

# CITY OF SALEM

## WILLOW LAKE BOILER REPLACEMENT

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APRIL 2024

# SECTION 13561

## PANEL MOUNTED INSTRUMENTS

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SELECTOR SWITCHES, INDICATING LIGHTS, AND PUSHBUTTONS



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## Panel Mounted Instruments

### SECTION 13561 - PANEL MOUNTED INSTRUMENTS

#### PART 1 - GENERAL

##### 1.1 SCOPE

- A. The Panel Mounted Instruments section covers the furnishing of all panel mounted instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.
- B. Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.
- C. When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

##### 1.2 DESIGN CRITERIA

- A. The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or the Instrument Device Schedule.
- B. Where possible, each instrument shall be factory calibrated to the calibration ranges indicated on the Drawings or in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. For "smart" devices, calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings and/or Instrument Device Schedule.
- C. Panel mounted instruments for each filter in a water plant, shall be supplied with power from a common source.

##### 1.3 SUBMITTALS

- A. See Section Instrumentation and Control System section.
  - 1. Submittals shall be as specified in the Instrumentation and Control System section.

## Panel Mounted Instruments

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. The following paragraphs describe minimum device stipulations. The Drawings or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.
- B. Programming Device
  - 1. For systems that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training stipulations. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.
- C. Configuration Software/Serial Interface
  - 1. Devices indicated as requiring a serial interface shall be provided with all accessories to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a laptop computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under the Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device need not be furnished.

#### 2.2 PANEL FRONT MOUNTED DEVICES.

- A. Switches, Lights, and Push Buttons.
  - 1. Selector Switches
    - a. Selector switches shall be 30.5-mm, heavy-duty, oil-tight type with gloved-hand or wing lever operators. Position legends shall be engraved on the switch faceplate. Switches for electric circuits shall have silver butting or sliding contacts, rated 10 amperes continuous at 120 V ac. Contact configuration shall be as indicated on the Drawings or for the application. Switches used in electronic signal circuits shall have contacts suitable for that duty. Switches shall be Eaton/Cutler-Hammer "10250T", without exception.
  - 2. Indicating Lights
    - a. Indicating lights shall be 30.5-mm, heavy-duty, oil-tight type, with full voltage LED lamps. Legends shall be engraved on the lens or on a legend faceplate. Lights shall be push-to-test type. Indicating lights shall be Eaton/Cutler Hammer "10250T", without exception.



## Panel Mounted Instruments

### 3. Push Buttons

- a. Push buttons shall be 30.5-mm, heavy-duty, oil-tight type. Legends shall be engraved on the push-button faceplate. Contacts shall be rated 10 amperes continuous at 120 V ac. Push buttons shall be Eaton/Cutler-Hammer "10250T", without exception

## 2.3 PANEL INTERIOR MOUNTED DEVICES

### A. Relays

1. Relays indicated to be provided in panels, enclosures, or systems furnished under this section shall be of the plug-in socket base type with dustproof plastic enclosures unless noted otherwise. Relays shall be UL recognized and shall have not less than double-pole, double-throw contacts. Control circuit relays shall have silver cadmium oxide contacts rated 10 amperes at 120 V ac. Electronic switching-duty relays shall have gold-plated or gold alloy contacts suitable for use with low-level signals. Relays used for computer input, alarm input, or indicating light service shall have contacts rated at least 3 amperes. Time delay relays shall have dials or switch settings engraved in seconds and shall have timing repeatability of  $\pm 2$  percent of setting. Latching and special purpose relays shall be for the specific application. Unless otherwise indicated, all relays shall have an integral pilot light that illuminates to indicate an energized condition. Relays shall be IDEC "Series RR"; Potter & Brumfield "Series KRP, CB"; or Struthers-Dunn "Series 219, 246".

## PART 3 - EXECUTION

### 3.1 FIELD SERVICES

- A. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section. Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

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## Electrical

### 1.1 SECTION 16050 - ELECTRICAL

#### PART 2 - GENERAL

##### 2.1 SCOPE.

- A. This section covers the furnishing and installation of all equipment and materials needed for the electrical requirements of this Contract. It also covers conduit, wiring, and terminations for electrical equipment installed under Electrical Equipment Installation section.
- B. This section covers the installation and interconnection of electrical equipment furnished under other sections, except electrical items designated to be installed under those sections.

##### 2.2 GENERAL.

- A. Electrical apparatus on all equipment shall be installed complete and placed in readiness for proper operation.
- B. Electrical materials furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.
- C. General Equipment Stipulations.
  - 1. The General Equipment Stipulations section shall apply to all equipment provided under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence
- D. Seismic Design Requirements.
  - 1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.
- E. Coordination.
  - 1. Electrical work shall conform to the construction schedule and the progress of other trades.
- F. Anchor Bolts and Expansion Anchors.
  - 1. All anchor bolts, nuts, washers, and expansion anchors shall comply with Anchorage in Concrete and Masonry section, except smaller than 3/4 inch will be permitted to match NEMA standard size bolt holes on motors and electrical equipment.
- G. Drawings.

## Electrical

1. Supplementing this section, the Drawings indicate locations of equipment and enclosures and provide one-line and schematic diagrams regarding the connection and interaction with other equipment.

### 2.3 CODES AND PERMITS.

- A. All work shall be performed and materials shall be furnished in accordance with the NEC - National Electrical Code, the NESC - National Electrical Safety Code, and the following standards where applicable:

AEIC	The Association of Edison Illuminating Companies
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
Fed Spec	Federal Specification
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
NEIS	National Electrical Installation Standards
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
UL	Underwriters' Laboratories

### 2.4 SEISMIC DESIGN REQUIREMENT.

- A. Seismic Design Requirements.
  1. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

### 2.5 IDENTIFICATION.

- A. Conduit.
  1. Conduits in manholes, handholes, building entrance pull boxes, junction boxes, and equipment shall be provided with identification tags. Identification tags shall be 19 gage stainless steel, with 1/2 inch stamped letters and numbers as indicated on the Drawings.

## Electrical

Identification tags shall be attached to conduits with nylon tie wraps and shall be positioned to be readily visible.

- B. Conductors. All conductors in power, control, and instrumentation circuits shall be identified and color coded as described herein.
1. Conductor Identification Number.
    - a. Except for lighting and receptacle circuits, each individual conductor in power, control, and instrumentation circuits shall be provided with wire identification markers at the point of termination.
    - b. The wire markers shall be of the heat-shrinkable tube type, with custom typed identification numbers.
    - c. The wire numbers shall be as indicated on the equipment manufacturer's drawings.
    - d. The wire markers shall be positioned to be readily visible for inspection.
  2. Conductor Color Coding.
    - a. Power conductors shall be color coded as indicated below. For conductors 6 AWG and smaller, the color coding shall be the insulation finish color. The equipment grounding conductor shall be green or green with one or more yellow stripes if the conductor is insulated.
    - b. The following color coding system shall be used:
      - 1) 120/240 V, single-phase — black, red, and white
      - 2) 120/208 V, three-phase — black, red, blue, and white
      - 3) 277/480 V, three-phase — brown, orange, yellow, and gray
    - c. Where 120/240 and 120/208 volt systems share the same conduit or enclosure, the neutral for either the 120/240 volt system or the 208 volt system shall be white with a permanent identifiable violet stripe.
    - d. Control and instrumentation circuit conductors shall be color coded as indicated in the Cable Data Figures at the end of this section.
- C. Control Stations.**
1. Control stations shall be provided with nameplates identifying the related equipment. Pilot controls and indicating lights shall have engraved or etched legends ("start", "stop", etc.) as indicated on the Drawings. Nameplates shall be laminated black-over-white plastic, with 1/8 inch engraved letters, and shall be securely fastened to the control stations.
- D. Disconnect Switches.
1. All switches shall have front cover-mounted permanent nameplates that include switch type, manufacturer's name and catalog number, and horsepower rating. An additional nameplate, engraved or etched, laminated black-over-white plastic, with 1/8 inch letters, shall be provided to identify the associated equipment. Both nameplates shall be securely fastened to the enclosure.
- E. Arc Flash Hazard Labels.

## Electrical

1. Lighting panels, power panels, power centers, switchgear, switchboards, motor control centers, motor control line ups, transfer switches, industrial control panels, adjustable frequency drives, fused switches, meter socket enclosures, and other electrical equipment likely to be worked on energized shall be provided with permanent labels warning the risk of arc flash and shock hazard. Labels shall be designed in accordance with ANSI Z535.4 and shall include the following:

**WARNING**  
**Arc Flash and Shock Hazard**

Appropriate personal protection equipment (PPE) required. SEE NFPA 70E. Equipment must be accessed by qualified personnel only.

Turn off all power sources prior to working on or inside equipment.

2. Additional information shall be provided on the labels where specified in the Arc Flash Hazard Analysis section of this section.

### 2.6 SUBMITTALS.

- A. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the work performed by the Contractor, shall be submitted in accordance with the Submittal Procedures section. The drawings and data shall include, but shall not be limited to, the following:

1. Drawings and data.
2. Operating manuals.
3. Samples.
4. Test reports
5. Studies

- B. Submittal Identification.

1. Information covering all materials and equipment shall be submitted for review in accordance with the Submittal Procedures section. Each sheet of descriptive literature submitted shall be clearly marked to identify the material or equipment as follows:
  - a. Lamp fixture descriptive sheets shall show the fixture schedule letter, number, or symbol for which the sheet applies.
  - b. Equipment and materials descriptive literature and drawings shall show the specification paragraph for which the equipment applies.
  - c. Sheets or drawings covering more than the item being considered shall have all inapplicable information crossed out.
  - d. A suitable notation shall identify equipment and materials descriptive literature not readily cross-referenced with the Drawings or Specifications.

## Electrical

- e. Schematics and connection diagrams for all electrical equipment shall be submitted for review. A manufacturer's standard connection diagram or schematic showing more than one scheme of connection will not be accepted, unless it is clearly marked to show the intended connections.
  - f. Surge protective device submittals shall include drawings (including unit dimensions, weights, component and connection locations, mounting provisions, and wiring diagrams), equipment manuals that detail the installation, operation and maintenance instructions for the specified unit(s), and manufacturer's descriptive bulletins and product sheets.
2. Contractor shall submit the name and qualifications of the Engineering and Testing Services firm proposed to perform the protective device study and the on-site testing.
  3. Within 90 days after the Notice to Proceed, Contractor shall furnish a submittal for all types of cable and conduit to be provided. The submittal shall include the cable manufacturer and type, and sufficient data to indicate that the cable and conduit meet the specified requirements.
  4. In addition to the complete specifications and descriptive literature, a sample of the largest size of each type of cable shall be submitted for review before installation. Each sample shall include legible and complete surface printing of the cable identification.
- C. Seismic Design Requirements.
1. Submitted confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

### 2.7 PROTECTION AND STORAGE.

- A. During construction, the insulation on all electrical equipment shall be protected against absorption of moisture, and metallic components shall be protected against corrosion by strip heaters, lamps, or other suitable means. This protection shall be provided immediately upon receipt of the equipment and shall be maintained continuously.

## PART 3 - PRODUCTS

### 3.1 CABLE.

- A. All cables of each type (such as lighting cable or 600 volt power cable) shall be from the same manufacturer.
- B. All types of cable shall conform to the Cable Data Figures at the end of this section and as described herein.
- C. 600 Volt Power Cable.

## Electrical

1. Cable in power, control, indication, and alarm circuits operating at 600 volts or less, except where lighting, multiconductor control, and instrument cables are required, shall be 600 volt (Figure 2-16050XHHW-2) power cable.

### D. Instrument Cable.

1. Cable for electronic circuits to instrumentation, metering, and other signalling and control equipment shall be two- or three-conductor instrument cable twisted for magnetic noise rejection and protected from electrostatic noise by a total coverage shield. Types of instrument cables shall be (Figure 4-16050 single pair).

## 3.2 RACEWAY.

### A. Conduit and cable tray shall be as described in the following paragraphs:

#### B. Rigid Steel Conduit.

1. Rigid steel conduit shall be heavy wall, hot-dip galvanized, shall conform to NEMA C80.1, and shall be manufactured in accordance with UL 6.

#### C. Liquidtight Flexible Metal Conduit.

1. Liquidtight flexible metal conduit shall be hot-dip galvanized steel, shall be covered with a moistureproof polyvinyl chloride jacket, and shall be UL labeled.

#### D. PVC-Coated Rigid Steel Conduit.

1. The conduit shall be rigid steel. Before the PVC coating is applied, the hot dip galvanized surfaces shall be coated with a primer to obtain a bond between the steel substrate and the coating. The PVC coating shall be bonded to the primed outer surface of the conduit. The bond on conduit and fittings shall be stronger than the tensile strength of the PVC coating. The thickness of the PVC coating shall be at least 40 mils.
2. A chemically cured two-part urethane coating, at a nominal 2 mil thickness, shall be applied to the interior of all conduit and fittings. The coating shall be sufficiently flexible to permit field bending the conduit without cracking or flaking of the coating.
3. Every female conduit opening shall have a PVC sleeve extending one conduit diameter or 2 inches, whichever is less, beyond the opening. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit before coating. The wall thickness of the sleeve shall be at least 40 mils.
4. All fittings, condulets, mounting hardware, and accessories shall be PVC coated. All hollow conduit fittings shall be coated with the interior urethane coating described above. The screw heads on condulets shall be encapsulated by the manufacturer with a corrosion-resistant material.
5. PVC coated rigid steel conduit shall be manufactured by Calbond, Ocal, or Robroy Industries.



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### E. Rigid Nonmetallic (PVC) Conduit.

1. PVC conduit shall be heavy wall, Schedule 40, UL labeled for underground uses, and shall conform to NEMA TC-2 and UL 651.

### F. Rigid Aluminum Conduit (RAC).

1. Rigid aluminum conduit and fittings shall be manufactured of 6063 T1 alloy, shall conform to ANSI C80.5, and shall be manufactured in accordance with UL 6A.

## 3.3 WIRING DEVICES, BOXES, AND FITTINGS.

### A. Concealed conduit systems shall have flush-mounted switches and convenience outlets. Exposed conduit systems shall have surface-mounted switches and convenience outlets.

### B. Conduit Boxes and Fittings.

1. Galvanized or cadmium plated, threaded, malleable iron boxes and fittings shall be manufactured by Crouse-Hinds, Appleton, or O Z Gedney. In applications utilizing aluminum conduit systems, aluminum boxes and fittings manufactured by Crouse-Hinds, Appleton, or O Z Gedney shall be installed.
2. Rigid PVC device boxes and fittings shall be manufactured by Carlon or Cantex.
3. Sheet steel device boxes shall be manufactured by Appleton, Raco, or Steel City.
4. PVC coated device boxes shall be manufactured by Calbond, Ocal, or Robroy Industries.
5. Hub arrangements on threaded fittings shall be the most appropriate for the conduit arrangement to avoid unnecessary bends and fittings.

### C. Device Plates.

1. Galvanized or cadmium-plated device plates shall be used on surface mounted outlet boxes where weatherproof plates are not required.
2. Device plates on flush mounted outlet boxes where weatherproof plates are not required shall be AISI Type 302 stainless steel, Eaton "93000 series", Hubbell "S series", or Leviton "840nn-40 series"; nylon or polycarbonate, Eaton "5000 series", Hubbell "Pn series", or Leviton "807nn-I series".
3. Device plate mounting hardware shall be countersunk and finished to match the plate.
4. Device plates for switches outdoors or indicated as weatherproof shall have provisions for padlocking switches "On" and "Off", and shall be Appleton "FSK-1VS", Crouse-Hinds "DS185" or O Z Gedney "FS-1-WSCA".
5. Device plates for receptacles indicated as weatherproof shall be Appleton "FSK-WRD", Crouse-Hinds "WLRD1", or O Z Gedney "FS-1-WDCA".

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6. Flush-mounted, weatherproof plates shall be provided with adapter plates, Appleton "FSK-SBA" or Crouse-Hinds "FS031".
7. Device plates for ground fault interrupter receptacles indicated to be weatherproof shall be Appleton "FSK-WGFI", Eaton "S966", or O Z Gedney "FS-1-GFCA".
8. Receptacle covers outdoors or otherwise indicated to be weatherproof while in-use shall be die cast aluminum and shall include a padlock eye. Covers for standard convenience outlets shall be Hubbell "WP8M" or Thomas and Betts Red Dot "CKMUV". Covers for ground fault interrupter receptacles shall be Hubbell "WP26M" or Thomas and Betts Red Dot "CKMUV".
9. Engraved device plates, where required, shall be manufactured by Leviton, or equal.
10. Device plates on PVC conduit fittings shall be Carlon "E98 Series" or Cantex "513300 Series".

### D. Wall Switches.

1. Switches on ac lighting panel load circuits through 277 volts shall be 20 amperes, 120/277 volts, Eaton "AH1221V" through "AH1224V", Hubbell "HBL 1221I" through "HBL 1224I", or Leviton "1221-2I" through "1224-2I".
2. Switches for pulse control of lighting contactors shall be 20 amperes, 120/277 volts, momentary, double-throw, center "Off", Eaton "1995V", Hubbell "1557I" or Leviton "1257-I".
3. Switches on ac lighting panel load circuits through 277 volts in Class I, Division 1 and Division 2, Group D hazardous areas indicated on the Drawings shall be 20 ampere, 120/277 volts. Hazardous area switches shall be factory sealed tumbler switches, Appleton "EDS" or Killark "FXS".

