
03300	Cast-In-Place Concrete
16941	Programmable Logic Controller (PLC) Hardware
16050	Basic Electrical Materials and Methods
16420	Motor Controllers
16940	Control Panels

1.3 SUBMITTALS

A. PRODUCT DATA

For each type of motor control center, accessory item, and component specified.

B. SHOP DRAWINGS

Include dimensioned plans, sections, and elevations. Show tabulations of installed devices, major features, and voltage rating. Include the following:

1. Enclosure type, wiring type.

2. Bus configuration, voltage and current ratings for horizontal bus and each separate vertical bus.

3. Short-circuit current ratings.

4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.

5. Elevation drawing with dimensions.

6. Identification of units and their location in the MCC.

7. Bill of Materials for each control unit.

8. Wiring diagrams for power distribution circuits.

9. Elementary wiring diagrams for each motor starter including wire numbers, terminal connectivity to contactors, relays, and drive modules. Clearly show field wiring termination points and numbering.

10. Nameplate schedules.

C. FIELD TEST REPORTS

Indicate and interpret test results for compliance with performance requirements.

D. MAINTENANCE DATA

For components to include in the maintenance manuals specified in Division 1.

E. 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.

1.4 QUALITY ASSURANCE

See Section 16050. Motor control centers must be factory assembled and wired as completed units by the manufacturer, except where shipping splits are required for shipping of the units. This requirement pertains to control wiring, PLC wiring, and similar wiring within the centers and/or to the "MCC side" of terminal blocks or terminal strips within the centers. Use of a third party to assembly and/or wire the centers is not permitted.

A. SOURCE LIMITATIONS

Obtain similar motor-control devices through one source from a single manufacturer.

B. PRODUCT SELECTION FOR RESTRICTED SPACE

Plans indicate maximum dimensions for motor-control centers, including clearances between motor-control centers and adjacent surfaces and items, and are based on types and models indicated. Other manufacturers' motor-control centers with equal performance characteristics and complying with indicated maximum dimensions may be considered. Refer to Division 1 Section "Substitutions."

1.5 DELIVERY, STORAGE, AND HANDLING

Protect motor control center during construction from moisture, dust, abrasion, or other damage or disfigurement, using plastic sheeting, kraft paper, space heaters, or other appropriate means. Field repair of material or equipment made defective by improper storage is not acceptable.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. MANUFACTURERS

Subject to compliance with requirements, provide products by the following:

1. Eaton; Cutler Hammer
2. Allen-Bradley
3. Square D Co.

2.2 MOTOR CONTROL CENTER FABRICATION

A. RATINGS

1. 600 V class, 3-phase, 60 hertz with operating voltage and number of wires as indicated on the Plans.
2. Bus bracing short circuit fault current rating: as indicated on the Plans.

B. ENCLOSURES

1. Free-standing, totally enclosed, metal-clad structure.

2. Sections nominally 20-inches wide by 20-inches deep by 90-inches high, bolted together to form a continuous assembly.

3. Suitable for mounting against a wall or back-to-back with other electrical units and not requiring rear or side access.

4. Designed to easily extend at either end with similar vertical structures.

5. Provide channel sills where indicated.

6. Enclosure

   NEMA 250, Type as indicated on the Plans.

C. WIRING

NEMA ICS 3, Class II, Type B.

1. Class C stranded, single copper conductor; No. 14 AWG minimum size for control wiring, No. 12 AWG minimum size for power wiring.

2. 600 volt rated MTW thermoplastic insulation. Insulation color as follows:

   a. Red for control circuits internally energized

   b. Yellow for control circuits externally energized

   c. Black for power wiring

   d. White for all grounded conductors

   e. Blue for dc conductors.

D. WIREWAYS

Continuous both vertically and horizontally.

1. Accessible from the front of the center.

2. Completely isolated from bus compartments and adjacent sections.

3. Vertical wireways adjacent to the slide-in units in each section, but accessible through a separate hinged door running the full height of each section between horizontal wireways.

4. Horizontal wireways at both top and bottom, each intersecting the vertical wireways of every section.

E. BUSING

1. Material

   Tin plated copper.

2. Main Horizontal Bus

   a. Ampacity

      600 amperes RMS tin plated copper unless otherwise indicated on the Plans.

   b. The main horizontal bus shall be at the top or the center, continuous without splices, except where shipping splits are required. Provide splice bars and hardware for shipping splits. Access to the horizontal bus is by removable barriers.

   c. Extend the main horizontal bus the full length of the MCC with provisions for splicing additional sections to either end.

   d. Lug connections to the bus are bolted.

