

SECTION 40 95 13 – CONTROL PANELS

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. General: The CONTRACTOR shall provide control panels, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 40 90 00 – Process Control and Instrumentation Systems apply to this Section.
- C. The provisions of this Section apply to local panels provided in equipment systems specified in other sections, unless indicated otherwise in those sections.
- D. Control and SCADA panels shall be built to UL 508, or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction. The panels shall have UL labels attached to them by the panel builder. The panel builder shall provide with each panel a certification from the independent testing lab inspector that the panel is built to their standards.
- E. Panels equipped with Intrinsically Safe controls shall also bear UL 913 label in addition to the UL 508.
- F. SCADA enclosures and power panel enclosures shall be built to NEC standards for enclosures.

1.2 REFERENCE DOCUMENTS

- A. UL 508A – 2001 Standard for Industrial Control Panels`
- B. UL 913 -2000 Standard for Safety of Intrinsically Safe Apparatus and Associated Apparatus for use in Class I, II and III, Division 1 Hazardous Locations.
- C. NFPA 79 – Electrical Standard for Industrial Machinery
- D. NFPA 70 – Article 409

1.3 SUBMITTALS

- A. General: Submittals shall be furnished in accordance with MASS Section 10.05 Article 5.6.
- B. Control Panel Engineering Submittal: The CONTRACTOR shall submit a control panel engineering submittal (CPES) for each control panel and enclosure provided under Division 40. The CPES shall completely define and document the construction, finish, fuses, circuit breakers, internally-mounted hardware, communications

hardware, and PLC system components. All panel drawings shall, as a minimum, be "B" size with all data sheets and manufacturer specification sheets being "A" size. The submittal shall be in conformance with ISA-S20 – Standard Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves, shall be submitted as a singular complete bound volume or multi volume package within 60 calendar days after Notice to Proceed, and shall have the following contents:

1. A complete index shall appear in the front of each bound volume. All drawings and data sheets associated with a panel shall be grouped together with the panels being indexed by systems or process areas. All panel tagging and nameplate nomenclature shall be consistent with the requirements of the Contract Documents.
2. Scale construction drawings which define and quantify the type and gauge of steel to be used for panel fabrication, the ASTM grade to be used for structural shapes and straps, panel door locks and hinge mechanisms, type of bolts and bolt locations for section joining and anchoring, details and proposed locations for "UNISTRUT" members, stiffener materials and locations, electrical terminal box and outlet locations, electrical access locations, print pocket locations, writing board locations, and lifting lug material and locations.
3. Cutout locations with nameplate identifications shall be shown.
4. The Contract Drawing wiring diagrams shall be edited to identify electrical devices, terminals, and interconnecting wiring. These diagrams shall show interconnecting wiring by lines, designate terminal assignments, and show the physical location of all electrical and control devices.
5. Completed ISA S20 data sheets for all instrumentation devices associated with each control panel supplemented with manufacturer specification sheets which verify conformance to the requirements of the Contract Documents.
6. A bill of material which enumerates all devices associated with the control panel.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Environmental Suitability: All indoor and outdoor control panels and instrument enclosures shall be suitable for operation in the ambient conditions associated with the locations designated in the Contract Documents. Heating, cooling, and dehumidifying devices shall be provided as shown on the Drawings in order to maintain all instrumentation devices 20 percent within the minimums and maximums of their rated environmental operating ranges. The CONTRACTOR shall provide all power wiring for these devices. Enclosures suitable for the environment shall be provided. All instrumentation in hazardous areas shall be suitable for use in the particular hazardous or classified location in which it is to be installed.
- B. Panel construction shall conform to NFPA 70 (NEC) Article 409 and NFPA 79.
- C. The control panel controls shall be 24 VDC. Control conductors shall be provided in accordance with the indicated requirements.