### E. Receptacles.

1. Standard convenience outlets shall be duplex, three-wire, grounding, 20 amperes, 125 volts, Eaton "AH5362V", Hubbell "5362I" or Leviton "5362-I" for 120 volt circuits, and 250 volts, Eaton "AH5462CV", Hubbell "5462I" or Leviton "5462-I" for 240 volt circuits.
2. Ground fault circuit interrupter receptacles shall be duplex, 20 amperes, 125 volts, Eaton "SGFH20", Hubbell "GFRST20I" or Leviton "G5362-I".
3. Ground fault circuit interrupter receptacles in damp or wet locations shall be duplex, 20 amperes, 125 volts, Hubbell "GFWRST20I" or Leviton "G5362-WTI".
4. 600 volt welding receptacles shall be 30 amperes, 3 phase, with grounding conductors connected through a fourth pole, Appleton "ADRE3034-100", Crouse-Hinds "AR348" plus "ARRC33" and "AR30" or Leviton "430MI5W". One matching plug, Appleton "ACP3034BC", Crouse-Hinds "APJ3485" or Leviton "430P5W" with appropriate woven grip and plug cap, shall be furnished for the cable size directed by Owner.

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5. 240 volt welding receptacles shall be 60 amperes, 3 phase, with grounding conductors connected through a fourth pole, Appleton "ADRE6034-150", Crouse-Hinds "AREA6425" or Leviton "460MI9W". One matching plug, Appleton "ACP6034BC", Crouse-Hinds "APJ6485" or Leviton "460P9W" with appropriate woven grip and plug cap, shall be furnished for the cable size directed by Owner.
6. Receptacles in Class I, Division 1 and Division 2, Group D hazardous areas indicated on the Drawings shall be three-wire, grounding, 20 amperes, 125 volts. Hazardous area receptacles shall be factory sealed, with an integral switch that is only activated when an approved matching plug is fully inserted and rotated into the engaged position. Hazardous area receptacles shall be Appleton "ENR", Crouse-Hinds "ENR", or Killark "UGR".

### 3.4 JUNCTION BOXES, PULL BOXES, AND WIRING GUTTERS.

- A. Indoor boxes (larger than switch, receptacle, or fixture type) and gutters shall be constructed of sheet steel, shall be galvanized after fabrication, and shall be rigidly supported by hot-dip galvanized hardware and framing materials, including nuts and bolts.
- B. Indoor boxes and gutters in corrosive areas indicated on the Drawings and outdoor boxes and gutters shall be NEMA Type 4X, stainless steel and shall be rigidly supported by PVC-coated or stainless steel framing materials. Mounting hardware, which includes nuts, bolts, and anchors, shall be stainless steel. All damaged coatings shall be repaired according to the manufacturer's instructions.
- C. Bolt-on junction box covers 3 feet square or larger, or heavier than 25 lbs, shall have rigid handles. Covers larger than 3 by 4 feet shall be split.
- D. Where indicated on the Drawings, junction and pull boxes with a removable side opposite the underground conduits shall be provided over building ends of underground conduit banks. Boxes shall be sized in accordance with the National Electrical Code, including space for full size continuations of all underground conduits not originally continued. Conduit arrangement shall leave maximum space for future conduits.

### 3.5 CONTROL STATIONS.

- A. Control stations shall be provided as indicated on the one-line diagrams or schematics or as required by the equipment furnished. Pilot devices shall be 30.5 mm heavy-duty, oiltight construction, and shall perform the functions indicated. Pilot lights shall be full voltage type with LED lamps. Indoor control stations shall have NEMA Type 13 enclosures. Control stations outdoors or indicated to be weatherproof shall have NEMA Type 4X stainless steel enclosures with protective caps on the control devices. Control stations in NEC Class I, Division 1 and Division 2, Group D hazardous areas shall have NEMA Type 7 enclosures, or be factory sealed type, Appleton "Contender Series" or Killark "Seal-X Series"

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### 3.6 DISCONNECT SWITCHES.

- A. Unless otherwise specified, each disconnect switch shall be 3 pole, nonfusible, 600 volts, with a continuous current rating as indicated on the Drawings.
- B. Where indicated on the Drawings, fused switches shall be furnished complete with fuses. Fuse sizing shall be as indicated on the Drawings, as required by the results of the protective device study, or as recommended by the respective protected equipment manufacturer.
- C. Switches located indoors shall have NEMA type enclosure designations as required by the locations where they will be installed. Switches located outdoors shall have NEMA Type 4X stainless steel enclosures. Switches in chlorine rooms, or in other areas where contact with caustic substances may occur, shall have NEMA Type 4X enclosures of molded reinforced polyester.
- D. Switches shall have high conductivity copper, visible blades; nontearable, positive, quick-make, quick-break mechanisms; and switch assembly plus operating handle as an integral part of the enclosure base. Each switch shall have a handle whose position is easily recognizable and which can be locked in the "Off" position with three padlocks. The "On" and "Off" positions shall be clearly marked.
- E. All switches shall be UL listed and horsepower rated, and shall meet the latest edition of NEMA KS1. Switches shall have defeatable door interlocks that prevent the door from being opened while the operating handle is in the "On" position.

## PART 4 - EXECUTION

### 4.1 INSTALLATION, TESTING, AND COMMISSIONING.

- A. All material, equipment, and components specified herein shall be installed, tested, and commissioned for operation in compliance with NECA 1000 – NEIS Specification System. Where required in NECA 1000, testing and commissioning procedures shall be followed prior to energizing equipment.
- B. General
  - 1. Prior to energizing the electrical circuits, insulation resistance measurements tests shall be performed using a 100-volt megohmmeter to verify the conductor is acceptable for use on the project, the test measurements shall be recorded on the specified forms to be provided by the City of Salem
- C. Insulation Resistance Measurements:
  - 1. General:
    - a. Insulation resistance measurements shall be made on conductors and energized parts of electrical equipment. Minimum acceptable values of insulation resistance shall be in accordance with applicable ICEA, NEMA or ANSI standards for the equipment or material being tested, unless otherwise specified. The ambient

temperature at which insulation resistance is measured shall be recorded on the test form.

2. Insulation resistance measurements shall be recorded on form 16050-A.
3. Conductor and Cable Test:
  - a. The phase-to-ground insulation resistance shall be measured for all circuits rated 120 volts and above except lighting circuits. Measurements may be made with motors and other equipment connected. Solid State equipment shall be disconnected, unless the equipment is normally tested by the manufacturer at voltages in excess of 1000 volts DC.

D. Pre-Functional Test Checkout:

1. Functional testing shall be performed. Prior to functional testing, all protective devices shall be adjusted and made operative.
2. Submit a description of the proposed functional test procedures prior to the performance of functional checkout.
3. Prior to energization of equipment, perform a functional checkout of the control circuit.
  - a. Checkout:
    - 1) Energizing each control circuit.
    - 2) Operating each control device, alarm device, or monitoring device.
    - 3) Operate each interlock to verify that the specified action occurs.

4.2 ARC FLASH HAZARD ANALYSIS.

- A. Contractor shall commission an Arc Flash Hazard Analysis in accordance with OSHA 29 CFR Part 1910, NEC, NFPA 70E, and IEEE 1584 and shall submit an Arc Flash Hazard Analysis report as specified herein. The scope of the analysis shall include arc flash labeling for Switchboard SWBD-5 and everything downstream including lighting panels, motor control centers, industrial control panels, and other electrical equipment likely to be worked on energized.
- B. The scope of the analysis shall include all electrical equipment downstream of Switchboard SWBD-5.
- C. The analysis shall calculate the incident energy value and arc flash boundary at defined working distances for all AC, three-phase, 208 volt through 15 kV, electrical equipment in accordance with the IEEE 1584 calculation method.
- D. AC single-phase equipment, rated 208 volt and above, shall be calculated using single-phase fault current values applied to the three-phase equations in accordance with IEEE 1584.
- E. AC single-phase equipment, rated below 208 volt, with a maximum available fault current of 25 kA and maximum fault clearing time of 2 cycles, shall be analysed and labelled using the Arc-

## Electrical

Flash PPE Categories for Alternating Current Systems, Table 130.7(C)(15)(a), in NFPA 70E (2018).

- F. The Arc Flash Hazard Analysis shall be performed in association with, or as a continuation of, the short circuit study and protective device study. Protective-device settings shall be selected to provide the necessary equipment protection and device coordination required while balancing the goal to reduce the calculated incident energy to the greatest extent possible.
- G. The analysis shall be performed for multiple electrical system modes of operation in order to calculate the worst-case incident energy at each piece of equipment. At a minimum, the system shall be analyzed for the minimum and maximum available fault current and X/R ratios from the electric utility supplying service or for the separately derived power system. The Contractor shall be responsible for obtaining the minimum and maximum, three-phase and line-to-ground available fault current and X/R ratios from the local electric utility. The analysis shall not assume bolted fault current values.
- H. Electric Utility is Portland General Electric(PGE), Phone Number 503-970-7200.
- I. For equipment with an integral main overcurrent protective device that is not adequately isolated from the bus, the upstream protective device shall be used as the fault clearing device in the analysis. Where arc reduction maintenance mode switches are installed on protective devices, the arc reduction shall only apply for downstream equipment that is adequately isolated from the protective device. Adequately isolated equipment shall be confirmed by the equipment manufacturer and shall be submitted to Engineer for review.
- J. The Contractor shall be responsible for collecting all field data for a complete analysis. Assumptions should only be made after every effort has been made to obtain the needed information. All assumptions used in the analysis shall be documented in the report for review by Engineer.
- K. The results shall include, but shall not be limited to, a tabulated spreadsheet of the following items for each piece of equipment included in the analysis:
  - 1. Equipment name.
  - 2. Three-phase bolted fault current.
  - 3. Arcing fault current.
  - 4. Arcing fault current through the protective device.
  - 5. Protective device clearing the fault.
  - 6. Protective device opening time.
  - 7. Bus gap.
  - 8. Worst-case incident energy and corresponding working distance. Equipment with arc reduction maintenance mode switches shall include the calculated incident energy level with and without the switch enabled.

## Electrical

9. Arc flash protection boundary.
- L. An Engineering and Testing Services firm acceptable to Engineer shall conduct the Arc Flash Hazard Analysis.
- M. Arc Flash Hazard Report.
  1. Contractor shall be responsible for submitting complete and accurate arc flash analysis information in the Arc Flash Hazard Report. The report shall be submitted to Engineer for review before the final report is prepared.
  2. The report shall include the following information at a minimum:
    - a. Executive summary.
    - b. Description of scope and study methodology.
    - c. Documentation of the modes of operation evaluated in the analysis including applicable input data such as utility fault current values.
    - d. Discussion of results and any recommendations.
    - e. Tabulated results spreadsheet.
    - f. List of assumptions.
    - g. One-line diagram(s) from the computer model software showing equipment names and other applicable information.
    - h. Documentation of software study parameters and configuration settings.
    - i. Recommended arc flash Personal Protective Equipment (PPE) selection in accordance with NFPA 70E.
  3. A bound hardcopy and digital PDF of the final Arc Flash Hazard Analysis report shall be submitted in accordance with the Submittal Procedures section.
  4. The final report shall be signed and sealed by a registered Professional Engineer.
- N. Arc Flash Labeling.
  1. After approval of the Arc Flash Hazard Report, Contractor shall furnish and install arc flash labels on the applicable electrical equipment. The label template shall be subject to review and acceptance by Engineer. The arc flash labels shall comply with ANSI Z535.4 and NFPA 70E requirements. Labels shall include, at a minimum, the nominal system voltage, the arc flash boundary distance, worst-case incident energy and the corresponding working distance, date of the analysis, and equipment name.
  2. Switchgear, motor control centers, and other multi-section equipment shall be provided with a duplicate label for each vertical section.
  3. Equipment with arc reduction maintenance mode switches shall include a dual label with the worst-case calculated incident energy level with and without the switch enabled. The label shall clearly identify the associated maintenance mode switch that shall be enabled in order for the lower incident energy level to apply.

4.3 PROTECTIVE DEVICE STUDY.

- A. Contractor shall commission a short circuit study and protective device study of relays, fuses, circuit breakers, and all other protective devices and shall submit a coordination and protective device settings report as specified herein. The study shall be in compliance with IEEE 242 and include the Primary Switchgear, Padmount Switchgear PSC075A, Transformer T-13 and everything downstream of Switchboard SWBD-5, including any and all existing power distribution components which will impact the results of the protective device study, starting with the smallest – 480 volt, 3 phase, 60 Hz – circuit protective device on the load end, to the nearest protective device on the power company's line side. Where existing electrical distribution system components are part of the study, the Contractor shall field verify and report the respective ratings and settings of each device as found as a prerequisite to the study analysis being performed. Protective device settings shall be selected to provide selective coordination to the maximum extent possible for equipment protection and device coordination while balancing the goal to reduce the calculated incident energy to the greatest extent possible.
- B. Contractor shall be responsible for and shall ensure that all relays, protective devices and circuit breakers shown on the Drawings and Specifications are sized and set according to the study results.
- C. The study shall include, but shall not be limited to, the following:
  - 1. Color-coded printouts of coordination curves prepared with calculation software.
  - 2. A tabulation of all protective relay and circuit breaker trip settings and recommended sizes and types of medium-voltage fuses.
  - 3. Motor starting profiles for all 50 horsepower and larger motors.
  - 4. Transformer damage curves and protection, evaluated in accordance with IEEE C57.109.
  - 5. Generator damage curves and protection, evaluated in accordance with manufacturers recommendations.
  - 6. Coordination curve(s) from the power company, if available.
  - 7. Calculated short-circuit values at all nodes in the distribution system included within the scope of the protective device study.
  - 8. Protective device settings shall include, but not limited to, motor and pump RTD settings, motor starts per hour, bus and transformer differential settings, synch-check settings, under and over-voltage settings, under and over-frequency settings, low-voltage breaker and MCC starter overload settings, and all protective functions shown on the Drawings and Specifications
  - 9. Adjustable frequency drive settings evaluated in accordance with the manufacturers recommendations and driven equipment requirements
  - 10. Reduced voltage starter settings evaluated in accordance with the manufacturers recommendations and driven equipment requirements



## Electrical

- D. An Engineering and Testing Services firm acceptable to Engineer shall conduct the protective device study.
- E. Contractor shall be responsible for obtaining the following:
  - 1. The coordination curves for relays, fuses, and circuit breakers.
  - 2. Transformer damage curves.
  - 3. Motor and pump data.
  - 4. Generator data
  - 5. Other applicable information for all new and existing electrical equipment.
- F. Contractor shall coordinate with the power company to obtain the required protective device curves and shall be responsible for all the field work associated with obtaining the necessary data on existing relays, circuit breakers, fuses, and transformers to be included in the protective device study.
- G. Electric Utility is Portland General Electric (PGE), Phone Number 503-970-7200.
- H. The available 3 phase, symmetrical fault current at the point of service shall be obtained from the Power Company.
- I. The protective device report shall be bound in a standard 8-1/2 by 11 inch three-ring binder and shall be submitted in accordance with the Submittal Procedures section. Final selection of all protective device settings or sizes shall be subject to review and acceptance by Engineer.

### 4.4 CABLE INSTALLATION.

- A. General.
  - 1. Except as otherwise specified or indicated on the Drawings, cable shall be installed according to the following procedures, taking care to protect the cable and to avoid kinking the conductors, cutting or puncturing the jacket, contamination by oil or grease, or any other damage. Circuits to supply electric power and control to equipment and devices, communication and signal circuits as indicated on the one-line diagrams shall be installed continuous and may not be spliced unless approved by the Engineer.
    - a. Stranded conductor cable shall be terminated by lugs or pressure type connectors. Wrapping stranded cables around screw type terminals is not acceptable.
    - b. Stranded conductor cable shall be spliced by crimp type connectors. Twist-on wire connectors may only be used for splicing solid cable and for terminations at lighting fixtures.
    - c. Splices may be made only at readily accessible locations.
    - d. Cable terminations and splices shall be made as recommended by the cable manufacturer for the particular cable and service conditions.
    - e. All 5,000 volt rated cable and above shielded cable stress cone terminations shall be IEEE Class 1 molded rubber type. Shielded cable splices shall be tape or molded rubber type as required. Shielded cable splices and stress cone

terminations shall be made by qualified splicers. Materials shall be by 3M Company, Plymouth/Bishop, or Raychem Electric Power Products.

- f. Cable shall not be pulled tight against bushings nor pressed heavily against enclosures.
- g. Cable-pulling lubricant shall be compatible with all cable jackets; shall not contain wax, grease, or silicone; and shall be Polywater "Type J".
- h. Cables operating at more than 2000 volts shall be fireproofed in all cable vaults, manholes, and handholes. Fireproofing shall be applied with a half-lapped layer of 3M "Scotch 77 Arc-Proofing Tape", anchored at each end with a double wrap of 3M "Scotch 69 Glass Cloth Tape" or with equivalent tape by Anixter or Plymouth/Bishop.
- i. Where necessary to prevent heavy loading on cable connections, in vertical risers, the cable shall be supported by Kellems, or equal, woven grips.
- j. Spare cable ends shall be taped, coiled, and identified.
- k. Cables shall not be bent to a radius less than the minimum recommended by the manufacturer. For cables rated higher than 600 volts, the minimum radius shall be 8 diameters for nonshielded cable and 12 diameters for shielded cable.
- l. All cables in one conduit, over 1 foot long, or with any bends, shall be pulled in or out simultaneously.
- m. Circuits to supply electric power and control to equipment and devices are indicated on the one-line diagrams. Conductors in designated numbers and sizes shall be installed in conduit of designated size. Circuits shall not be combined to reduce conduit requirements unless acceptable to Engineer.
- n. Instrument cable shields and drain wires shall be continuous over the entire length of the circuit and grounded at one end only. In general, the field end of the shield shall be ungrounded. At the ungrounded termination of the circuit, the shield and drain wire shall be insulated by taping to prevent grounding.
- o. Cables operating at more than 2,000 volts which terminate at medium-voltage padmounted equipment bushings shall include a metal oxide varistor surge protective elbow terminator conforming to IEEE Standard 386. Elbows shall provide a weatherproof, dead-front, hot-stick operable separable connection. Surge protector rating shall be as recommended by the terminator supplier.