3. Vertical Buses

   a. Ampacity

      Sized for maximum load on vertical section. 300 amperes RMS tin plated copper minimum.

   b. Securely bolted to the main horizontal bus with connections easily accessible for maintenance.

   c. Completely isolated and insulated by means of a barrier.

d. Continuous from the top of the section to the lowest unit opening possible in the section.

e. Lug connections to the bus are bolted.

4. Ground Bus

a. Ampacity

Tin plated copper, 50 percent of the RMS ampacity of the main horizontal bus. 300 amperes RMS minimum.

b. Extend the full length of the MCC with provisions for splicing additional sections to either end.

c. Copper ground bus at the bottom of the center, mechanically and electrically connected to each vertical structure.

d. Provide ground lug connections.

e. Lug connections to the bus are bolted.

5. Bracing

a. Short circuit fault current rating: as indicated on the Plans.

b. Bracing designed to avoid accumulation of dirt, lint, etc., on supports between phases.

c. Supports are moisture-resistant, non-carbonizing and non-tracking.

d. Bracing designed to avoid accumulation of dirt, lint, etc. on supports between phases.

6. Barriers

a. Insulated horizontal and vertical bus barriers and a barrier cover below the vertical bus to protect the ends of the bus from contact with items entering the bottom of the enclosure.

F. SECTION UNITS FOR MOTOR CONTROL

1. Units consist of protective/disconnect devices, magnetic starters, control power transformers, control units, pilot lights, relays, terminal blocks and associated wiring mounted on a metal slide-in structure of a modular size.

2. Units of equal rating are interchangeable within the center structure and from center to center.

3. Unit components do not protrude into or restrict wireways.

4. Unit barriers isolate each unit from adjacent units, vertical bus and horizontal bus.

5. Pushbuttons, selector switches, and pilot lights are mounted on the draw-out compartment; but they are visible and operable externally through gasketed, die-cut openings in the unit door. Provide an external reset mechanism for overload relays on the unit door.

6. Plug-in contacts for bus connection of the units are silver plated, free-floating but captive in an insulating block and easily replaceable. The unit plug-in arrangement is completely self-aligning and fail-safe against accidental short or ground. Each plug-in control unit is retained in the structure.

7. Short-circuit protective devices in combination starters and branch circuit protective devices have an external operator. This operator is interlocked with the door so that the circuit must be de-energized before the door can be opened and the device cannot be closed with the door open. A semi-concealed interlock defeat mechanism is provided.

8. The lugs compartment does not interfere with routing of control or power wiring nor interrupt the vertical wireway in the vertical section where it is installed.

9. Locate units as indicated on Plans. Do not revise locations, layout, or number of sections of center from that shown on Plans.

G. IDENTIFICATION

1. Provide a main nameplate for each center, 2" x 10" minimum size with 1/2-inch engraved letters. Nameplate is Lamacoid or equal plastic laminate or engraved metal plate. Lettering is white;

backgrounds are black. No abbreviations are permitted unless approved by the Owner. Engraving is subject to the Owner's approval.

2. Lugs [Main Breaker] compartment is identified by a 1" x 4" nameplate engraved "MAIN LUGS [BREAKER] COMPARTMENT."

3. Each unit door and each slide-in unit shall has a permanently attached, engraved nameplate: 3/8 of an inch letter unless otherwise shown.

4. Provide legend plates for all cover-mounted control devices, including pilot lights, selector switches and pushbuttons. Engraving is subject to the Owner's approval.

5. Provide nameplates for all relays, timers, transformers, fuses, terminal blocks, and switches mounted internally to the unit. Nameplates are Lamacoid sized to the scale of device to which they refer. Engrave as indicated for the device on the elementary wiring diagrams.

6. Identify conductors at each termination by yellow sleeve wire markers of the heat-shrink or stretch-on type with indelible black letters and numbers at each termination or splice.

    a. The manufacturer's standard internal wiring may be numbered per NEMA or manufacturer's standard.

H. FINISH

Ferrous parts are cleaned, rustproofed and finished with light gray baked enamel. Manufacturer's standard gray colors or accents are acceptable.

2.3 PROTECTIVE AND CONTROL DEVICES

A. CIRCUIT BREAKERS MEET NEMA STANDARD AB-1

1. Main breakers: molded case units with solid state long and short time trip circuits individually and separately adjustable for both time and pickup. Four wire systems have ground trip units. Provide two normally open individual dry auxiliary contacts, rated 10 A at 250 Vac, that open when the breaker is tripped or manually opened; closed when the breaker is closed.