- D. The control panel shall be the source of power for any 120 VAC solenoid valves interconnected with the control panel. All equipment associated with the control panel shall be ready for service after connection of conductors to equipment, controls, and control panel.
- E. Unless indicated otherwise, control panels shall be housed in NEMA-rated enclosures as shown on the Drawings. Control panels shall be either wall-mounted, pedestal-mounted or equipment skid-mounted, as indicated. Internal control components shall be mounted on an internal back-panel or side-panel as required.
 - 1. All interior control or relay panels mounted above ground level shall be NEMA 12.
 - 2. All control or relay panels mounted below ground level, unless noted otherwise on the Drawings, shall be NEMA 4X.
 - 3. All exterior control panels and enclosures mounted above ground level, unless noted otherwise on the Drawings, shall be NEMA 4 with rain shield across top of doors.
 - 4. All control panels mounted in enclosures meeting the above requirements shall be NEMA 1.
- F. Each source of 'external' voltage shall be isolated by providing disconnecting fused terminal blocks or DIN rail mounted relays. Each control panel shall be provided with identified terminal strips for the connection of all external conductors. The CONTRACTOR shall provide sufficient terminal blocks as shown on the Drawings.
- G. Motor starters, where required, shall be in accordance with Section 26 24 19 – Low Voltage Motor Control Centers. Each motor starter shall be provided with PLC interface circuits as indicated on the drawings. Electrical components shall be of standard American manufacture.
- H. Discrete outputs from the control panels shall be provided by electrically isolated contacts rated for 2 amps at 24 VDC or 5 amps at 120 VAC.
- I. All control panel mounted devices shall be provided as shown on the Drawings.
- J. Painting: Steel control panels shall be thoroughly cleaned and sand blasted per Steel Structures Painting Council Specification SSPC SP 6 (Commercial Blast) after which surfaces shall receive a prime coat of **Amercoat 185**, or equal, 3 mils DFT, for a total thickness of the prime plus finish system of 6 mils. The finished color of the outside surfaces shall be ANSI 61 gray paint. Interior of the control panel, back-panel, and side-panels shall have a white finish coat.

2.2 CONTROL PANELS

- A. NEMA 4X
 - 1. Enclosure shall be 16-gauge or 14-gauge thickness, unless otherwise indicated on the Drawings, Type 304 or 316L stainless steel.
 - 2. Enclosures shall have stainless steel hinges, hinge pins, and door clamps.

3. Finish shall be unpainted, smooth #4 brushed finish, as specified for steel control panels.
4. Enclosures and Panels shall be as manufactured by **Hoffman**, or equal.

B. NEMA 12

1. Steel panel section faces shall be No. 14 gauge minimum thickness, unless otherwise indicated on the Drawings. All materials shall be selected for levelness and smoothness.
2. Structural shapes and strap steel shall comply with ASTM A 283 – Low and Intermediate Tensile Strength Carbon Steel Plates, Grade C.
 - a. Bolting Material: Commercial quality carbon steel bolts, nuts, and washers shall be 1/2-inch diameter with UNC threads. Carriage bolts shall be used for attaching end plates. All other bolts shall be hex end machine bolts. Nuts shall be hot pressed hex, American Standard, heavy. Standard wrought washers shall be used for foundation bolts and attachments to building structures. All other bolted joints shall have SAE standard lock washers.
3. Construction: Dimensions shall be as shown on the Drawings.
4. Enclosures and Panels shall be as manufactured by **Hoffman**, or equal.

C. Weatherproof NEMA 3R Enclosures: Large, weatherproof enclosures, 4 feet high or higher, shall be built to NEMA 4 standards and shall be rated for outdoor use in wet environments. The enclosures shall be built of 12ga steel to the size shown on the Drawings, and have the following features:

1. Fully gasketed single or double door access as shown on the Drawings, with removable post.
2. Seams continuously welded.
3. Lifting eyes.
4. 3-point latching pad lockable handle on each door.
5. Rollers for the latching rods for 3-point latch.
6. Back panels (full size).
7. Insulation.
8. Open bottom with 2" flange for pad mounting.
9. Provision for mounting fluorescent lights.
10. Enclosures shall be Hoffman, or equal.

D. Fabrication

1. End plates, top plates, and top closure panels (to hung ceiling) shall be provided when required by the material requisition. End plates, top plates, and top closure panels shall be removable with countersunk bolts to match panels. Top closure panels shall be furnished in lengths that match the widths of standard panels, except that one top closure panel may extend across two 4 feet 6 inches wide or five 2 feet wide standard panels. The vertical joints of these panels shall align with the vertical joints of the standard panels.
2. Doors shall be flush-fitting, gasketed, and be of the hinged type with door handles. Screwdriver 1/4 turn or Dzus type fasteners are not acceptable.