#### 4.5 RACEWAY INSTALLATION.

- A. Contractor shall be responsible for routing all raceway. This shall include all conduits indicated on the one-lines, riser diagrams, and home-runs shown on the plan Drawings. Conduits shall be routed as defined in these Specifications. Where conduit routing is shown on plans, it shall be considered a general guideline and shall be field verified to avoid interferences.
- B. Except as otherwise specified or indicated on the Drawings, conduit installation and identification shall be completed according to the following procedures.
- C. Installation of Interior and Exposed Exterior Conduit.
  - 1. This section covers the installation of conduit inside structures, above and below grade, and in exposed outdoor locations. Large conduit and conduit stubs may be exposed unless otherwise specified or indicated on the Drawings. No conduit shall be exposed in water chambers unless so indicated on the Drawings.

2. Unless otherwise indicated on the Drawings, Contractor shall be responsible for routing the conduit to meet the following installation requirements:
  - a. Conduit installed in all exposed indoor locations, except corrosive areas indicated on the Drawings, and in floor slabs, walls, and ceilings of hazardous (classified) locations, shall be rigid steel or rigid aluminum. Exposed conduit shall be rigidly supported by hot-dip galvanized hardware and framing materials, including nuts and bolts.
  - b. Rigid Aluminum conduit shall not be installed in concrete and shall not come in contact with concrete if passing through a concrete slab.
  - c. Conduit installed in floor slabs and walls in non-hazardous locations shall be rigid Schedule 40 PVC.
  - d. Conduit installed in all exposed outdoor locations shall be PVC-coated rigid steel or rigid aluminum, rigidly supported by PVC-coated framing materials. Mounting hardware, which includes nuts, bolts, and anchors, shall be stainless steel. All damaged coatings shall be repaired according to the manufacturer's instructions.
  - e. Final connections to dry type transformers, to motors without flexible cords, and to other equipment with rotating or moving parts shall be liquidtight flexible metal conduit with watertight connectors installed without sharp bends and in the minimum lengths required for the application, but not longer than 6 feet unless otherwise acceptable to Engineer.
  - f. Terminations and connections of rigid steel and intermediate metal conduit shall be taper threaded. Conduits shall be reamed free of burrs and shall be terminated with conduit bushings.
  - g. Exposed conduit shall be installed either parallel or perpendicular to structural members and surfaces.
  - h. Two or more conduits in the same general routing shall be parallel, with symmetrical bends.
  - i. Conduits shall be at least 6 inches from high temperature piping, ducts, and flues.
  - j. Conduit installed in corrosive chemical feed and storage areas as indicated by Area Type on the Drawings shall be rigid PVC Coated Rigid Steel. Exposed conduit in corrosive areas shall be supported by FRP framing materials with stainless steel hardware, including nuts and bolts.
  - k. Metallic conduit connections to sheet metal enclosures shall be securely fastened by locknuts inside and outside.
  - l. Conduits in walls or slabs, which have reinforcement in both faces, shall be installed between the reinforcing steel. In slabs with only a single layer of reinforcing steel, conduits shall be placed under the reinforcement. Conduits larger than 1/3 of the slab thickness shall be concrete encased under the slab.
  - m. Conduits that cross structural joints where structural movement is allowed shall be fitted with concrete tight and watertight expansion/deflection couplings, suitable for use with metallic conduits and rigid Schedule 40 or 80 PVC conduits. The couplings shall be Appleton Type DF, Crouse-Hinds Type XD, or O-Z Type DX.
  - n. Conduit shall be clear of structural openings and indicated future openings.
  - o. Conduits through roofs or metal walls shall be flashed and sealed watertight.
  - p. Conduit installed through any openings cut into non-fire rated concrete or masonry structure elements shall be neatly grouted. Conduit penetrations of fire rated structure elements shall be sealed in a manner that maintains the fire rating as indicated on the Architectural Drawings.

## Electrical

- q. Conduits shall be capped during construction to prevent entrance of dirt, trash, and water.
- r. Exposed conduit stubs for future use shall be terminated with galvanized pipe caps.
- s. Concealed conduit for future use shall be terminated in equipment or fitted with couplings plugged flush with structural surfaces.
- t. Where the Drawings indicate future duplication of equipment wired hereunder, concealed portions of conduits for future equipment shall be provided.
- u. Horizontal conduit shall be installed to allow at least 7 feet of headroom, except along structures, piping, and equipment or in other areas where headroom cannot be maintained.
- v. Conduit shall not be routed across the surface of a floor, roof, or walkway unless approved by Engineer.
- w. PVC-coated rigid steel conduit shall be threaded and installed as recommended by the conduit manufacturer's installation procedure using appropriate tools.
- x. All conduits that enter enclosures shall be terminated with acceptable fittings that will not affect the NEMA rating of the enclosure.
- y. Conduit which turns out of concrete slabs or walls, shall be connected to a 90 degree elbow of PVC-coated rigid steel conduit before it emerges. Conduits shall have PVC-coated rigid steel coupling embedded a minimum of 3 inches when emerging from slabs or walls and the coupling shall extend 2 inches from the wall.
- z. Power conductors to and from adjustable frequency drives shall be installed in steel conduit.

### D. Sealing of Conduits.

- 1. After cable has been installed and connected, conduit ends shall be sealed by forcing nonhardening sealing compound into the conduits to a depth at least equal to the conduit diameter. This method shall be used for sealing all conduits at handholes, manholes, and building entrance junction boxes, and for 1 inch and larger conduit connections to equipment.
- 2. Conduits entering chlorine feed and storage rooms shall be sealed in a junction box or conduit body adjacent to the point of entrance.
- 3. Conduits entering hazardous (classified) areas and submersible or explosion proof enclosures shall have Appleton "Type ESU" or Crouse-Hinds "EYS" sealing fittings with sealing compound.

### E. Reuse of Existing Conduits.

- 1. Existing conduits shall not be reused.

## 4.6 WIRING DEVICES, BOXES, AND FITTINGS INSTALLATION.

### A. Metallic conduit boxes and fittings shall be installed in the following locations:

### B. Conduit Boxes and Fittings.

- 1. Galvanized or cadmium plated, threaded, malleable iron boxes and fittings shall be installed in concrete walls, ceilings, and floors; in the outdoor faces of masonry walls;

## Electrical

and in all locations where weatherproof device covers are required. These boxes and fittings shall also be installed in exposed rigid steel, intermediate metal conduit systems, and rigid aluminum.

2. Galvanized or cadmium plated sheet steel boxes shall be installed in the indoor faces of masonry walls, in interior partition walls, and in joist supported ceilings.
3. PVC coated boxes and fittings shall be installed in PVC coated conduit systems.
4. Telephone conduit shall be provided with separate junction boxes and pull fittings.

### C. Device Plates.

1. Oversized plates shall be installed where standard-sized plates do not fully cover the wall opening.

### D. Wall Switches.

1. Wall switches shall be mounted 3'-6" above floor or grade.
2. After circuits are energized, all wall switches shall be tested for proper operation.

### E. Receptacles.

1. Convenience outlets shall be 18 inches above the floor unless otherwise required.
2. Convenience outlets outdoors and in garages; in basements, shops, storerooms, and rooms where equipment may be hosed down; shall be 4 feet above floor or grade.
3. Welding receptacles shall be surface-mounted 4 feet above the floor.
4. After circuits are energized, each receptacle shall be tested for correct polarity and each GFCI receptacle shall be tested for proper operation.
5. Conduit and wire for convenience outlet installation is not shown on the Drawings and shall be sized, furnished, and installed by Contractor. Conductors shall be minimum 12 AWG and conduit shall be minimum 3/4 inch for convenience outlet installation.

### F. Special Outlets.

1. Wall thermostats shall be 4'-6" above the floor unless otherwise required. Thermostats on exterior walls shall be suitably insulated from wall temperature.
2. Telephone outlets shall be 18 inches above the floor unless otherwise required. Telephone outlets outdoors and in garages; in basements, shops, storerooms, and rooms where equipment may be hosed down; shall be 4 feet above floor or grade.
3. Clock outlets shall be located 7 feet above the floor.

## Electrical

4. Horns and strobe lights for audio/visual alarms shall be mounted a minimum of 8 feet above finished floor and shall be positioned to provide maximum penetration of the surrounding area.

### 4.7 EQUIPMENT INSTALLATION.

- A. Except as otherwise specified or indicated on the Drawings, the following procedures shall be used in performing electrical work.
- B. Setting of Equipment.
  1. All equipment, boxes, and gutters shall be installed level and plumb. Boxes, equipment enclosures, metal raceways, and similar items mounted on water- or earth-bearing walls shall be separated from the wall by at least 1/4 inch thick corrosion-resistant spacers. Where boxes, enclosures, and raceways are installed at locations where walls are not suitable or available for mounting, concrete equipment pads, framing material, and associated hardware shall be provided.
- C. Sealing of Equipment.
  1. All outdoor substation, switchgear, motor control center, and similar equipment shall be permanently sealed at the base, and all openings into equipment shall be screened or sealed with concrete grout to keep out rodents and insects the size of wasps and mud daubers. Small cracks and openings shall be sealed from inside with silicone sealant, Dow-Corning "795" or General Electric "SCS1200".

### 4.8 GROUNDING.

- A. General.
  1. The electrical system and equipment shall be grounded in compliance with the National Electrical Code and the following requirements:
    - a. All ground conductors shall be at least 12 AWG soft drawn copper cable or bar, bare or green-insulated in accordance with the National Electrical Code.
    - b. Ground cable splices and joints, ground rod connections, and equipment bonding connections shall meet the requirements of IEEE 837, and shall be exothermic weld connections or irreversible high-compression connections, Cadweld "Exothermic" or Burndy "Hyground". Mechanical connectors will not be acceptable. Cable connections to bus bars shall be made with high-compression two-hole lugs.
    - c. Ground cable through exterior building walls shall enter within 3 feet below finished grade and shall be provided with a water stop. Unless otherwise indicated, installation of the water stop shall include filling the space between the strands with solder and soldering a 12 inch copper disc over the cable. The copper disc shall be installed on the exterior of the wall and shall be a minimum thickness of 12 gauge and have a diameter that is a minimum of 2 inch larger than the diameter of the core hole that the ground cable passes through. The copper disc shall be soldered to the ground cable and caulk shall be applied around the outside

edge of the copper disc where it adjoins the exterior wall. Caulk shall be rated for submerged application and shall comply with Joint Sealants section.

- d. Ground cable near the base of a structure shall be installed in earth and as far from the structure as the excavation permits, but not closer than 24 inches. The tops of ground rods and ground cable interconnecting ground rods shall be buried a minimum of 30 inches below grade, or below the frost line, whichever is deeper.
- e. All powered equipment, including lighting fixtures and receptacles, shall be grounded by a copper ground conductor in addition to the conduit connection.
- f. Ground connections to equipment and ground buses shall be made with copper or high conductivity copper alloy ground lugs or clamps. Connections to enclosures not provided with ground buses or ground terminals shall be made with irreversible high-compression type lugs inserted under permanent assembly bolts or under new bolts drilled and inserted through enclosures, other than explosion proof enclosures, or by grounding locknuts or bushings. Ground cable connections to anchor bolts; against gaskets, paint, or varnish; or on bolts holding removable access covers will not be acceptable.
- g. The grounding system shall be bonded to the station piping by connecting to the first flange inside the building, on either a suction or discharge pipe, with a copper bar or strap. The flange shall be drilled and tapped to provide a bolted connection.
- h. Ground conductors shall be routed as directly as possible, avoiding unnecessary bends. Ground conductor installations for equipment ground connections to the grounding system shall have turns with minimum bend radii of 12 inches.
- i. Ground rods not described elsewhere shall be a minimum of 3/4 inch in diameter by 10 feet long, with a copper jacket bonded to a steel core.
- j. Test wells and covers for non-traffic areas shall be molded high density polyethylene. Test wells for traffic areas shall be precast concrete construction rated for traffic duty with concrete or cast iron covers.

B. Grounding System Resistance.

- 1. The ground system resistance shall comply with National Electrical Code.

4.9 MODIFICATIONS TO EXISTING EQUIPMENT.

- A. Modifications to existing equipment shall be completed as specified herein and indicated on the Drawings. All existing facilities shall be kept in service during construction. Temporary power or relocation of existing power and control wiring, equipment, and devices shall be provided as required during construction. Coordination and timing of outages shall be as specified in other sections of these Specifications. Electrical power interruptions will only be allowed where agreed upon in advance with Owner, and scheduling at times of low demand may be required.
- B. Lighting panel EDP9154 shall have the 2 pole circuit breaker connected to circuits 2,4 demolished and removed. A new 2P-35A circuit breaker that is compatible with EDP9154 shall be installed in circuits 2,4 to feed HP-1/FC-1.
- C. Existing spare 1P-15A breakers connected to circuit 16 and 18 shall be used to power HUH-1 and TCP respectively.
- D. Existing ground connection to MCC-20 shall be preserved and reused for MCC076A.

## Electrical

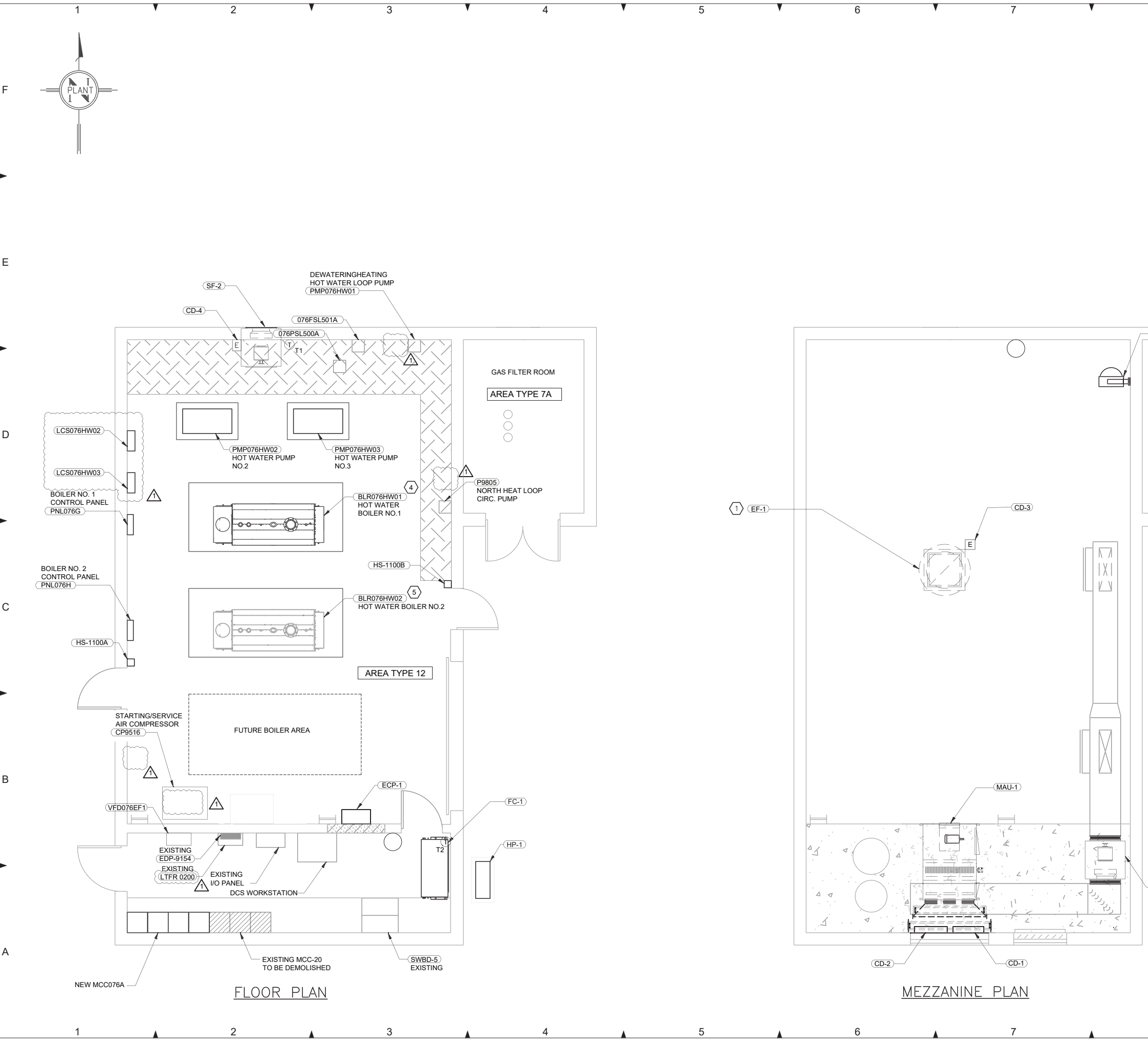
### E. Demolition.

1. Unless otherwise specified or indicated on the Drawings, all cable and all exposed conduit for power and control signals of equipment indicated to be removed shall be demolished. Conduit supports and electrical equipment mounting hardware shall be removed, and holes or damage remaining shall be grouted or sealed flush. Conduit partially concealed shall be removed where exposed, and plugged with expanding grout flush with the floor or wall. Repairs shall be refinished to match the existing surrounding surfaces. Demolished equipment shall be discarded or salvaged as indicated on the Drawings and as specified in other sections of these Specifications.