2. Feeder breakers: molded case breakers with thermal magnetic trip, adjustable for magnetic pickup. Provide two normally open individual dry auxiliary contacts, rated 10 A at 250 Vac, that open when the breaker is tripped or manually opened; closed when the breaker is closed.

3. Motor circuit breakers: magnetic only trip with adjustable trip setting. Provide two normally open individual dry auxiliary contacts, rated 10 A at 250 Vac, that open when the breaker is tripped or manually opened; closed when the breaker is closed.

4. Branch circuit breakers: molded case, thermal-magnetic trip, trip-free with non-interchangeable, non-adjustable trip unless otherwise noted.

5. Breakers meet the integrated equipment rating required for the available short circuit current at the equipment in which they are used.

6. All breakers provided in MCC shall be coordinated with respect to their trip points by the MCC manufacturer.

B. MOTOR STARTERS MEET NEMA STANDARD ICS

1. Motor starters shall not include intrinsically safe areas or circuits. Intrinsically safe areas shall be located in electrical enclosures other than the MCC.

   Where a field device directly associated with the starter requires an intrinsically safe interface, provide the power to the intrinsically safe circuit from the starter. In this manner, if power is lost to the control panel but the starter is still operable, then the field device and its associated intrinsic interface shall also remain operable.

2. Complete with three overload units of the melting alloy or bimetal type. The overload units are manual reset type.

3. Starter sizes as stated by NEMA, no half or third sizes or IEC devices or ratings are allowed. Minimum size NEMA 1.

4. 600 volt rated, three-pole with 120 Vac control power and 120 Vac coils.

5. Provide three normally open/normally closed (Form C) dry auxiliary contact sets, rated 10 A at 250 Vac, on each starter as a minimum.

    a. Provide a means of mounting up to two additional auxiliary contact sets on each starter.

    b. Provide additional auxiliary contact sets as required or indicated for specified functionality and interface with control systems.

C. MISCELLANEOUS PROTECTION AND CONTROL DEVICES

1. Fuses

    Power fuses, Class RK-5 silver element. Control fuses, Busman FNQ or equal.

2. Power Monitor Metering

    Reference Section 16940, Control Panels.

3. Surge Protection

    The main bus of the MCC shall be protected with a Surge Protective Device (SPD). Reference Section 16280.

4. Pilot Devices: Reference Section 16940.

5. Control Relays: Reference Section 16940.

6. Time Delay Relays: Reference Section 16940.

7. Intrinsically Safe Relays: Reference Section 16940.

8. Interval Timers: Reference Section 16940.

9. Running Time Meters

    Eagle Signal six digit non-reset or equal.

10. Ammeters

    Sized for approximately two times the Full Load motor Amps (FLA), ±2 percent accuracy, 3-1/2 to 4 inch size, GE "Big Look" or equal, Simpson, Weston, or Crompton.

11. Current Transformers

    One percent accuracy at burden and lead length as installed. G.E., Midwest, or Westinghouse.

12. Current Monitor

    Reference Section 16940.

2.4 OTHER MOTOR CONTROL CENTER MOUNTED EQUIPMENT

Sections may contain units, equipment or devices other than motor starters such as transformers, panelboards, power factor correction capacitors, metering equipment, programmable logic controllers, or similar devices or equipment. These items are standard products of the same manufacturer as the center and meet the requirements of the specification sections for those items.

Units, equipment, and devices are factory mounted in the center. Locate units, equipment and devices as indicated on Plans. Do not revise locations or layout of center from that shown on Plans.

PART 3 EXECUTION

3.1 INSTALLATION

Install motor control centers and accessory items according to NEMA ICS.

A. MOUNTING

1. Level, plumb and rigid without distortion of enclosure.

2. Install on floor or pad level within ±1/8 of an inch in a square yard.

3. Shim with stainless steel shims where necessary.

4. Bolt units to the floor with 3/8 of an inch stainless steel expansion anchors and bolts or weld to embedded steel channels.

5. Grout or caulk enclosure to floor or pad.

B. CONDUIT CONNECTIONS

1. Provide bushings on conduits entering from above or at the sides.

2. Provide grounded insulating bushings bonded to the ground bus or pad on conduits entering from below.

C. WIRING IN WIREWAYS

Arrange conductors into groups, and bundle and wrap with wire ties.

D. Prior to energization, remove bracing, packing materials, tape on movable parts, etc. as necessary. Check for damage to enclosure, cracked porcelain, chipped bushings, etc.

3.2 IDENTIFICATION

Identify field-installed wiring and components and provide warning signs as specified in Section 16050.