- a. The flanged edges of all panels shall be straight and smooth. Corners shall be welded and ground smooth.
- b. The face of the panel shall be true and level after flanging.
- c. All panel cut outs and holes may be cut or drilled by any standard method that does not cause deformation. Burrs shall be ground smooth.
- d. Adjacent panels shall assemble with faces flush. Gaps or cracks shall not be visible from the front of the assembled instrument board.
- e. Stiffeners shall be welded to the back of panels, as required to prevent panel deformation due to the weight of face-mounted instruments.
- f. Panels shall be self-supporting as defined below.

E. Framework and Supports

1. The rear of each panel section shall have a steel framework assembled to it for supporting conduit, wireways, switches, piping, and all instrument accessory items such as relay or terminal enclosures, transducers, pressure switches, valves, and air relays. The main framework shall be constructed of standard structural shapes. Special shapes such as "Unistrut" may be used for secondary supports. Framework must neither interfere with instrument connections nor interfere with access needed for maintenance or adjustments.
2. Steel framework shall extend 2 feet 4 inches back from the panel face, or as indicated in the material requisition. Where indicated, individual adjustable leg supports shall be provided at the back of the framework so that the entire panel is self-supporting.

F. Preparation of Panel Surface

1. The following requirements apply to the front and rear face of the panel, both sides and the edges of all flanges, and the periphery of all holes or cut outs.
 - a. All high spots, burrs, and rough spots shall be ground smooth.
 - b. The surfaces shall be sanded or sandblasted to a smooth, clean, bright finish.
 - c. All traces of oil shall be removed with a solvent.
 - d. The first coat of primer shall be applied immediately.

- G. Instrument Finishing: The final coats applied to painted surface of instrument cases, doors, or bezels that are visible from the front of panels shall be manufacturer's standard, unless otherwise indicated. Black japan or "crinkle" finishes on instrument cases are not acceptable.

H. Mounting of Instruments

1. The panel vendor shall provide cut outs, and shall mount all instrument items indicated to be panel-mounted, including any instruments indicated to be furnished by other vendors but installed in the panel.
2. The panel vendor shall also mount behind the panels other instrument accessory items as required for functionality or as indicated.
3. Equipment mounted at the rear of panel shall be installed to allow for commissioning adjustments, servicing requirements, and cover removal.
4. Spare space shall be kept clear of wiring, etc., to give maximum space for future additions.

I. Electrical Requirements

1. The CONTRACTOR shall provide conduit, wireways, switches, wire, and electrical fittings for all 24 VDC and 120 VAC circuits to instruments and other electrical devices as required for a complete and operable installation.
2. Conduit, wireways, junction boxes and fittings shall include those required between sensors and transmitters and between the junction boxes and instruments.
3. Each terminal connection shall have a plastic plate with a terminal and instrument tag number. Wiring shall be identified with stamped tubular wire end markers. Terminals shall be DIN rail mounted, rated at 400 VAC, manufactured by **Entrelec**, or equal.
4. Each panel shall be provided with a switched 60 watt incandescent T-10 style light fixture, as shown on the Drawings. The fixture shall include a 120-volt receptacle and door switch. The fixture shall be **Hoffman model A-LTDB1**, or equal.
5. Each panel shall be provided with a switched light fixture, as shown on the Drawings. The fixture shall include a 120-volt receptacle and door switch.
6. Wiring Methods: Wiring methods and materials for all panels shall be in accordance with the N.E.C. requirements for General Purpose (no open wiring) unless otherwise indicated.
7. Signal and Control Circuit Wiring
 - a. Wire type and sizes: Conductor shall be flexible stranded copper wire, UL. Wires for instrument signal circuits and alarm input circuits shall be No. 16 AWG Type MTW rated for 300 volts. The analog cables between the PLC I/O card and terminal strips shall be (8) conductor No. 18 AWG cable rated 300 volts for loop powered devices and 8-pair shielded No. 18 AWG cable rated 300 volts for 4-wire loops. DeviceNet cable shall be as per Allen-Bradley requirements, and terminated per Allen-Bradley requirements.
 - b. Wire Insulation Colors:
 - 1) 120 VAC Power - Black 14 AWG minimum
 - 2) 120 VAC Neutral - White 14 AWG minimum
 - 3) 120 VAC Ground - Green 14 AWG minimum
 - 4) 120 VAC Control - Red 14 AWG minimum
 - 5) 120 VAC Foreign Power - Yellow 16 AWG minimum
 - 6) 120 VAC Foreign Neutral - Yellow 16 AWG minimum
 - 7) DC Positive - Blue 16 AWG minimum
 - 8) DC Negative - White/Blue 16 AWG minimumAll 120 VAC power wiring protected by the main circuit breaker and incoming power service shall be No. 12 AWG.
 - c. Wire Marking: Wire numbers shall be marked using white numbered wire markers made from heat shrink plastic. Wires shall be marked as shown on the Drawings. Numbers shall read from left to right.
 - d. Flexible conduit is only to be used where specified.
 - e. Conduit fittings shall be **Crouse Hinds cast fittings**, or equal.
 - f. For equipment grounding, panels shall be provided with a 1/4 inch by 1 inch copper ground bus complete with solder-less connector for one No. 4 AWG bare stranded copper cable. The copper cable shall be provided by the