End of Section



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**GENERAL NOTES**

- SEE DRAWING E-00-001 & E-00-002 FOR ELECTRICAL LEGENDS, ABBREVIATIONS AND NOTES.

**SHEET KEYNOTES**

- EF-1 IS LOCATED ON THE ROOF.

- PSL-1131, VSL-1132, PSL-1123, VSL-1134, VG-1126, VSL-1133, VG-1125, PSH-1127, PSH-1135, VBM-1136, FAN-1110 BURNER FAN, FSL-1141, VBF-1129, FSL-1138, TIT-1140 AND TIT-1145 ARE LOCATED ON OR NEAR HOT WATER BOILER NO.1 BLR076HW01.
- PSL-1231, VS-1232, PSL-1223, VSL-1234, VG-1226, VSL-1233, VG-1225, PSH-1227, PSH-1235, VBM-1236, FAN-1210 BURNER FAN, FSL-1241, VBF-1229, FSL-1238, TIT-1240 AND TIT-1245 ARE LOCATED ON OR NEAR HOT WATER BOILER NO. 2 BLR076HW02.



SHEET PREPARED BY:



THIS DRAWING WAS ORIGINALLY SEALED BY ANDREW J. TRUMAN, A LICENSED PROFESSIONAL ENGINEER IN THE STATE OF OREGON, ON 05/18/2023

CERTIFICATE EXPIRES: DATE SIGNED:

**WILLOW LAKE WATER POLLUTION CONTROL FACILITY**  
**BOILER REPLACEMENT PROJECT**

REVISIONS			
NO.	DESCRIPTION	DATE	BY
1	ADDENDUM #1	8/28/2023	JCN

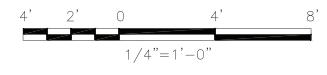
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 VERT DATUM: NGVD 1929(47)  
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 DESIGN: JCN  
 DRAWN: AJS  
 CHECKED: AJT  
 APPROVED: CCS

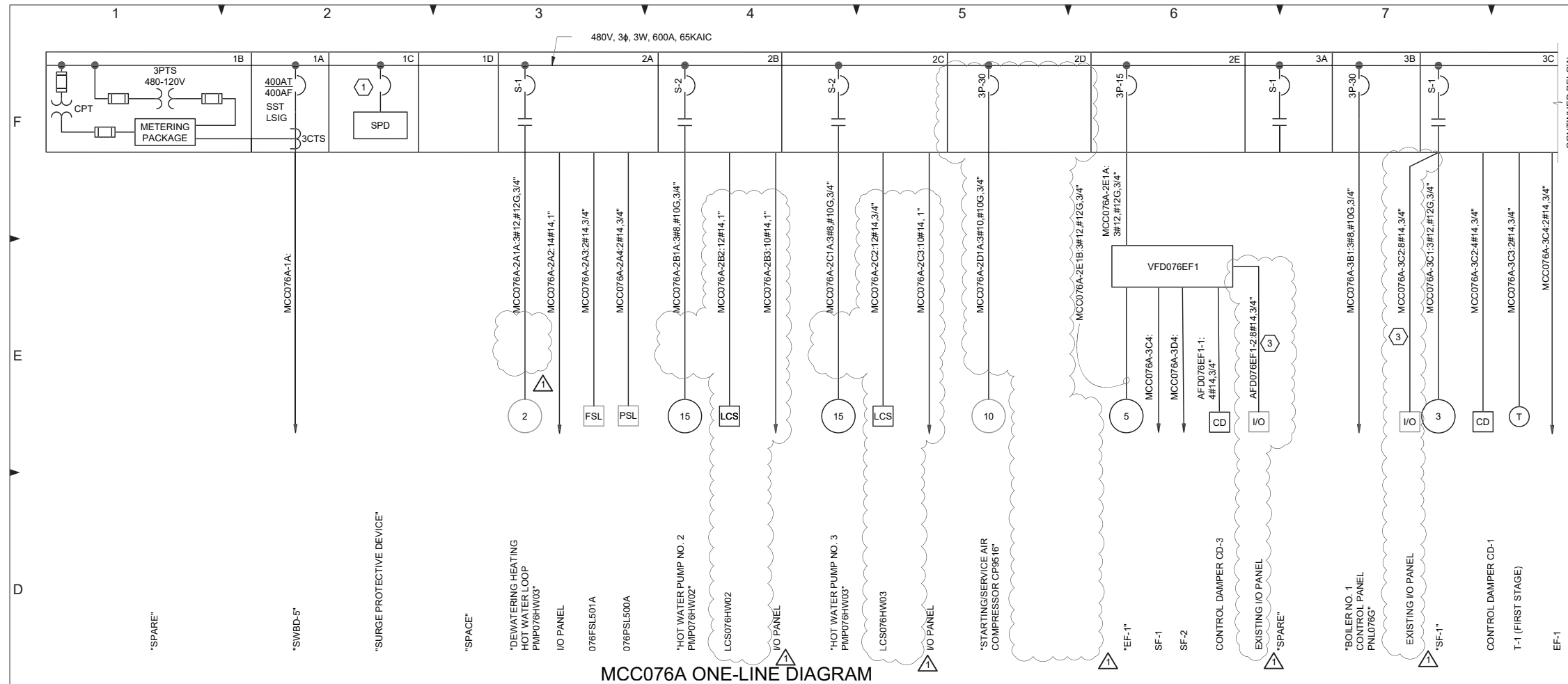
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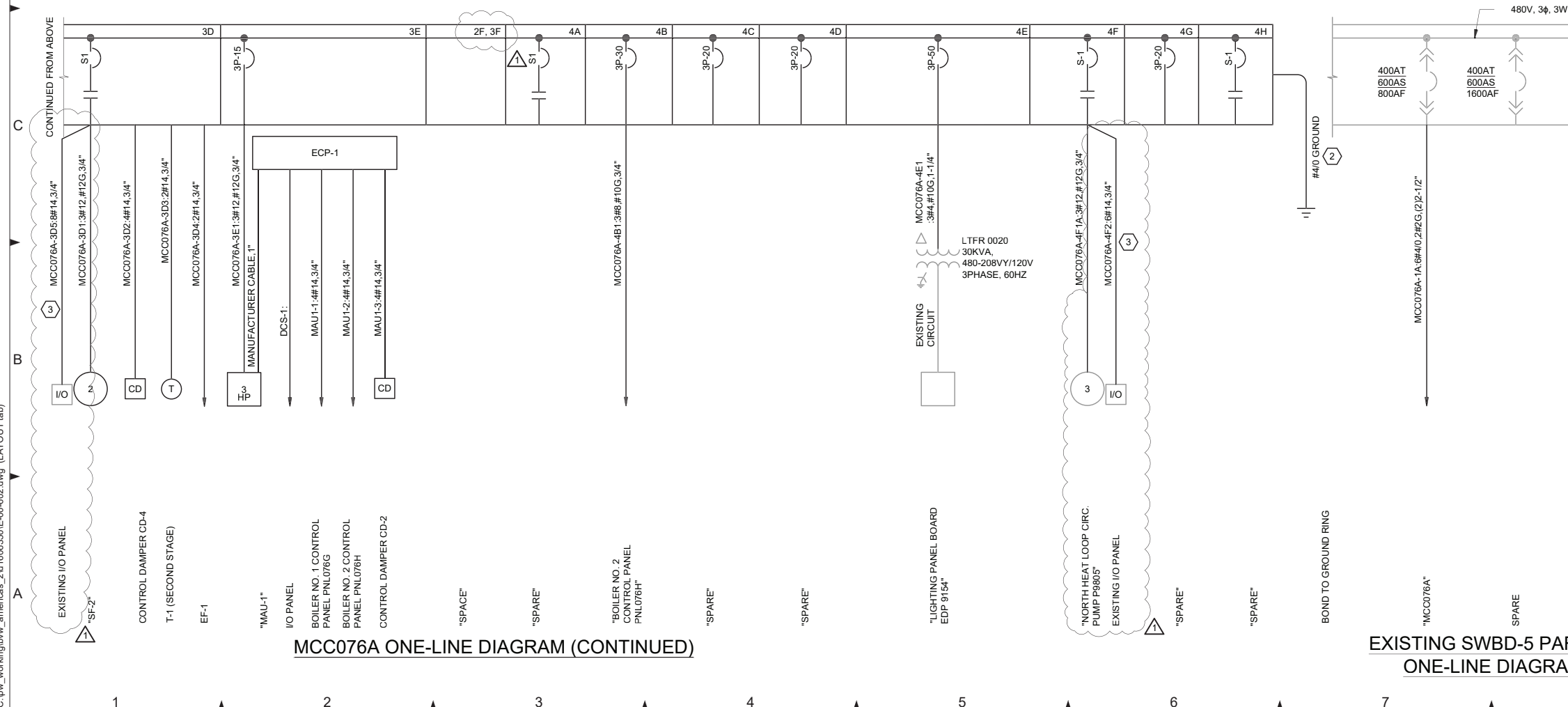
**E-00-101**  
 SHEET 38 OF 50



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MCC076A ONE-LINE DIAGRAM



MCC076A ONE-LINE DIAGRAM (CONTINUED)

EXISTING SWBD-5 PARTIAL ONE-LINE DIAGRAM

**GENERAL NOTES**

- SEE DRAWING E-00-001 & E-00-002 FOR ELECTRICAL LEGENDS, ABBREVIATIONS AND NOTES.
- NAMEPLATES FOR MCC BUCKETS SHALL BE AS SHOWN IN QUOTATION MARKS.

**SHEET KEYNOTES**

- PROTECTIVE DEVICE FOR SPD SHALL RATED AS PER MANUFACTURERS RECOMMENDATION.
- EXISTING GROUND CONNECTION TO MCC-20 SHALL BE REUSED TO GROUND NEW MCC076A.
- ADDENDUM #1 CIRCUITS GOING TO EXISTING I/O PANEL SHALL BE IN ADDITION TO THE CIRCUITS SHOWN ON THE EXISTING I/O PANEL PARTIAL ONE-LINE DIAGRAM.

**MCC076A FRONT ELEVATION**

1A	2A	3A	4A
		3B	4B
		3C	4C
1B		3D	4D
		3E	4E
1C		3F	4F
		3G	4G
1D	2D		4H
	2E		
	2F		

**REVISIONS**

NO.	DESCRIPTION	DATE	BY
1	ADDENDUM #1	8/28/23	JCN

**PN: 721102**

HORIZ DATUM: NAD 83-SPCS  
 VERT DATUM: NGVD 1929(47)  
 HORIZ SCALE: AS SHOWN  
 VERT SCALE: AS SHOWN  
 DESIGN: JCN  
 DRAWN: AJS  
 CHECKED: AJT  
 APPROVED: CCS

**SHEET TITLE**

MCC076A & SWBD-5 ONE-LINE DIAGRAM

**E-00-602**

SHEET 40 OF 50



SHEET PREPARED BY:

**BLACK & VEATCH**

CERTIFICATE EXPIRES: DATE SIGNED:

THIS DRAWING WAS ORIGINALLY SEALED BY ANDREW J. TRUMAN, A LICENSED PROFESSIONAL ENGINEER IN THE STATE OF OREGON, ON 05/18/2023

**WILLOW LAKE WATER POLLUTION CONTROL FACILITY**  
 BOILER REPLACEMENT PROJECT

SHEET PREPARED BY:



THIS DRAWING WAS  
ORIGINALLY SEALED BY  
ANDREW J. TRUMAN, A  
LICENSED PROFESSIONAL  
ENGINEER IN THE STATE  
OF OREGON, ON  
05/18/2023

CERTIFICATE EXPIRES:  
DATE SIGNED:

**WILLOW LAKE  
WATER POLLUTION  
CONTROL FACILITY**  
BOILER REPLACEMENT PROJECT

REVISIONS

NO.	DESCRIPTION	DATE	BY
1	ADDEDUM #1	8/23/2023	JCN

**PN: 721102**

HORIZ DATUM: NAD 83-SPCS  
VERT DATUM: NGVD 1929(47)  
HORIZ SCALE: AS SHOWN  
VERT SCALE: AS SHOWN  
DESIGN: JCN  
DRAWN: AJS  
CHECKED: AJT  
APPROVED: CCS

SHEET TITLE

**SCHEMATICS**

**E-00-605**

**GENERAL NOTES**

- SEE DRAWING E-00-001 & E-00-002 FOR ELECTRICAL LEGENDS, ABBREVIATIONS AND NOTES.
- DCS/I/O WIRE COLORS ARE TO BE DETERMINED BY THE CITY PRIOR TO CONSTRUCTION

**SHEET KEYNOTES**

- SEE HVAC SEQUENCE OF OPERATION AND SCHEDULES FOR MORE INFORMATION.