3.3 GROUNDING

Connect equipment grounding conductors to ground bus, except for circuits requiring isolated grounding.

Provide ground continuity to facility electrical ground system as indicated.

3.4 CONNECTIONS

Clean splice plates with Stoddard's Solvent before assembling.

Assemble all shipping splits.

Tighten bus splices, electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

Check factory connections for proper torque.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. The manufacturer shall make insulation-resistance tests of each motor control center bus, component, and connecting supply, feeder, and control circuits.

2. The manufacturer shall make continuity tests of each circuit.

B. TESTING AGENCY

Provide the services of a qualified independent testing agency to perform specified field quality-control testing.

C. TESTING

1. Prior to Energization

Provide third party breakers testing per Specification 16050, Section 3.

After installing disconnect switches and circuit breakers, perform visual and mechanical inspection of enclosure and devices.

Check connections and mounting for proper torque.

Remove any burrs, filings, or other foreign materials from enclosure. Completely wipe down and vacuum enclosure.

2. After Energization

After electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

Correct malfunctioning units on site where possible and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.6 ADJUSTING

Tighten all structural connections, barriers, racking mechanisms, etc.

Check alignment of plug-in devices with stationary parts.

Check operating mechanisms for binding, lubrication, etc.

Set field-adjustable switches and circuit-breaker trip ranges as indicated.

Check continuity and phase uniformity from unit to unit and for all control or metering circuits.

3.7 CLEANING

Vacuum equipment clean after installation; remove metal cuttings with a magnet or suitable means before assembling equipment; wipe insulating supports, bushings, etc., with a clean lint-free cloth; clean debris, shavings, etc., from breakers, bus, switches, relays, and similar components before startup.

***** END OF SECTION *****

SECTION 16460

LOW VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 SCOPE

The work specified in this Section consists of dry-type distribution and specialty transformers rated 1000 V and less.

1.2 RELATED WORKS SPECIFIED ELSWHERE

Section	Item
01300	Submittals
16050	Basic Electrical Materials and Methods

1.3 SUBMITTALS

Submit under the provisions of Section 01300.

A. PRODUCT DATA

Submit the following:

1. Nameplate ratings
2. Mounting methods
3. Dimensioned plans, sections, elevation views and minimum clearances

B. WIRING DIAGRAMS

Submit manufacturer's wiring diagrams and clearly identify terminals for tap changing and connecting field-installed wiring.

C. FIELD TEST REPORTS

Indicate and interpret test results for tests specified in Part 3.

D. MAINTENANCE DATA

Include in the maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

See Section 16050

1.5 DELIVERY, STORAGE, AND HANDLING

Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.

PART 2 PRODUCTS

2.1 MANUFACTURERS

Subject to compliance with requirements, provide transformers by one the following:

A. Cutler-Hammer/Eaton Corp.

B. GE Electrical Distribution & Control.

C. Siemens Energy & Automation, Inc.

D. Square D; Groupe Schneider.

2.2 TRANSFORMERS, GENERAL

A. DESCRIPTION

Factory-assembled and -tested, air-cooled units of types and sizes specified, designed for 60-Hz service.

B. CORES

Grain-oriented, nonaging silicon steel.

C. COILS

Continuous copper windings without splices, except for taps.

D. INTERNAL COIL CONNECTIONS

Brazed or pressure type.

E. ENCLOSURE

Class complies with NEMA 250 for the environment in which installed.

F. SOUND LEVELS

Manufacturer shall guarantee not to exceed the following:

1. 10 to 50 kVA: 45 dB.

G. EFFICIENCY

Ventilated, dry type, 15 kVA and larger: Energy efficient meeting DOE 2016 requirements.

2.3 GENERAL-PURPOSE DISTRIBUTION AND POWER TRANSFORMERS

Comply with NEMA ST 20 and list and label as complying with UL 1561.

A. CORES

One leg per phase.

B. WINDINGS

One coil per phase in primary and secondary.

C. ENCLOSURE

As follows unless otherwise indicated.

1. Indoor, ventilated.

D. INSULATION CLASS

185 or 220 degrees C class for transformers 15 kVA or smaller;
220 degrees C class for transformers larger than 15 kVA.

1. Rated Temperature Rise

150 degrees C maximum rise above 40 degrees C for 220 degrees C class insulation; 115 degrees C maximum rise for 185 degrees C class insulation.

E. TAPS

For transformers 3 kVA and larger, full-capacity taps in high-voltage windings are as follows:

1. Taps, 25 through 500 kVA

Six 2.5-percent taps, 2 above and 4 below rated high voltage.

F. WALL-MOUNTING BRACKETS

Manufacturer's standard brackets for wall mounted transformers up to 75 kVA.

2.4 CONTROL AND SIGNAL TRANSFORMERS

A. Units comply with NEMA ST 1 and are listed and labeled as complying with UL 506.

B. RATINGS

Continuous duty. If rating is not indicated, provide capacity exceeding peak load by 50 percent minimum.

C. DESCRIPTION

Self-cooled, 2 windings.

2.5 FINISHES

A. INDOOR UNITS

Manufacturer's standard paint over corrosion-resistant pretreatment and primer.

2.6 SOURCE QUALITY CONTROL

Design and routine factory tests comply with referenced standards.

PART 3 EXECUTION

3.1 INSTALLATION

Comply with safety requirements of IEEE C2.

Arrange equipment to provide adequate spacing for access and for circulation of cooling air.

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 and UL 486B.

3.2 GROUNDING

Comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near the transformer.

Comply with Division 16 Section "Grounding and Bonding" for materials and installation requirements.

3.3 FIELD QUALITY CONTROL

Test to ensure transformer is operational within industry and manufacturer's tolerances, is installed according to the Contract Documents, and is suitable for energizing.

A. TESTS

Include the following minimum inspections and tests according to manufacturer's written instructions.

1. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers.

2. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, if not available, those specified in UL 486A and UL 486B.

3. Insulation Resistance: Perform megohmmeter tests of primary and secondary winding to winding and winding to ground.

B. TEST FAILURES

Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest. Verify that transformers meet specified requirements.

3.4 CLEANING

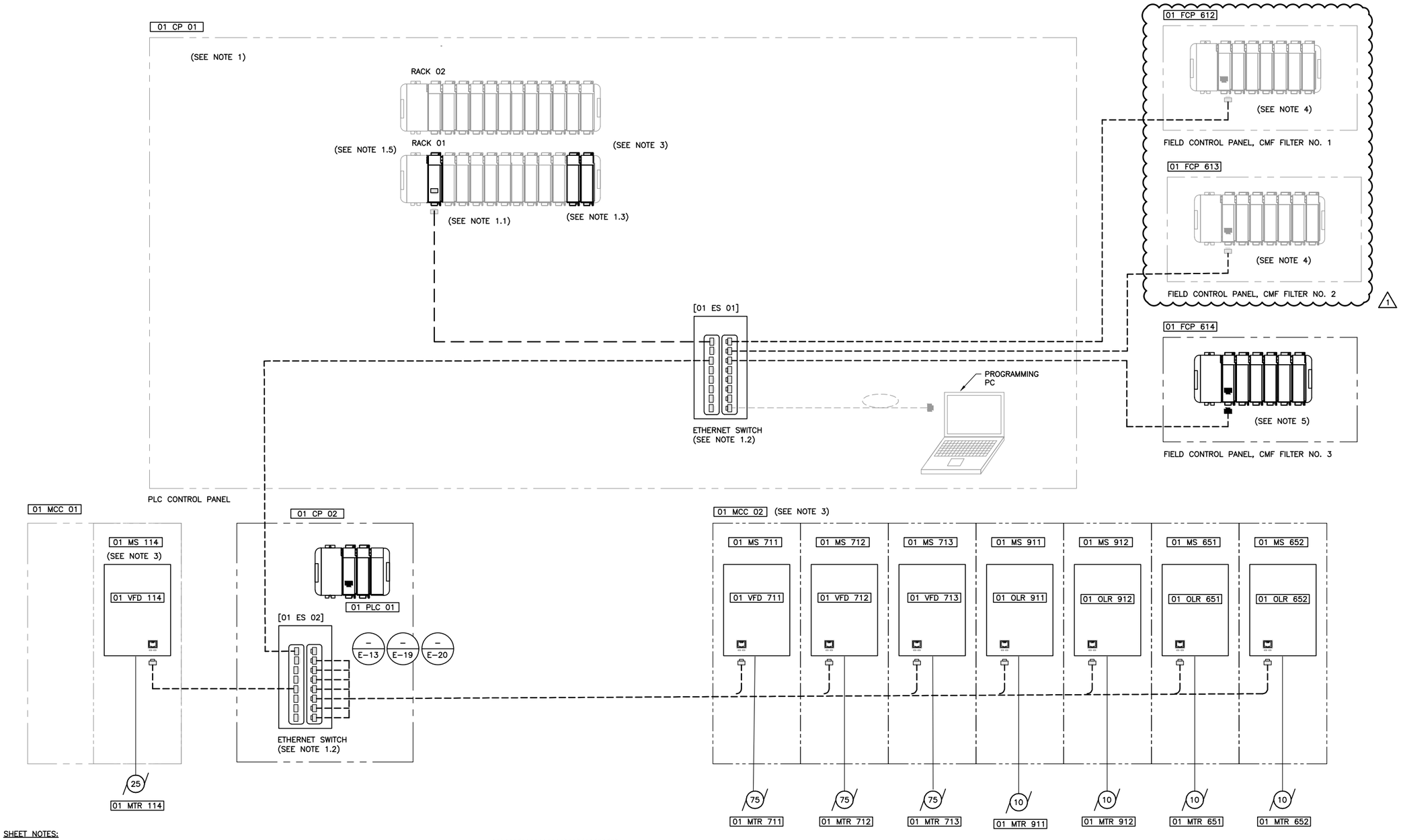
On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.5 ADJUSTING