**SWITCH DEVELOPEMENTS**

SS1

CONTACTS	POSITION		
	LOCAL	OFF	REMOTE
1-2	X		
3-4			X
5-6	X	X	
7-8		X	X

SS3

CONTACTS	POSITION	
	ON	OFF
1-2	X	
3-4		X
5-6	X	X
7-8	X	

SS4

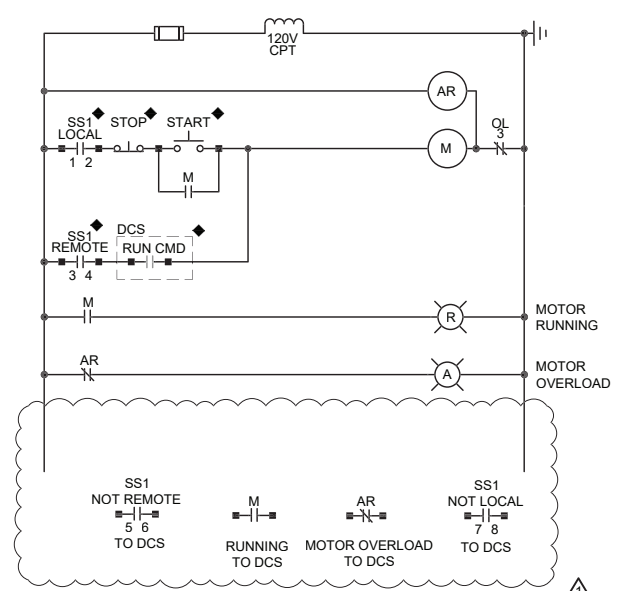
CONTACTS	POSITION		
	LOCAL	OFF	REMOTE
1-2	X		
3-4			X
5-6	X	X	
7-8		X	X

SS5

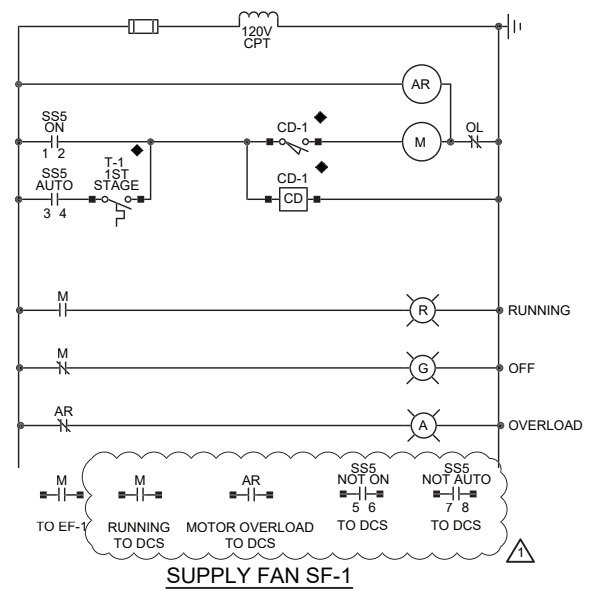
CONTACTS	POSITION		
	ON	OFF	AUTO
1-2	X		
3-4			X
5-6	X	X	
7-8	X	X	X

**SYMBOL LEGEND**

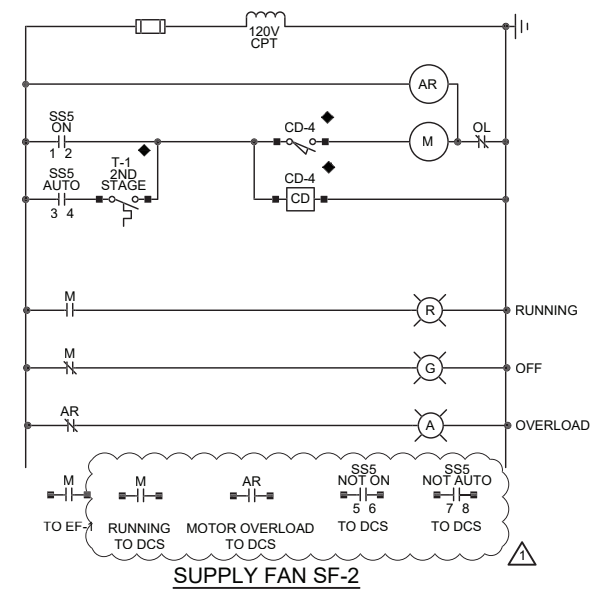
- ◇ AT DRIVEN EQUIPMENT
- ◆ REMOTE FROM STARTER AND DRIVEN EQUIPMENT



**HOT WATER PUMP NO. 3 PMP076HW03**  
SIMILAR FOR HOT WATER PUMP NO. 2 PMP076HW02



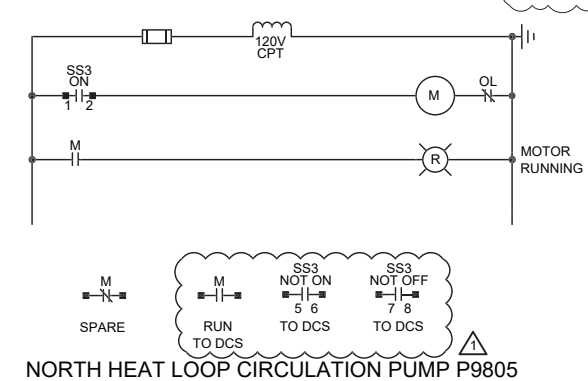
**SUPPLY FAN SF-1**



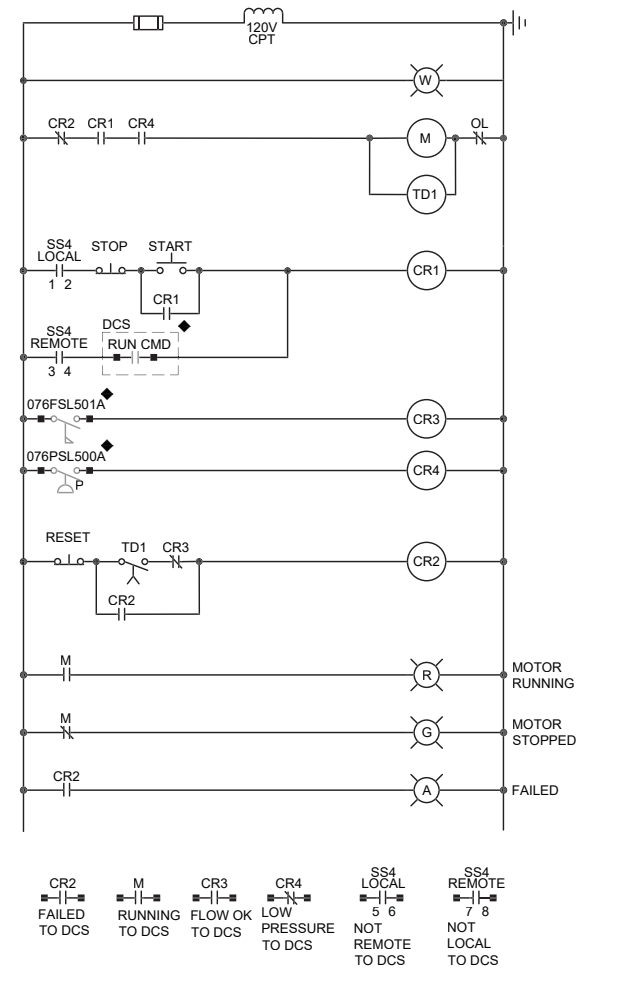
**SUPPLY FAN SF-2**



**EXHAUST FAN EF-1**



**NORTH HEAT LOOP CIRCULATION PUMP P9805**



**DEWATERING HEATING HOT WATER LOOP PUMP PMP076HW01**

SHEET PREPARED BY:



THIS DRAWING WAS  
ORIGINALLY SEALED BY JULIA  
L.T. RICKS, A LICENSED  
PROFESSIONAL ENGINEER IN  
THE STATE OF OREGON, ON  
5/22/2023

CERTIFICATE EXPIRES:  
DATE SIGNED:

**WILLOW LAKE  
WATER POLLUTION  
CONTROL FACILITY**  
BOILER REPLACEMENT PROJECT

REVISIONS			
NO.	DESCRIPTION	DATE	BY
1	ADDENDUM #1	08/28/23	JLTR

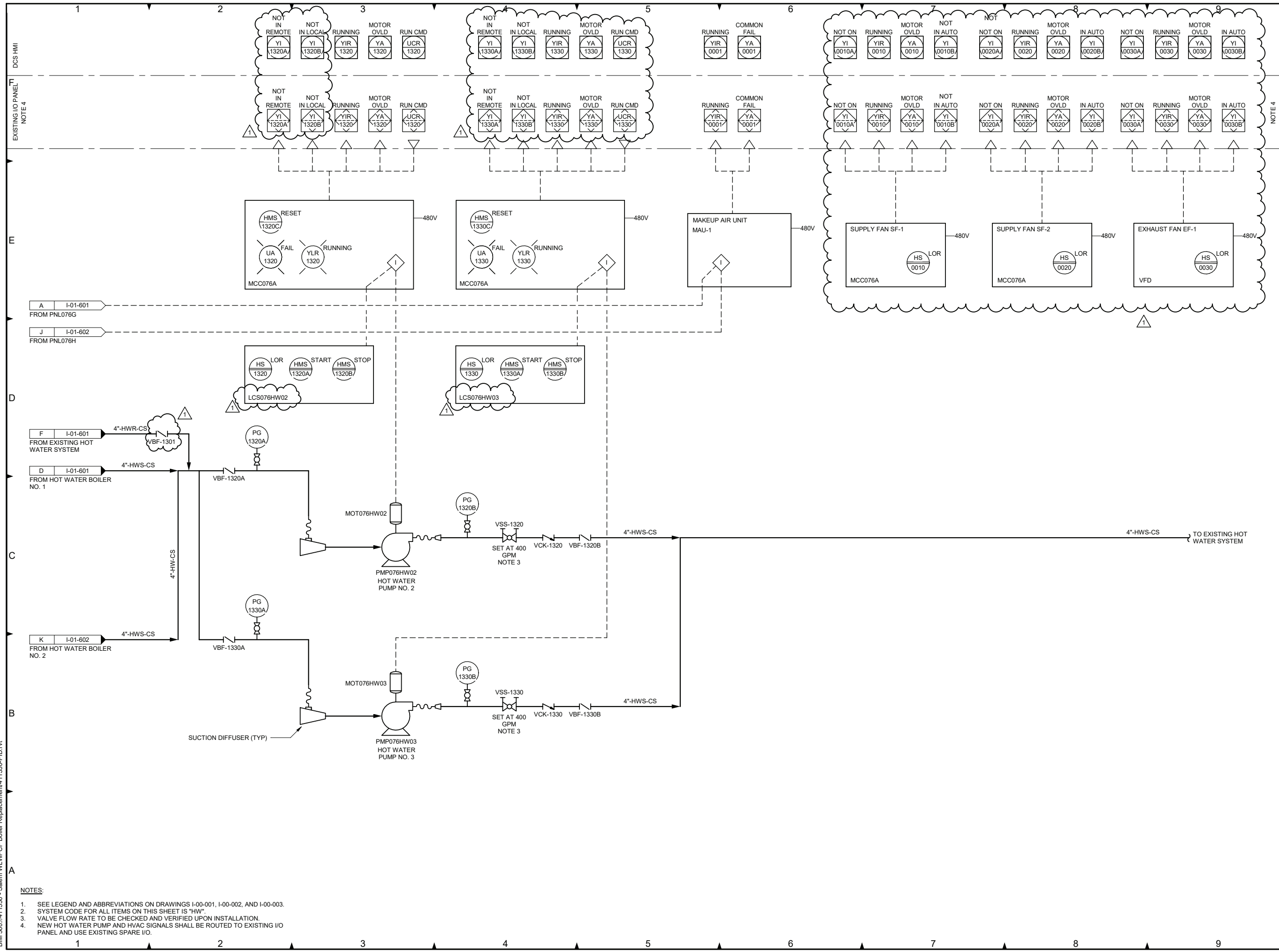
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HORIZ DATUM:	
VERT DATUM:	
HORIZ SCALE:	
VERT SCALE:	
DESIGN:	JLTR
DRAWN:	PVR
CHECKED:	DC
APPROVED:	CCS

SHEET TITLE

**P&ID  
HOT WATER  
PUMPS**

**I-01-603**



- NOTES:
- SEE LEGEND AND ABBREVIATIONS ON DRAWINGS I-00-001, I-00-002, AND I-00-003.
  - SYSTEM CODE FOR ALL ITEMS ON THIS SHEET IS "HW".
  - VALVE FLOW RATE TO BE CHECKED AND VERIFIED UPON INSTALLATION.
  - NEW HOT WATER PUMP AND HVAC SIGNALS SHALL BE ROUTED TO EXISTING I/O PANEL AND USE EXISTING SPARE I/O.

8/28/2023 2:44:57 PM BIM-360//411530 - Salem WL WPCF Boiler Replacement/411530-PID.rvt

# Bill of Materials

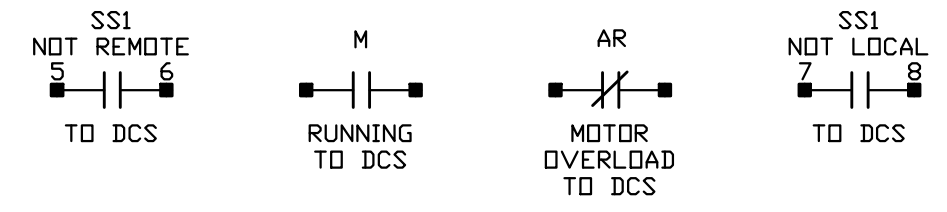
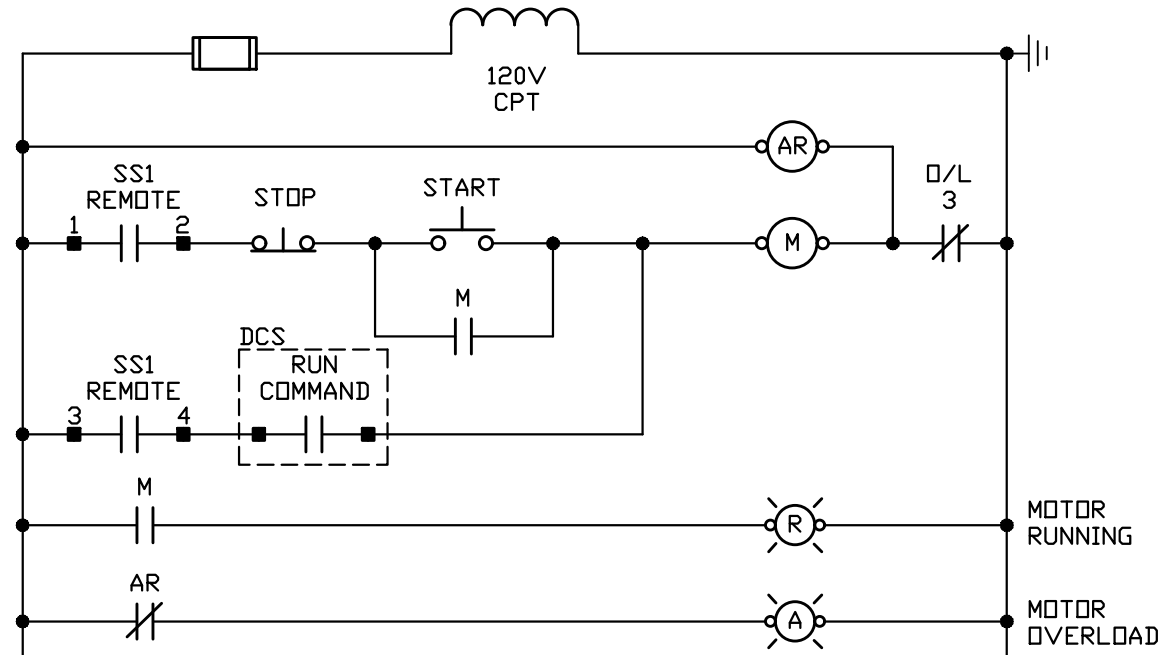


**Project:** City of Salem – Willow Lake Boiler Replacement  
**Specification Section(s):** Section 13561 – Panel Mounted Instruments  
**Date:** April 2024

Item No.	Qty.	Tag(s)	Description	Manufacturer	Mfr. Part Number	Specification	Drawing
001	1	LCS076HW02	PBX Enclosure 8.00" H x 4.00" W x 4.75" D	Saginaw Control & Engineering	SCE-3PBX	Section 16050	E-00-101, E-00-602, E-00-605, I-01-603
002	1	LCS076HW02	Selector Switch, 3-Position, Black, Lever	Eaton	10250T3023	Section 13561	E-00-101, E-00-602, E-00-605, I-01-603
003	2	LCS076HW02	Contact Block, 1NO/1NC	Eaton	10250T1	Section 13561	E-00-101, E-00-602, E-00-605, I-01-603
004	1	LCS076HW02	Pushbutton, Green, Flush, 1NO	Eaton	10250T23G	Section 13561	E-00-101, E-00-602, E-00-605, I-01-603
005	1	LCS076HW02	Pushbutton, Red, Flush, 1NC	Eaton	10250T102-51	Section 13561	E-00-101, E-00-602, E-00-605, I-01-603
006	3	LCS076HW02	Faceplates for Pilot Devices	Optimal Control Systems	—	Section 13561	E-00-101, E-00-602, E-00-605, I-01-603
007	1	LCS076HW03	PBX Enclosure 8.00" H x 4.00" W x 4.75" D	Saginaw Control & Engineering	SCE-3PBX	Section 16050	E-00-101, E-00-602, E-00-605, I-01-603
008	1	LCS076HW03	Selector Switch, 3-Position, Black, Lever	Eaton	10250T3023	Section 13561	E-00-101, E-00-602, E-00-605, I-01-603
009	2	LCS076HW03	Contact Block, 1NO/1NC	Eaton	10250T1	Section 13561	E-00-101, E-00-602, E-00-605, I-01-603
010	1	LCS076HW03	Pushbutton, Green, Flush, 1NO	Eaton	10250T23G	Section 13561	E-00-101, E-00-602, E-00-605, I-01-603
011	1	LCS076HW03	Pushbutton, Red, Flush, 1NC	Eaton	10250T102-51	Section 13561	E-00-101, E-00-602, E-00-605, I-01-603
012	3	LCS076HW03	Faceplates for Pilot Devices	Optimal Control Systems	—	Section 13561	E-00-101, E-00-602, E-00-605, I-01-603
013							
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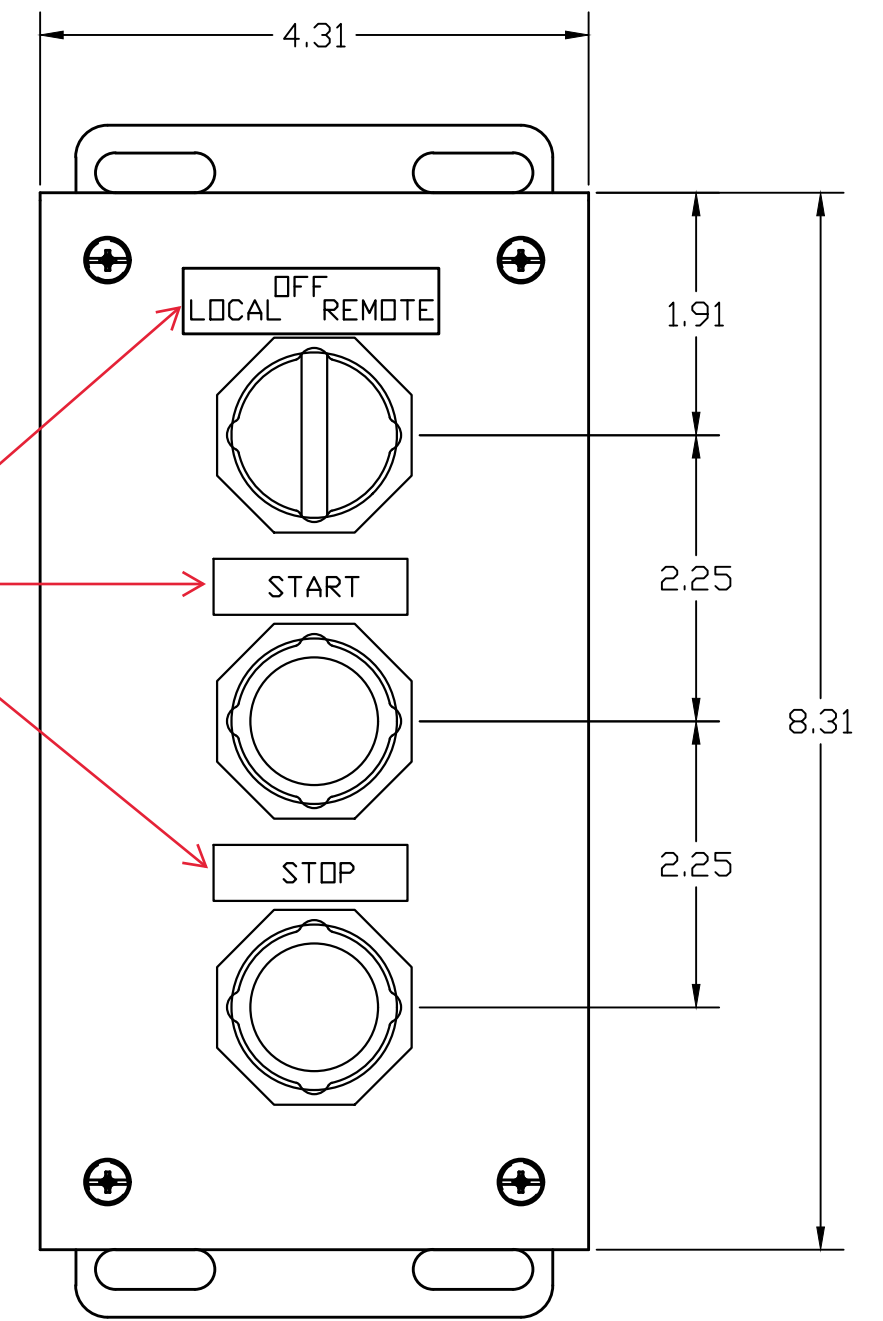
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HOT WATER PUMP NO. 2 PMP076HW02

All pilot devices shall have faceplates for indication/selection.