After installing and cleaning, touch up scratches and mars on finish to match original finish.

Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility. Record primary and secondary voltages and tap settings and submit with test results.

***** END OF SECTION *****



SHEET NOTES:

1. THE EXISTING PLANT MASTER PLC PANEL [01 CP 01] WILL BE MODIFIED UNDER THIS PROJECT AS FOLLOWS BY THE FILTER MANUFACTURER/EVOQUA: 1

   1.1. MANUFACTURER TO REPLACE THE EXISTING SLC 5/04 PLC WITH A NEW SLC 5/05 PLC.
   1.2. MANUFACTURER TO PROVIDE A NEW MANAGED, 16-PORT (COPPER), 24 VDC, DIN RAIL MOUNTED ETHERNET SWITCH.
   1.3. MANUFACTURER TO PROVIDE 1X NEW 4-CHANNEL ANALOG INPUT CARD AND 1X NEW 4-CHANNEL ANALOG OUTPUT CARD IN SPARE SLOTS 11 AND 12. CONNECT ALL NEW STATUS AND CONTROL SIGNALS. REFERENCE PLC EXTENDED I/O TABLES ON SHEET E-16.
   1.4. MANUFACTURER TO MODIFY THE EXISTING HMI TO DISPLAY THE NEW STATUS AND CONTROL SIGNALS.
   1.5. MANUFACTURER TO VERIFY EXISTING 24VDC POWER SUPPLY IS SIZED PROPERLY TO ACCOMMODATE THE NEW PLC, ANALOG CARDS AND ETHERNET SWITCH.
   1.6. ALL MODIFICATIONS TO CONTROL PANEL [01 CP 01] RELATED TO THIS PROJECT SHALL BE PERFORMED BY UL 508 CERTIFIED PERSONNEL.

2. IT IS UNDERSTOOD THAT DIFFERENT NETWORKING CONFIGURATIONS EXIST BETWEEN DIFFERENT MANUFACTURERS. THIS DIAGRAM ASSUMES ETHERNET I/P COMMUNICATIONS INTO EATON/CUTLER-HAMMER MOTOR STARTERS. IF A DIFFERENT NETWORKING SCHEME IS PROPOSED, THEN THE CONTRACTOR SHALL SUBMIT CLEAR NETWORKING DIAGRAMS TO ENGINEERING SPECIFICALLY SHOWING THE PROPOSED METHOD AND CONNECTIVITY. THE DIAGRAMS SHALL INCLUDE THE CONNECTIONS TO THE MOTOR STARTERS AND THE MODULES/DEVICES BY WHICH THE STATUS AND COMMAND DATA SHALL BE TRANSFERRED. NONE OF THE FEATURES, FUNCTIONALITY, OR DATA TRANSFERS SHOWN IN THESE PLANS SHALL BE COMPROMISED. CHANGES SHALL NOT BE MADE WITHOUT ENGINEERING APPROVAL THROUGH THE SUBMITTAL PROCESS.

3. REFERENCE NETWORKED AND EXTENDED I/O TABLES FOR A COMPLETE LIST OF NETWORKED AND HARDWIRED DATA TRANSFERS.

4. NOT USED.

5. FILTER MANUFACTURER/EVOQUA TO PROVIDE CMF FILTER FIELD CONTROL PANEL [01 FCP 614] WITH A SLC 5/05 PLC. 1

E-14

Gray & Osborne, Inc.
CONSULTING ENGINEERS
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SEATTLE, WASHINGTON 98144 • (206) 284-0860

DATE: AUG 2020	SCALE: NOTED	DRAWN: PEB	CHECKED: PAM	APPROVED: MBS

No.	REVISION	DATE	APPD
1	ADDENDUM NO. 3	9/21/2020	MBS

MICHAEL B. SWEENEY — STATE OF WASHINGTON — 15286 — REGISTERED PROFESSIONAL ENGINEER

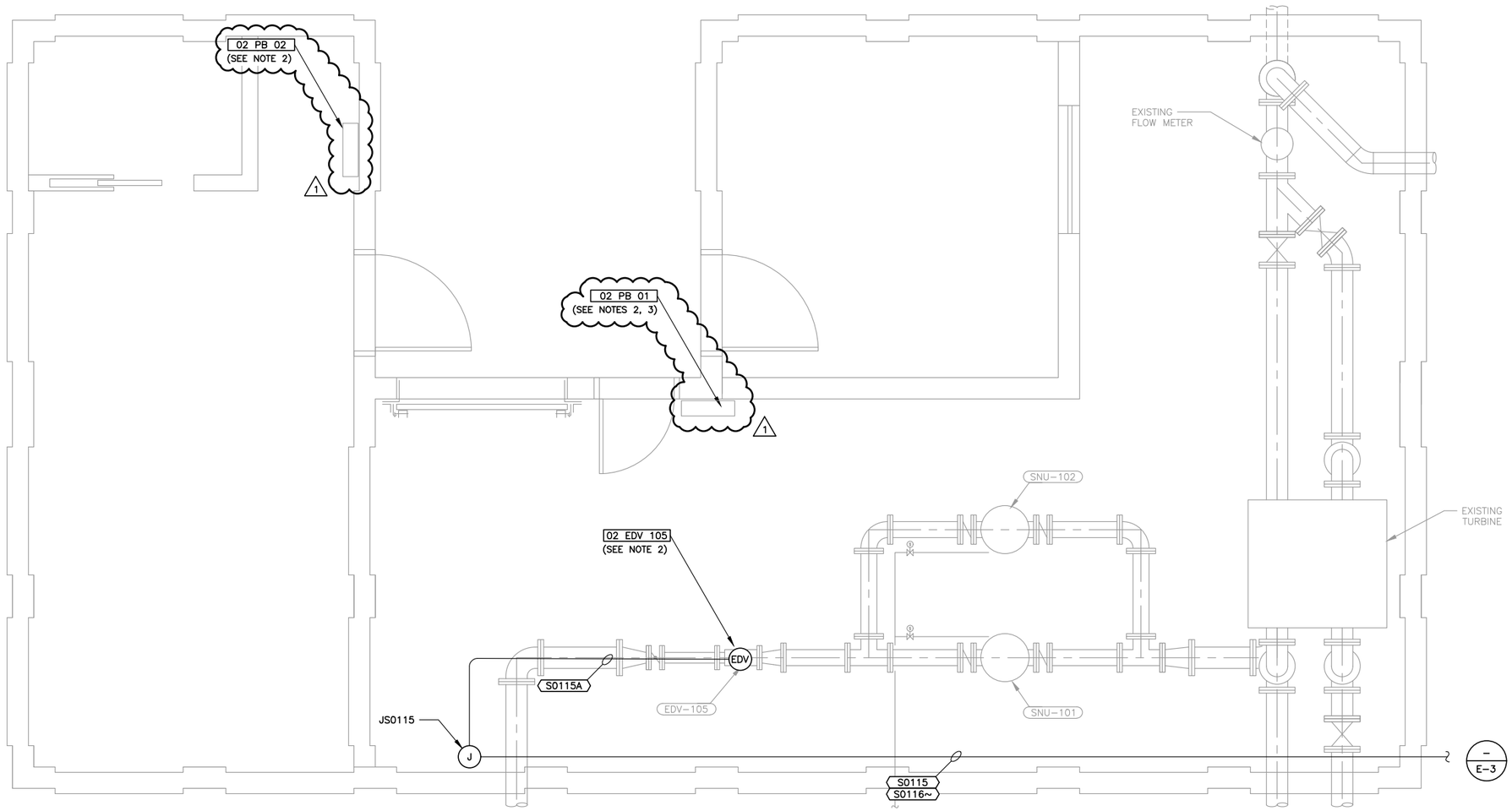
CITY OF SOUTH BEND
PACIFIC COUNTY WASHINGTON

WATER TREATMENT PLANT UPGRADE AND EXPANSION

NETWORK CONFIGURATIONS

SHEET: E-13
OF: 20

JOB NO.: 15286.00
DWG:E_NTWK



NOTES:

1. SEE NOTES ON E-1.
2. DEMOLISH THE EXISTING ENERGY DISSIPATION VALVE. CONNECT NEW CONTROL TO THE NEW ENERGY DISSIPATION VALVE PER THE MANUFACTURER'S INSTRUCTIONS AND RECONNECT EXISTING POWER CIRCUIT FROM [02 PB 01]. REFERENCE MECHANICAL SHEETS.
3. PRIOR TO THE CEILING DEMOLITION, THE CONTRACTOR SHALL FIELD DOCUMENT THE EXISTING LIGHTING BRANCH CIRCUITS WITHIN THE WEST WTP NOTING THE CABLE AND CONDUCTOR TYPE, NUMBER, ROUTING, MULTIWAY SWITCHING, AND TERMINATIONS IN THE EXISTING PANELBOARDS LOCATED IN THE BUILDING. THE CONTRACTOR SHALL ALSO FIELD DOCUMENT THE APPROXIMATE LOCATION OF EACH EXISTING SURFACE MOUNTED LIGHT FIXTURE.
4. THE CONTRACTOR SHALL DEMOLISH THE EXISTING FLUORESCENT LIGHT FIXTURES AND DEMOLISH THE EXISTING LIGHTING CONDUCTORS BACK TO THE LIGHT SWITCHES AND CIRCUIT BREAKERS TO ALLOW THE CEILING TO BE REMOVED. AFTER THE NEW CEILING IS COMPLETE THE CONTRACTOR SHALL PROVIDE EQUIVALENT LED REPLACEMENTS. PROVIDE ROUND, OPEN FACE, CEILING MOUNTED FIXTURE, LITHONIA MODEL VGR1C OR EQUAL, MATCHING THE VOLTAGE AND LUMEN OUTPUT OF THE ORIGINAL INSTALLATION. INSTALL EACH NEW SURFACE MOUNTED FIXTURE IN THE SAME LOCATION AS DOCUMENTED TO MATCH THE ORIGINAL INSTALLATION. INSTALL NEW CONDUIT AND CONDUCTORS OF THE SAME TYPE AND NUMBER AND TERMINATE TO MATCH THE ORIGINAL INSTALLATION. CONTRACTOR SHALL REINSTALL CONDUIT LABELING OR PROVIDE NEW.
5. EXISTING EQUIPMENT SHOWN IS ESTIMATED, CONTRACTOR TO FIELD VERIFY AS REQUIRED.
6. PRIOR TO THE CEILING DEMOLITION, THE CONTRACTOR SHALL FIELD DOCUMENT ALL OTHER EXISTING (NON-LIGHTING) ELECTRICAL CIRCUITS/CONDUITS DIRECTLY MOUNTED ON THE CEILING WITHIN THE WEST WTP NOTING THE CABLE AND CONDUCTOR TYPE, NUMBER, ROUTING, AND TERMINATIONS. THE CONTRACTOR SHALL REMOVE THE CEILING MOUNTED ELECTRICAL CIRCUITS/CONDUITS TO ALLOW THE CEILING TO BE REMOVED AND FURNISH AND INSTALL TEMPORARY SO CORDS TO MAINTAIN FUNCTIONALITY DURING CONSTRUCTION. AFTER THE NEW CEILING IS COMPLETE THE CONTRACTOR SHALL REMOVE THE TEMPORARY CONNECTIONS AND REINSTALL THE CEILING MOUNTED ELECTRICAL CIRCUITS/CONDUITS IN THE SAME LOCATIONS AS DOCUMENTED TO MATCH THE ORIGINAL INSTALLATION. REINSTALL EXISTING OR PROVIDE NEW CONDUIT AND CONDUCTORS OF THE SAME TYPE AND NUMBER AND TERMINATE TO MATCH THE ORIGINAL INSTALLATION. CONTRACTOR SHALL REINSTALL CONDUIT LABELING OR PROVIDE NEW.

1

1/– EXISTING WEST WTP MODIFIED ELECTRICAL PLAN

SCALE: 1/2"=1'-0"

0 1" 2"
TWO INCHES AT FULL SCALE.
IF NOT, SCALE ACCORDINGLY

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MICHAEL B. SWEENEY — STATE OF WASHINGTON — 22599 — REGISTERED PROFESSIONAL ENGINEER

CITY OF SOUTH BEND
WASHINGTON
PACIFIC COUNTY

WATER TREATMENT PLANT UPGRADE AND EXPANSION

WEST WTP MODIFIED ELECTRICAL PLAN

SHEET: E2-1
OF: 1

JOB NO.: 15286.00
DWG:E_BLDG_EX

M:\South Bend\15286 Water Treatment Plant Upgrade\Planset\Electrical\E_BLDG_EX.dwg, 9/21/2020 3:51 PM, LIZ BATES