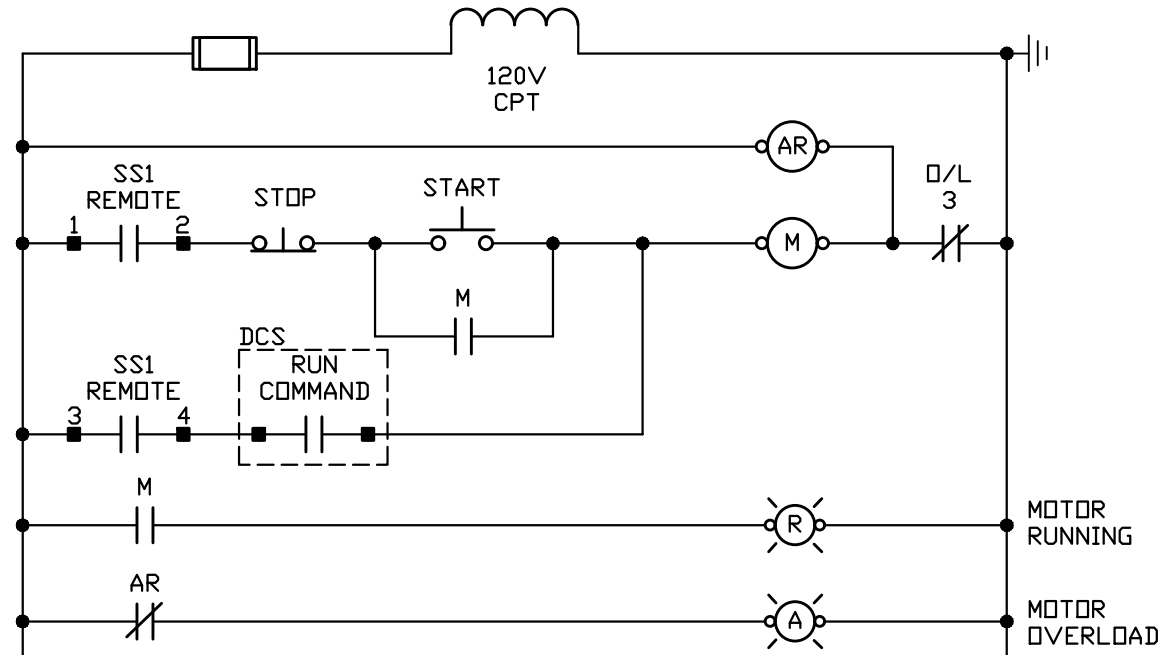


FRONT VIEW

SS1			
CONTACTS	POSITION		
	LOCAL	OFF	REMOTE
1 TO 2	X		
3 TO 4			X
5 TO 6	X	X	
7 TO 8		X	X

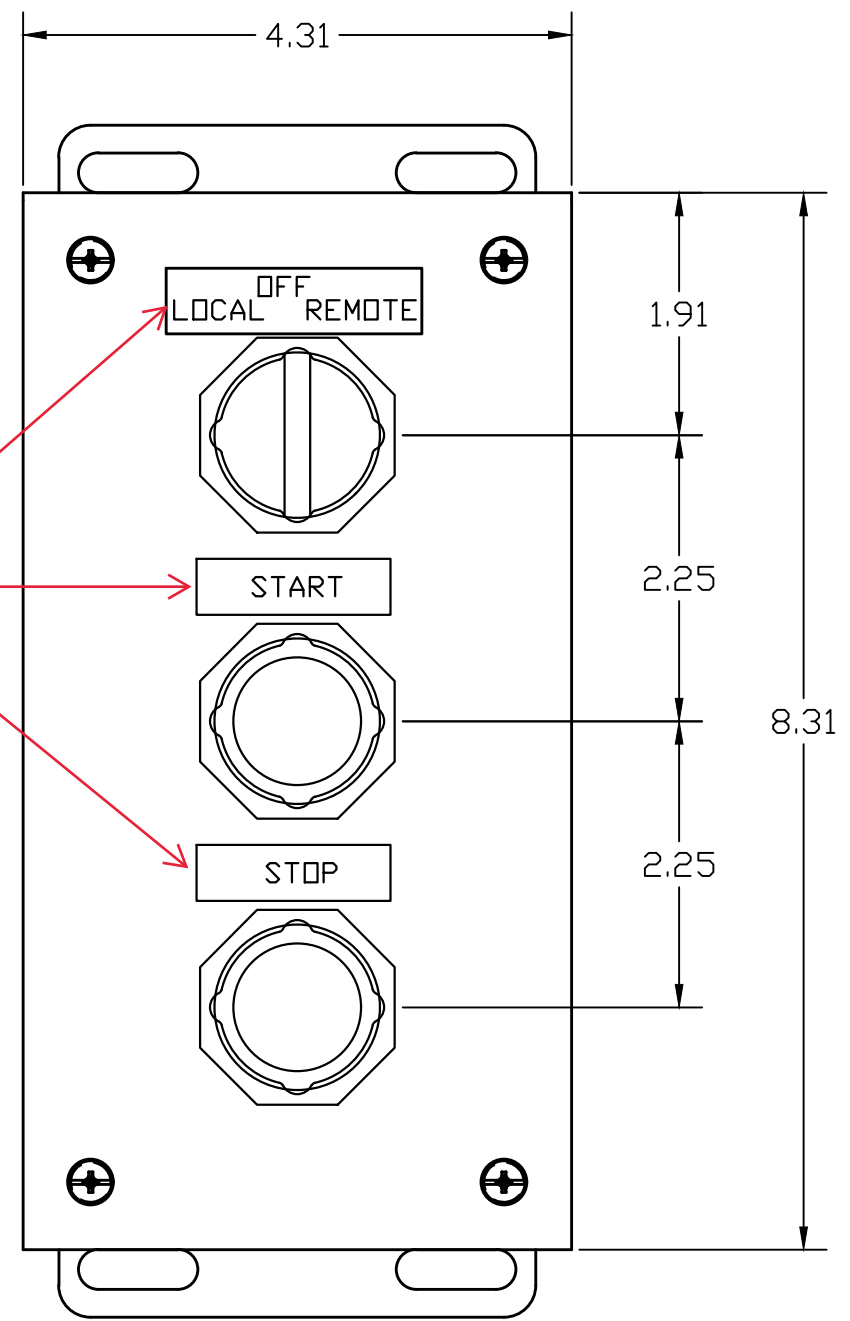
H				OPTIMAL CONTROL SYSTEMS		
G				2324 THREE LAKES RD / PO BOX 462		
F				ALBANY, OR 97321		
E				PHONE (541) 967-9323 FAX (541) 967-9485		
D				CLIENT S&S ELECTRICAL CONTRACTORS LLC		
C				TITLE WILLOW LAKE BOILER REPLACEMENT		
B	2024.422	Local Off Remote	HAD	LCS076HWD2 PANEL LAYOUT & WD		
A	2023.12.23	Original Draft	KCD	DRAWN KCD	ISSUED	JOB NO. 1223-11SSE
REV	DATE	DESCRIPTION	INIT	CHECKED ME	DATE 2023.12.13	DWG NO. 1223-11SSE-01
REVISIONS				APPROVED HAD	SCALE NONE	SHEET 1 OF 1

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HOT WATER PUMP NO. 3 PMP076HW03

All pilot devices shall have faceplates for indication/selection.



FRONT VIEW

SS1			
CONTACTS	POSITION		
	LOCAL	OFF	REMOTE
1 TO 2	X		
3 TO 4			X
5 TO 6	X	X	
7 TO 8		X	X

H				OPTIMAL CONTROL SYSTEMS		
G				2324 THREE LAKES RD / PO BOX 462		
F				ALBANY, OR 97321		
E				PHONE (541) 967-9323 FAX (541) 967-9485		
D				CLIENT S&S ELECTRICAL CONTRACTORS LLC		
C				TITLE WILLOW LAKE BOILER REPLACEMENT		
B	2024.4.22	Local Off Remote	HAD	LCS076HW03 PANEL LAYOUT & WD		
A	2023.12.23	Original Draft	KCD	DRAWN KCD	ISSUED	JOB NO. 1223-11SSE
REV	DATE	DESCRIPTION	INIT	CHECKED ME	DATE 2023.12.13	DWG NO. 1223-11SSE-02
				APPROVED HAD	SCALE NONE	SHEET 1 OF 1





Your Enclosure Source®

Saginaw Control and Engineering  
95 Midland Road Saginaw, MI 48638-5770  
(800) 234-6871 - Fax: (989) 799-4524  
SCE@SaginawControl.com

## SCE-3PBX

### Product Specifications:



**Part Number:** SCE-3PBX  
**Description:** PBX Enclosure  
**Height:** 8.00"  
**Width:** 4.00"  
**Depth:** 4.75"  
**Price Code:** A1  
**List Price:** \$80.02  
**Catalog Page:** 60  
**Est. Ship Weight:** 3.00 lbs

#### Construction

- \* 0.063 In. carbon steel
- \* Continuously welded seams
- \* Captivated cover screws thread into sealed wells
- \* 4-way standard pushbutton holes accept all brands of oil-tight pushbuttons, switches, and pilot lights. Hole diameter is 1.20 In. (30.5 mm)
- \* Immediate removal of cover is still permitted
- \* Pour in place oil & water resistant gasket
- \* Welded mounting provision top and bottom of back

#### Application

Designed to offer protection for oil-tight pushbuttons, switches, and pilot lights from dust, water, dirt and oil.

#### Finish

ANSI-61 gray powder coating inside and out.

#### Industry Standards - (IS2)

- \* NEMA Type 4, 12 and Type 13
- \* UL Listed Type 4 and 12
- \* CSA Type 4 and 12
- \* IEC 60529
- \* IP 66

#### Notes

Add "I" to catalog number to receive with 22.5mm hole diameter

#### Optional Accessories

SCE-ASPB-09 Plug, Hole

#### Similar Part Numbers

SCE-10PBXPBX Enclosure  
SCE-12PBXPBX Enclosure  
SCE-1PBXPBX Enclosure  
SCE-2PBXPBX Enclosure  
SCE-4PBXPBX Enclosure  
SCE-4SPBXPBX Enclosure  
SCE-6PBXPBX Enclosure  
SCE-6PBXVLPBX Enclosure  
SCE-9PBXPBX Enclosure

#### Installation Information

- \* Pushbutton Enclosures
- \* Sub-Plate Layout & Grounding for 10-32

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### 30.5 mm Heavy-Duty Watertight/Oiltight—10250T



### Contents

<i>Description</i>	<i>Page</i>
30.5 mm Heavy-Duty Watertight/Oiltight—10250T	
Product Overview . . . . .	V7-T1-214
Product Identification . . . . .	V7-T1-214
Catalog Number Selection . . . . .	V7-T1-215
Product Selection	
Point-of-Purchase Packaging . . . . .	V7-T1-217
Non-Illuminated Momentary Pushbutton Units . . . . .	V7-T1-218
Pushbuttons . . . . .	V7-T1-219
Illuminated Momentary Pushbutton Units . . . . .	V7-T1-222
Indicating Light Units . . . . .	V7-T1-223
Illuminated Pushbuttons and Indicating Lights . . . . .	V7-T1-224
Push-Pull Emergency Stop . . . . .	V7-T1-226
Illuminated Push-Pull Units . . . . .	V7-T1-229
Potentiometers . . . . .	V7-T1-232
Push-Pull Operators . . . . .	V7-T1-233
Selector Switch Units . . . . .	V7-T1-237
Selector Switch Selection . . . . .	V7-T1-238
Selector Switch Operators . . . . .	V7-T1-241
Illuminated Selector Switch Operators . . . . .	V7-T1-244
Joystick Units . . . . .	V7-T1-245
Joysticks . . . . .	V7-T1-246
Roto-Push Units . . . . .	V7-T1-249
Roto-Push Operators . . . . .	V7-T1-250
Accessories . . . . .	V7-T1-255
Options . . . . .	V7-T1-260
Replacement Parts . . . . .	V7-T1-269
Technical Data and Specifications . . . . .	V7-T1-271
Dimensions . . . . .	V7-T1-274



### Product Description

The 30.5 mm pushbutton line features a zinc die cast construction with chrome-plated housing and mounting nut. The same durable construction is also available with the corrosive resistant E34 line of pushbuttons. See E34 section on **Pages V7-T1-284 to V7-T1-325**.

### Features

- Heavy-duty zinc die cast construction
- Enclosed silver contacts with reliability nibs
- Diaphragm seals with drainage holes
- Grounding nibs on the operator casing

### Benefits

- Reliability nibs improve contact reliability even under dry circuit and fine dust conditions
- Drainage holes prevent buildup of liquid inside the operator which can prevent operation in freezing environments
- Grounding nibs bit through paint and other coatings to provide secure ground

### Application Description

#### Contact Operation

Slow make and break. All normally closed contacts have positive opening operation, i.e., normally closed contacts are forced open in the event of contact weld or spring breakage.

### Standards and Certifications

- CE EN 60947-5-1 and 60947-5-5
- UL 508—File No. 131568
- CSA C22.2 No. 14—File No. LR68551



### Ingress Protection

When mounted in similarly rated enclosure—

- Standard indicating lights
  - UL (NEMA) Type 1, 2, 3, 3R, 3S, 4, 4X, 12, 13
  - IEC IP65
- Most other operators
  - UL (NEMA) Type 1, 2, 3, 3R, 4, 4X, 12, 13
  - IEC IP65

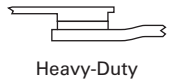
#### 1

### Product Overview

#### Reliability Nibs

Eaton's contact blocks feature enclosed silver contacts with pointed "reliability nibs" for reliable performance from logic level up to 600V. To ensure reliable switching, nibs bite through oxide which can form on silver contacts, eliminating the need for expensive logic level blocks for most applications.

#### Reliability Nibs



Reliability nibs improve performance in dry circuit, corrosive, fine dust and other contaminated atmospheres. Under normal environmental conditions, the minimum operational voltage is 5V and the minimum operational current is 1 mA, AC/DC. For operation under a wider range of environmental conditions, logic level contact blocks with inert palladium tipped contacts are recommended.

#### Grounding Nibs

10250T line operators have "grounding nibs"—four metal points on the operator casting designed to bite through most paints and other coatings on metal panels to enhance the ground connection when the operator is securely tightened.

#### Grounding Nibs

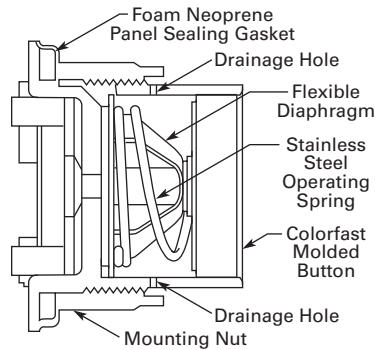


#### Diaphragm Seal with Drainage Holes

##### Liquid Drainage

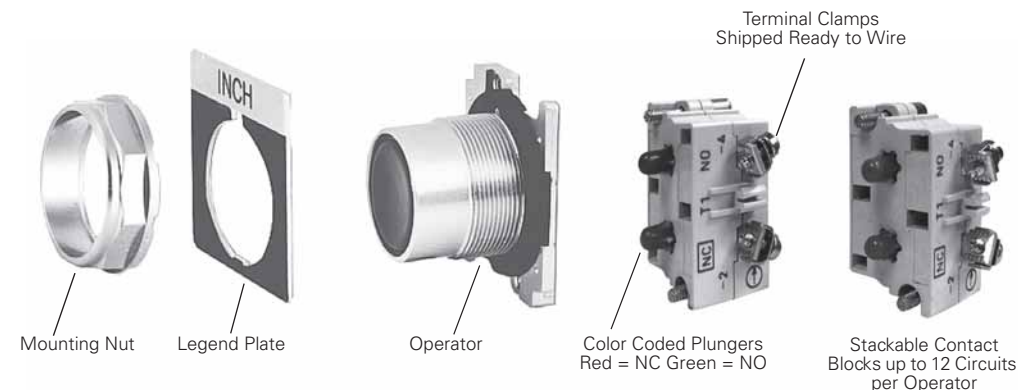
Eaton's pushbutton operators offer front of panel drainage via holes in the operator bushing. Hidden from view by the mounting nut, these holes prevent buildup of liquid inside the operator, which can prevent operation in freezing environments. The holes also provide a route for escaping liquid in high pressure washdowns, effectively relieving pressure from the internal diaphragm seal, ensuring reliable sealing in applications even beyond NEMA 4.

#### Diaphragm Seal



### Product Identification

#### 30.5 mm Heavy-Duty Watertight/Oiltight—10250T Series



**Non-Illuminated Momentary Pushbutton Units**

UL (NEMA) Type 3, 3R, 4, 4X, 12, 13

**Flush Button****Extended Button****Mushroom Button****Jumbo Mushroom****Pushbutton Units—Flush, Extended, Mushroom Head or Jumbo Mushroom Head Operators**

Contact Type	Button Color	Flush Button Catalog Number	Extended Button Catalog Number	Mushroom Button Catalog Number	Jumbo Mushroom Catalog Number <sup>①</sup>
1NO	Black	10250T23B	10250T25B	10250T26B	10250T27B
	Red	10250T23R	10250T112-53	10250T122-53	10250T172-53
	Green	10250T23G	10250T25G	10250T26G	10250T27G
	Yellow	10250T23Y	10250T25Y	10250T26Y	10250T27Y
	Red—Engraved EMERG. STOP	—	—	—	10250T17213-53
1NC	Black	10250T101-51	10250T111-51	10250T121-51	10250T171-51
	Red	10250T102-51	10250T25R	10250T26R	10250T27R
	Green	10250T103-51	10250T113-51	10250T123-51	10250T173-51
	Yellow	10250T104-51	10250T120-51	10250T124-51	10250T174-51
	Red—Engraved EMERG. STOP	—	—	—	10250T29
1NO-1NC	Black	10250T30B	10250T31B	10250T32B	10250T33B
	Red	10250T30R	10250T31R	10250T32R	10250T33R
	Green	10250T30G	10250T31G	10250T32G	10250T33G
	Yellow	10250T30Y	10250T31Y	10250T32Y	10250T33Y
	Red—Engraved EMERG. STOP	—	—	—	10250T33
2NO	Black	10250T101-2	10250T111-2	10250T121-2	10250T171-2
	Red	10250T102-2	10250T112-2	10250T122-2	10250T172-2
	Green	10250T103-2	10250T113-2	10250T123-2	10250T173-2
	Yellow	10250T104-2	10250T120-2	10250T124-2	10250T174-2
	Red—Engraved EMERG. STOP	—	—	—	10250T17213-2
2NC	Black	10250T101-3	10250T111-3	10250T121-3	10250T171-3
	Red	10250T102-3	10250T112-3	10250T122-3	10250T172-3
	Green	10250T103-3	10250T113-3	10250T123-3	10250T173-3
	Yellow	10250T104-3	10250T120-3	10250T124-3	10250T174-3
	Red—Engraved EMERG. STOP	—	—	—	10250T17213-3







**Note**

① Anodized aluminum head is not suitable for use in ultraviolet light applications.

### Pushbuttons

UL (NEMA) Type 3, 3R, 4, 4X, 12, 13

#### Momentary Pushbutton Operators, Non-illuminated

Part Number	Button	Color	Catalog Number			
			Vertical	Horizontal		
<b>10250T10_</b> 	Flush button ①	Black	<b>10250T101</b>			
		Red	<b>10250T102</b>			
		Green	<b>10250T103</b>			
		Yellow	<b>10250T104</b>			
		Gray	<b>10250T105</b>			
		White	<b>10250T106</b>			
		Blue	<b>10250T108</b>			
		Orange	<b>10250T109</b>			
		<b>10250T11_</b> 	Extended button	Black	<b>10250T111</b>	
Red	<b>10250T112</b>					
Green	<b>10250T113</b>					
Yellow	<b>10250T120</b>					
White	<b>10250T116</b>					
Blue	<b>10250T118</b>					
Orange	<b>10250T119</b>					
<b>10250T5_</b> 	Half shrouded button			Black	<b>10250T501</b>	<b>10250T511</b>
				Red	<b>10250T502</b>	<b>10250T512</b>
		Green	<b>10250T503</b>	<b>10250T513</b>		
		Yellow	<b>10250T504</b>	<b>10250T514</b>		
		Gray	<b>10250T505</b>	<b>10250T515</b>		
		White	<b>10250T506</b>	<b>10250T516</b>		
		Blue	<b>10250T508</b>	<b>10250T518</b>		
		Orange	<b>10250T509</b>	<b>10250T519</b>		
		<b>10250T12_</b> 	Mushroom button	Black	<b>10250T121</b>	
Red	<b>10250T122</b>					
Green	<b>10250T123</b>					
Yellow	<b>10250T124</b>					
Blue	<b>10250T129</b>					
<b>10250T17_</b> 	Jumbo mushroom button ②	Black	<b>10250T171</b>			
		Red	<b>10250T172</b>			
		Red (EMERG. STOP)	<b>10250T17213</b>			
		Green	<b>10250T173</b>			
		Yellow	<b>10250T174</b>			
<b>10250ED1164_</b> 	Low operating force— jumbo mushroom ②③	Black	<b>10250ED1164-2</b>			
		Red	<b>10250ED1164-3</b>			
		Green	<b>10250ED1164-4</b>			
		Yellow	<b>10250ED1164-5</b>			
		Clear	<b>10250ED1164</b>			

**Note:** To order complete assembled unit using one composite catalog number, add contact block and legend plate suffix to the end of operator catalog number. Example: 10250T101-1TS33



**Operator**  
**10250T101**

+



**Contact Block**  
**10250T1**

+



**Legend Plate**  
**10250TS33**

#### Notes

- ① To order operator with factory assembled extended retaining nut, **10250TA12**, for thick panel applications, add suffix letter **E** to listed catalog number. Example: 10250T101**E**.
- ② Anodized aluminum head is not suitable for use in ultraviolet light applications.
- ③ Operating force—Standard = 2.4 lb; low force = 1.6 lb.

### Selector Switch Units

UL (NEMA) Type 3, 3R, 4, 4X, 12, 13

- Two-, three- and four-position maintained
- Non-illuminated and illuminated

#### Two-Position Maintained Switch



#### Two-Position Selector Switch

Operator Position <sup>①</sup>		Operator Action <sup>②</sup>	Contact Type	Mounting Location		Non-Illuminated		Illuminated—120V Transformer	
				A	B	Black Knob Catalog Number <sup>③</sup>	Black Lever Catalog Number <sup>③</sup>	Red Knob Catalog Number <sup>③</sup>	Red Lever Catalog Number <sup>③</sup>
X	0		1NC			<u>10250T20KB</u>	<u>10250T20LB</u>	<u>10250ED1117-KR</u>	<u>10250ED1117-LR</u>
0	X		1NO						

#### Three-Position Maintained Switch



#### Three-Position Selector Switch

Operator Position <sup>①</sup>			Operator Action <sup>②</sup>	Contact Type	Mounting Location		Non-Illuminated		Illuminated—120V Transformer	
					A	B	Black Knob Catalog Number <sup>③</sup>	Black Lever Catalog Number <sup>③</sup>	Red Knob Catalog Number <sup>③</sup>	Red Lever Catalog Number <sup>③</sup>
X	0	0		1NO		<u>10250T21KB</u>	<u>10250T21LB</u>	<u>10250ED1117-2KR</u>	<u>10250ED1117-2LR</u>	
0	0	X		1NO						

#### Three-Position Maintained Switch



X	0	0		1NO		<u>10250T22KB</u>	<u>10250T22LB</u>	<u>10250ED1117-3KR</u>	<u>10250ED1117-3LR</u>
0	X	0		2NC (Series)					
0	0	X		1NO					

#### Three-Position Maintained Switch



#### Four-Position Selector Switch

Operator Position <sup>①</sup>				Operator Action <sup>②</sup>	Contact Type	Mounting Location		Non-Illuminated		Illuminated—120V Transformer	
						A	B	Black Knob Catalog Number <sup>③</sup>	Black Lever Catalog Number <sup>③</sup>	Red Knob Catalog Number <sup>③</sup>	Red Lever Catalog Number <sup>③</sup>
X	0	0	0		1NC		<u>10250T46KB</u>	<u>10250T46LB</u>	<u>10250ED1117-4KR</u>	<u>10250ED1117-4LR</u>	
0	X	0	0		1NO						
0	0	X	0		1NO						
0	0	0	X		1NC						

#### Color Selection

Illuminated						Non-Illuminated					
Color	Code Letter	Color	Code Letter	Color	Code Letter	Color	Code Letter	Color	Code Letter	Color	Code Letter
Red	<b>R</b>	White	<b>W</b>	Amber	<b>A</b>	Black	<b>B</b>	Green	<b>G</b>	Blue	<b>L</b>
Green	<b>G</b>	Blue	<b>B</b>	Clear	<b>C</b>	Red	<b>R</b>	White	<b>W</b>	Orange	<b>O</b>

#### Notes

① X = closed circuit, 0 = open circuit.

② M = Maintained.

③ To order different type or color selector switch, substitute the underlined character with appropriate suffix code from the Color Selection table. Example: 10250T20KG.

#### 1

### Selector Switch Selection



#### Cam and Contact Block Selection

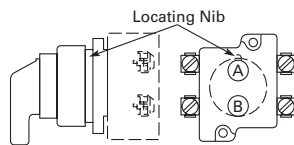
Selector switches in their varied forms (two-position, three-position and four-position) are a big factor contributing to the great flexibility of control that a well rounded line of “pushbuttons” can achieve. Because of their flexibility, they tend to cause difficulty with product selection and application. The following systematic approach should simplify that task.

Cam and contact block selection is better understood if you:

- Work with each incoming and outgoing wire/circuit separately.
- Recognize the terms NO and NC only identify the type of contact by its mode before mounting to the operator. The “X-O” table (Page V7-T1-240) shows how that contact will act after assembly to the operator with the selected cam shape. X = closed circuit, O = open circuit.

- Up to six NO or NC contacts may be mounted behind each plunger location for a total of twelve contacts. Single circuit contact blocks have only one plunger with the other side of the block “open.” Therefore, single circuit contact blocks transmit motion to blocks behind them only for the position containing the circuit.
- Each cam has two separate lobes, each of which operates one of the two contact block plungers independently of each other. Those are identified as position A (locating nib side) and position B (opposite of locating nib). The position designations give direction in selecting and mounting of the contact blocks.

#### Contact Circuit Locations

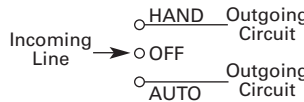


#### Systematic Approach

Application: **HAND-OFF-AUTO** selector switch. In this circuit, one incoming line is distributed to two other outgoing circuits by the switch. The two circuits can be looked at individually.

#### Step 1: Elementary Diagram.

Construct on paper, or in your mind, a simple elementary diagram of the switching scheme as follows:



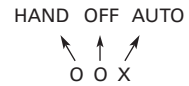
#### Step 2: “X-O” Pattern.

From the elementary diagram, you can construct an “X-O” diagram which describes when the contacts are to be closed (X) or open (O) in the various positions of the switch. The “X-O” for the **HAND** circuit looks like this:



In this circuit, you want a contact closed on the left (HAND) but open in the center and right.

For the **AUTO** circuit, the “X-O” diagram would look like this:



Putting them together, the complete “X-O” diagram is:



Once the “X-O” diagram has been generated the next step is to select the cam and contact block, or blocks, needed to perform the desired “X-O” functions. The selection tables on the following pages list the various types (shapes) of cams by number to choose from and the type of contact and position to achieve the function outlined in your “X-O” diagram.



### Step 3: Cam Selection.

The cam you select determines the operation of all contact blocks mounted to the operator. It is selected on the basis that it provides the simplest circuitry for the desired “X-O” diagram. The selection tables show all the “X-O” combinations. For the purpose of this example, the applicable portion of those tables is shown on this page.

Now to make the cam selection, make a simple worksheet such as:

	Cam 2	Cam 3
X O O	(A)NO-(B)NC	(A)NO
O O X	(B)NO	(B)NO

It becomes immediately obvious that cam 3 is the better choice for two reasons, (1) the series combination can be avoided making it simpler to wire, (2) only two contacts are required, which is less expensive than the three contacts required by cam 2.

### Step 4: Contact Block Selection.

Having selected the cam, contact block selection is simply a matter of gathering the A position and B position circuits into pairs which make up the most convenient contact block arrangement. If there is an imbalance in the number of circuits under A or B, then single circuit blocks must be selected for these leftover circuits.

Back to the worksheet, having selected cam 3 do this:



### Step 5: Selector Switch Operator.

Lastly, you have to choose from the many types of operators—knob and lever in various colors or keyed. Also what combinations of maintained and spring return functions are required. Selection of these operators can be found on **Page V7-T1-242**. For the example in step 4 you may want a three-position maintained black knob, cam 3—Catalog Number 10250T1323.

**The Complete Switch:** 10250T1323 with one 10250T2 or, for one composite catalog number, 10250T21KB found on **Page V7-T1-237**.

### Diagrams

Circuits shown illustrate connections to obtain a selector switch circuit combination and are shown with their appropriate line diagrams. Field wiring of jumper connections required as shown.

X = Closed circuit  
O = Open circuit

### Wiring of Jumper Connections



Four-position selector switches are limited to four contact blocks.

### Contact Blocks

For selection and number of available contact blocks per operator, see **Pages V7-T1-265 to V7-T1-268**.

### Example Selection Table

No.	“X-O” Pattern	Cam Code #2		Cam Code #3	
		Top A	Bottom B	Top A	Bottom B
1	X 0 0				—
4	0 0 X	—		—	

### Two-Position Selector Switch Contact Block Selection

No.	Desired Circuit and Operator Position		Contact Blocks Required to Accomplish Circuit Function	
			Top Plunger A	Bottom Plunger B
1	X	0	or	
2	0	X		or

**Note**  
① Wired in series.

#### 1 Three-Position Switch—Cam and Contact Block Selection

No.	Desired Circuit and Operator Position			Contact Blocks Required to Accomplish Circuit Function (Jumpers must be installed where indicated)		Operator with Cam Code #2		Operator with Cam Code #3	
				Top Plunger A	Bottom Plunger B	Top Plunger A	Bottom Plunger B	Top Plunger A	Bottom Plunger B
	X	0	0						
1	X	0	0						
2	X	X	0						
3	X	0	X						
4	0	0	X						
5	0	X	X						
6	0	X	0						



#### Four-Position Switch—Contact Block Selection

No.	Desired Circuit and Operator Position				Contact Blocks Required to Accomplish Circuit Function		No.	Desired Circuit and Operator Position				Contact Blocks Required to Accomplish Circuit Function	
					Top Plunger A	Bottom Plunger B						Top Plunger A	Bottom Plunger B
1	X	0	0	0			10	X	0	X	0		
2	0	X	0	0									
3	0	0	X	0			11	X	X	X	0		
4	0	0	0	X									
5	X	0	0	X			12	0	X	X	X		
6	0	X	X	0									
7	0	0	X	X			13	X	0	X	X		
8	X	X	0	0									
9	0	X	0	X			14	X	X	0	X		

#### Selector Switch Operators with Caps

UL (NEMA) Type 3, 3R, 4, 4X, 12, 13

#### Selector Switch Operators with Caps

	Positions	Operator Action <sup>②</sup>	Black Knob Selector Switch— Vertical Mounting <sup>③</sup>		Black Lever Selector Switch— Vertical Mounting <sup>③</sup>	
			Cam Code <sup>④</sup>	Catalog Number	Cam Code <sup>④</sup>	Catalog Number
<b>Two-Position Maintained</b> <sup>①</sup> 	Two-position—60° throw		1	10250T1311	1	10250T3011
			1	10250T1371	1	10250T3071
<b>Three-Position Maintained</b> <sup>⑤</sup> 	Three-position—60° throw		2	10250T1322	2	10250T3022
			3	10250T1323	3	10250T3023
			2	10250T1332	2	10250T3032
			3	10250T1333	3	10250T3033
			2	10250T1342	2	10250T3042
			3	10250T1343	3	10250T3043
			2	10250T1352	2	10250T3052
			3	10250T1353	3	10250T3053
		Four-position—40° throw		7	10250T1367	7

#### Notes

- ① Black knob selector switch, cam 1 shown.
- ② M = Maintained. S = Spring return in direction of arrow (R).
- ③ Field convertible to horizontal mounting or order operator only and separate operator cap.
- ④ For selection of the proper cam and contact block to obtain the proper circuit sequence, see selection instructions and tables on **Pages V7-T1-238, V7-T1-239 and V7-T1-240**.
- ⑤ Black lever selector switch, cam 3 shown.

### Selector Switch Operators without Caps

Operators can be ordered with caps assembled to them by adding the code number from the table on this page to the end of catalog number below.  
Example: 10250T4011**KB**

#### Two-Position Selector Switch Maintained



### Selector Switch Operators without Caps

Positions	Operator Action <sup>①</sup>	Cam Code <sup>②</sup>	Catalog Number
Two-position—60° throw		1	<b>10250T4011</b>
		1	<b>10250T4081</b>
Three-position—60° throw		2	<b>10250T4022</b>
		3	<b>10250T4023</b>
		2	<b>10250T4032</b>
		3	<b>10250T4033</b>
		2	<b>10250T4042</b>
		3	<b>10250T4043</b>
Four-position—40° throw		2	<b>10250T4052</b>
		3	<b>10250T4053</b>
		7	<b>10250T4067</b>

#### Knob



#### Lever



#### Lever for Use with Maintained Operators



#### Coin Slot



### Operating Caps

Color	Knob Catalog and Code Number	Lever Catalog and Code Number	Color	Lever <sup>③</sup> Catalog and Code Number	Coin Slot Catalog and Code Number
Black	<b>10250TKB</b>	<b>10250TLB</b>	Black	<b>10250TSB</b>	<b>10250TCB</b>
Red	<b>10250TKR</b>	<b>10250TLR</b>	Red	<b>10250TSR</b>	<b>10250TCR</b>
Green	<b>10250TKG</b>	<b>10250TLG</b>	Green	<b>10250TSG</b>	<b>10250TCG</b>
Yellow	<b>10250TKY</b>	<b>10250TLY</b>	Yellow	<b>10250TSY</b>	<b>10250TCY</b>
White	<b>10250TKW</b>	<b>10250TLW</b>	White	<b>10250TSW</b>	<b>10250TCW</b>
Gray	<b>10250TKA</b>	<b>10250TLA</b>	Gray	<b>10250TSA</b>	<b>10250TCA</b>
Blue	<b>10250TKL</b>	<b>10250TLL</b>	Blue	<b>10250TSL</b>	<b>10250TCL</b>
Orange	<b>10250TKD</b>	<b>10250TLO</b>	Orange	<b>10250TSO</b>	<b>10250TCO</b>

#### Notes

- ① M = Maintained. S = Spring return in direction of arrow (R).
- ② For selection of the proper cam and contact block to obtain the proper circuit sequence, see selection instructions and tables on **Pages V7-T1-238, V7-T1-239 and V7-T1-240**.
- ③ Designed for added ingress protection. For use in maintained operators only.

### Contact Blocks

#### Standard Contact Blocks

- UL A600/P600 rated
- Color-coded plungers—red/green for NC/NO circuits
- Silver contact tips with “reliability nibs”
- Gray (opaque) or amber (translucent) housings
- Pressure plate or spade terminals
- Fingerproof shrouds (for pressure terminals only)

#### Logic Level Contact Blocks

- UL A600/P600 rated
- Color-coded plungers
- Inert palladium knife-blade contacts
- Gray (opaque) housings
- Pressure plate or spade terminals

#### Special Function Contact Blocks

- UL A600/P600 rated
- Color-coded plungers
- Silver contact tips with “reliability nibs”
- Gray (opaque) housings
- Pressure plate terminals only

#### Special Purpose Contact Block

- Maximum 300V rated
- Black plungers
- Silver contact tips with “reliability nibs”
- Black (opaque) housings
- Pressure plate terminals only
- Fingerproof shrouds not available

#### Reliability Nibs

Reliability nibs are the hallmark of Eaton’s contact blocks. A pointed silver nib on the contact tip ensures reliable switching from logic level (5V) up to 600V applications. Therefore standard contact blocks can be used for most logic level applications where the contacts are not exposed to any harsh environmental conditions.

#### Palladium Contacts

Palladium, which is more inert than gold, is well suited for voltages and currents approaching zero and is recommended for applications where environmental conditions are a factor.

#### Maximum Contact Block Mounting per Operator Type

Operator	Max. Stack
Pushbuttons	6
Push-pull operators	2
Roto-push operators	4
Two- or three-position selector switches	6
Four-position selector switches	4
Joysticks	4

## 10250T1



## Contact Blocks

Symbol	Circuit	Description <sup>①</sup>	Standard	Spade Terminal <sup>②</sup> Catalog Number	Logic Level Pressure Terminal Catalog Number	Spade Terminal <sup>②</sup> Catalog Number
			Pressure Terminal Catalog Number			
	1NC	Stack up to six blocks (six circuits) unless otherwise noted.	<b>10250T51</b>	<b>10250T59</b>	<b>10250T51E</b>	<b>10250T59E</b>
	1NO	Stack up to six blocks (six circuits) unless otherwise noted.	<b>10250T53</b>	<b>10250T60</b>	<b>10250T53E</b>	<b>10250T60E</b>
	NO-NC	Stack up to six blocks (12 circuits) unless otherwise noted.	<b>10250T1</b>	<b>10250T40</b>	<b>10250T1E</b>	<b>10250T40E</b>
	2NC	Stack up to six blocks (12 circuits) unless otherwise noted.	<b>10250T3</b>	<b>10250T42</b>	<b>10250T3E</b>	<b>10250T42E</b>
	2NO	Stack up to six blocks (12 circuits) unless otherwise noted.	<b>10250T2</b>	<b>10250T41</b>	<b>10250T2E</b>	<b>10250T41E</b>
<b>Special Function Blocks <sup>③</sup></b>						
	LONC	Late opening NC. Stack up to six blocks (six circuits) unless otherwise noted.	<b>10250T71 <sup>③</sup></b>	—	<b>10250T71E <sup>③</sup></b>	—
	ECNO-NC	Early closing NO and standard NC. Stack up to six blocks unless otherwise noted.	<b>10250T47 <sup>③④</sup></b>	—	<b>10250T47E <sup>③</sup></b>	—
	ECNO-NO	Early closing NO and standard NO. Stack up to four blocks unless otherwise noted.	<b>10250T57 <sup>③④</sup></b>	—	<b>10250T57E <sup>③</sup></b>	—
	2LONC	Two late opening NC contacts. Stack up to six blocks unless otherwise noted.	<b>10250T45 <sup>③</sup></b>	—	<b>10250T45E <sup>③</sup></b>	—
	LONC-ECNO	Overlapping contacts. Stack up to four blocks unless otherwise noted.	<b>10250T55 <sup>③④</sup></b>	—	<b>10250T55E <sup>③</sup></b>	—
<b>Special Purpose Blocks <sup>⑤</sup></b>						
	2NO-2NC	Four circuits in single block depth. Rated 300V max. Stack up to four blocks unless otherwise noted.	<b>10250T44 <sup>⑤</sup></b>	—		

**Notes**

- <sup>①</sup> All 10250T contact blocks shown are suitable for use on standard 10250T and E34 operators. These contact blocks are not suitable for Class I Division 2 type 10250T or E34 devices.
- <sup>②</sup> Contact blocks with spade terminals are limited to a maximum of one contact block per operator and minimum spacing between devices is 2.5 in (63.5 mm). Not suitable for use in 10250T or E34 enclosures. Also available in amber housing. Not available with fingerproof shrouds.
- <sup>③</sup> Special function contact blocks are not suitable for use with roto-push operators, three-position push-pull operators, or four-position selector switches.
- <sup>④</sup> ECNO contact blocks are not suitable for use with two-position joysticks or when operators are used with padlock attachments.
- <sup>⑤</sup> Special purpose 10250T44 contact blocks are not suitable on selector switches or roto-push operators. Okay to use with three-position push-pull operators only on low voltage (30V or less) circuits. Fingerproof shrouds not available.

### Replacement Parts

#### Replacement Lamps—For 10250T Illuminated Operators

Mfg. Lamp Type	Voltage	Base Style	Application	Part Number
120MB	120V	T 3-1/4 bayonet	10250T resistor indicating light	28-3044
#267	6.3V	T 3-1/4 bayonet	10250T flasher	10250ED986-4
#755	6.3V	T 3-1/4 bayonet	10250T transformer, PresTest and full voltage	28-2202
#756	12V	T 3-1/4 bayonet	10250T full voltage	28-5184
#757	24V	T 3-1/4 bayonet	10250T full voltage	28-5185
#1828	32V	T 3-1/4 bayonet	10250T full voltage	28-5186
#1835	55V	T 3-1/4 bayonet	10250T resistor	28-5187
NE48	120V	T 4-1/2 bayonet	10250T neon	28-494
NE51H-R22	120V	T 3-1/4 bayonet	10250T neon	28-3754
NE51H-R68	240V	T 3-1/4 bayonet	10250T neon	28-3755

#### Standard LED Lamp



#### Replacement LED Lamps—For 10250T, E34 and E22 Units

Voltage	Color	Continuous AC/DC Catalog Number	Flashing AC Catalog Number	DC Catalog Number
6–12V	Red	E22LED612RN	E22LED006RAF	E22LED006RDF
	Orange	E22LED612ON	E22LED006OAF	E22LED006ODF
	Yellow	E22LED612YN	E22LED006YAF	E22LED006YDF
	Green	E22LED612GN	E22LED006GAF	E22LED006GDF
	Blue	E22LED612BN	E22LED006BAF	E22LED006BDF
	White	E22LED612WN	E22LED006WAF	E22LED006WDF
24V	Red	E22LED024RN	E22LED024RAF	E22LED024RDF
	Orange	E22LED024ON	E22LED024OAF	E22LED024ODF
	Yellow	E22LED024YN	E22LED024YAF	E22LED024YDF
	Green	E22LED024GN	E22LED024GAF	E22LED024GDF
	Blue	E22LED024BN	E22LED024BAF	E22LED024BDF
	White	E22LED024WN	E22LED024WAF	E22LED024WDF
48V	Red	E22LED048RN	E22LED048RAF	E22LED048RDF
	Orange	E22LED048ON	E22LED048OAF	E22LED048ODF
	Yellow	E22LED048YN	E22LED048YAF	E22LED048YDF
	Green	E22LED048GN	E22LED048GAF	E22LED048GDF
	Blue	E22LED048BN	E22LED048BAF	E22LED048BDF
	White	E22LED048WN	E22LED048WAF	E22LED048WDF
60V	Red	E22LED060RN	E22LED060RAF	E22LED060RDF
	Orange	E22LED060ON	E22LED060OAF	E22LED060ODF
	Yellow	E22LED060YN	E22LED060YAF	E22LED060YDF
	Green	E22LED060GN	E22LED060GAF	E22LED060GDF
	Blue	E22LED060BN	E22LED060BAF	E22LED060BDF
	White	E22LED060WN	E22LED060WAF	E22LED060WDF
120V	Red	E22LED120RN	E22LED120RAF	E22LED120RDF
	Orange	E22LED120ON	E22LED120OAF	E22LED120ODF
	Yellow	E22LED120YN	E22LED120YAF	E22LED120YDF
	Green	E22LED120GN	E22LED120GAF	E22LED120GDF
	Blue	E22LED120BN	E22LED120BAF	E22LED120BDF
	White	E22LED120WN	E22LED120WAF	E22LED120WDF



**Two-Position Joystick Operator**



**Flush Head Pushbutton Operator**



**Mushroom Head Pushbutton Operator**



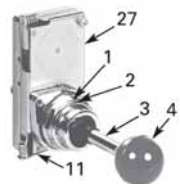
**Mushroom Head Operator with Padlock Attachment**



**Jumbo Mushroom Head Operator**



**Knob-Operated Selector Switch Operator**



**Four-Position Joystick Operator (without Latch)**



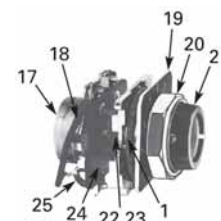
**Illuminated Pushbutton Operator**



**Full Voltage, Resistor and Transformer Type Illuminated Selector Switch**



**Transformer Type Indicating Light**



**Potentiometers**

#### 10250T Style Operator Replacement Parts

Item No.	Description	No. Req.	Part Number
1	Gasket	1	16-1548
2	Mounting nut	1	15-1530
3	Handle	1	24-5045
4	Knob	1	53-3157
	Knob (not shown) for joystick operator with latch	1	53-3159
5	Common gate (supplied with operator)	2	16-3400
6	Set screw (#6-32 x 0.250 in long hollow hex)	2	11-2014
7	Mushroom head button (includes [2] Item 6)	1	As Req. Below
	Black	—	53-1317
	Red	—	53-1317-2
	Yellow	—	53-1317-3
	Green	—	53-1317-4
	Blue	—	53-1317-22
8	Set screw (#10-32 x 0.250 in long hollow hex)	2	11-544
9	Jumbo mushroom head button (aluminum—includes [2] Item 8)	1	As Req. Below
	Red	—	53-1317-9
	Black	—	53-1317-10
	Yellow	—	53-1317-11
	Green	—	53-1317-12
10	Jumbo mushroom head button (aluminum—red EMERG. STOP) does not include Item 8	1	53-1349-18
11	Position gate:		
	Two-position	1	54-7278
	Three-position	1	54-7173
	Four-position	1	54-12278
	Eight-position	1	54-12279
12	Mounting screw (#6-32 x 0.710 in long)	2	10250TA79
	Washer	2	16-2038
13	Terminal screw and lug (captives)	Req.	80-5502KIT

Item No.	Description	No. Req.	Part Number
14	Gasket (supplied with basic unit)	1	32-803
15	Round head screw (#4-40 x 0.344 in long) (supplied with basic unit)	2	11-4553
16	Mounting screw	2	11-1632
17	Simple potentiometer (does not include items 18, 28 or 29)	1	As Req. Below
	1,000 ohms	—	41-782-2
	2,500 ohms	—	41-782-3
	5,000 ohms	—	41-782-10
	10,000 ohms	—	41-782-4
	25,000 ohms	—	41-782-5
	50,000 ohms	—	41-782-6
18	Connector (includes screw and lug)	2	25-1851
19	Indicating plate	1	As Req. Above
	Standard size (without legend)	—	30-4460
	Large size (specify legend)	—	10250TR30
20	Retaining nut	1	15-1547
21	Knob	1	53-1314
	Socket set screw (#6-32 x 0.250 in long)	2	11-2014
22	Coupling	1	29-3749-2
23	Set screw (#6-32 x 0.188 in long)	1	11-1199
24	Spacer	2	56-1066-18
25	Connector (includes screw and lug)	1	25-1851-2
26	Mounting nut	1	15-1938
27	Four-position joystick operating mechanism (complete)	1	24-6565
28	Four-position joystick operating mechanism (not shown) (with latch) complete	1	24-6565-2
29	Spring loaded latch	1	52-1214-2
30	Hand operated latch	1	52-913-3



## Technical Data and Specifications

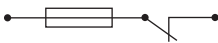
### Mechanical Ratings

Description	Specification
<b>Frequency of Operation</b>	
All pushbuttons	6000 operations/hr.
Key and lever selection switches	3000 operations/hr.
Auto-latch devices	1200 operations/hr.
<b>Life</b>	
Pushbuttons	10 x 10 <sup>6</sup> operations
Contact blocks	10 x 10 <sup>6</sup> operations
PresTest units	10 x 10 <sup>6</sup> operations
Lever and key selector switches	0.25 x 10 <sup>6</sup> operations
Twist to release pushbuttons	0.3 x 10 <sup>6</sup> operations
<b>Shock Resistance</b>	
Duration	20 ms ≥5g

### General Specifications

Description	Specification
<b>Climate Conditions</b>	
Operating temperature	1° to 150°F (–17° to 66°C)
Storage temperature	–40° to 176°F (–40° to 80°C)
Altitude	6,562 ft (2,000m)
Humidity	Max. 95% RH at 60°C
<b>Terminals</b>	
Marking	NC-NO on the contact block to meet the NEMA requirements. Dual marking system 1–2 for normally closed, 3–4 for normally open to meet BS5472 (Cenelec EN50 005).
Clamps	Terminals are saddle clamp type for 1 x 22 AWG (0.34 mm <sup>2</sup> ) to 2 x 14 AWG (2.5 mm <sup>2</sup> ) conductors
Torque	7 lb-in (0.8 Nm)
Degree of protection against direct electrical contact	IP2X with fingerproof shroud
<b>Light Units</b>	
Transformers	Will withstand short-circuit for 1 hour per IEC 60997-5-1
Bulbs—average life:	
Transformer type	20,000 hrs.
Resistor/direct voltage type	2500 hrs. minimum at rated voltage
LED	60,000 to 100,000 hrs.

#### Electrical Ratings

Description	Specification
Insulation	$U_i = 660 \text{ Vac or Vdc}$
Thermal	$I_{th} = 10\text{A}$
<b>Short Circuit Coordination to IEC/EN 60947-5-1</b>	
Rated conditional short circuit current	1 kA
Fuse type	GE power controls TIA 10, red spot type gG, 10A, 660 Vac, 460 Vdc, BS88-2, IEC 60269-2-1
	
UL rating	A600, P600
AC load life duty cycle 1200 operations/hour	
10A	110V pf 0.4— $1 \times 10^6$ operations
5A	250V pf 0.4— $1 \times 10^6$ operations
2A	600V pf 0.4— $1 \times 10^6$ operations
Switching capacity	
AC 15 rated make/break ( $11 \times I_a$ at $1.1 \times U_e$ )	
6A	120V pf 0.3
4A	240V pf 0.3
2A	660V pf 0.3
DC13 rated make/break ( $1.1 \times I_a$ at $1.1 \times U_e$ )	
1.0A	125V L/R $\geq 0.95$ at 300 ms
0.55A	250V L/R $\geq 0.95$ at 300 ms
0.1A	660V L/R $\geq 0.95$ at 300 ms
10A	110V pure resistive
Maximum ratings for logic level and hostile atmosphere application	
Maximum amperes	0.5A
Maximum volts	120 Vac/Vdc

#### Electrical Ratings—Contact Block

Description	50 Vac or 60 Hz				Vdc		
	120	240	480	600	24/28	125	250
<b>Meet or Exceed NEMA Rating Designations A600, A300 and B300 for AC and P600 for DC</b>							
Make and emerg. interrupting capacity (amp)	60	30	15	12	5.7	1.1	0.55
Normal load break (amp)	6	3	1.5	1.2	5.7	1.1	0.55
Thermal current (amp)	10	10	10	10	5.0	5.0	5.0
Voltamperes:							
Make and emerg. interrupting capacity	7200	7200	7200	7200	138	138	138
Normal load break	720	720	720	720	138	138	138

### Mounting Options

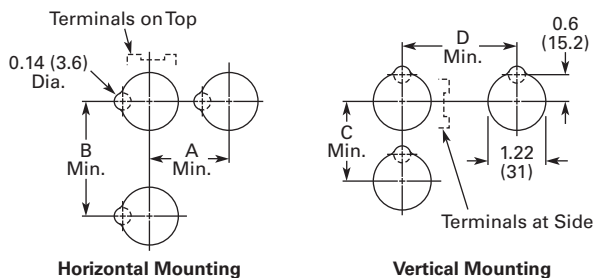
#### Panel Thickness

- Minimum: 0.06 in (1.6 mm)
- Maximum: 0.25 in (8 mm) including legend plate
- Maximum can be increased to 0.375 in (15.9 mm) using optional retaining nut
  - Indicating light: 10250TA30
  - Pushbutton/selector switch: 10250TA31

### Mounting Matrix

Legend Plate	Dimensions in Inches (mm)			
	A	B	C	D
Small	1.63 (41.3)	2.25 (57.2)	2.25 (57.2)	1.63 (41.3)
Medium	1.75 (44.5)	2.25 (57.2)	2.25 (57.2)	1.75 (44.5)
Large	2.25 (57.2)	2.25 (57.2)	2.25 (57.2)	2.25 (57.2)

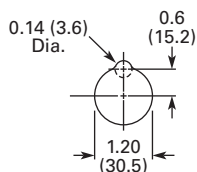
### Mounting Options in Inches (mm)



Horizontal mounting means terminals are located top and bottom of contact block. Vertical mounting means terminals are left and right of contact block. This allows close spacing of adjacent operators with easy access to terminals.

Locating nib hole or notch is 0.14 in (3.6 mm) #29 drill.

### Drilling Dimensions in Inches (mm)



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