CONTRACTOR and be connected to the electrical equipment ground of the 120-volt panel supplying power.

8. Power Supply Wiring
 - a. Unless otherwise indicated, all instruments, alarm systems, and motor controls shall operate on 24 VDC circuits.
 - b. The panel fabricator shall provide terminal box connections for the main power supply entry as shown on the Drawings.
 - c. When instruments do not come equipped with integral fuses, provide fuses as required for the protection of individual instruments against fault currents. Fuses shall be mounted on the back of the panel in a fuse holder, and each fuse shall be identified by a service name tag. Fuses shall be as manufactured by **Bussmann Manufacturing Division, Type KAW TRON**, or equal. Circuit breakers shall be provided as shown on the Drawings.

J. Relays:

1. DIN rail mounted relays shall have contacts rated at 8 amps, 230 volts, at 20,000 operations. The coils shall be 24 VDC at 0.03 amps. Relays shall be **Entrelec model RB121A**, or equal, for single pole, and **RB122** for 5-amp double pole.
2. Battery system test relays shall have contacts rated at 15 amps, 120 VAC, at 150,000 operations. The coils shall be 24 VDC at 0.8 watts. Relays shall be **Siemens 3TX7110-5JC03** with **3TX7144-1E7** socket.
3. Intrinsic Safety Relay: The intrinsic safety relay shall provide isolation of 2-wire 24 VDC circuits in a hazardous location. The safety relays for 4-20 ma analog circuits shall be capable of driving up to a 500-ohm load and pass HART protocol signals to the field devices. The relays shall be **Turk model MK33**, or equal.

- K. Terminals: Fused Terminals for analog input and output points shall be a 3-wire terminal with a fused circuit, a feed through circuit and a ground terminal. Fused Terminals for the discrete input points shall be 2-wire terminal with a fused circuit and a feed through circuit. Provide a one-tenth of an ampere rapid blow 250-volt fuse for all analog circuits and all discrete input circuits. The analog terminals shall be **Weidmuller model KDKS 1 part 953245**, and the discrete input terminal shall be **Weidmuller model KDKS 1 PE part 953245**.

L. Spare Fuses: For each panel, provide the following spare fuses:

1. A minimum of two spare fuses of each size
2. One spare fuse for every ten fused circuits

Provide the fuses in a spare fuse box mounted on the interior wall of the panel. Fuse box shall be **Plano Tackle Systems 1061 Accessory Box, Plano, IL**, www.planomolding.com, or equal.

- M. Power Supply 24 VDC: Each panel shall be supplied from a battery-backed 24 VDC power supply. Each power supply module shall include a DC-OK relay contact that shall be wired to a discrete input card. The power supply shall meet the requirements of Section 26 33 05.

- N. The DC power supply shall be a **SENS model Q 024-025-T-L-511-C**, or equal. The batteries shall be 24 V sealed lead acid rated at 103Ah at the 10 hour rate. Batteries are to be (2) units of the **Powersonic Battery model PS-121100**, or equal.
- O. DC-DC Converters: Where 0-5 VDC is required a DC to DC converter shall be provided. The converter is to be provided with an overload protection function that protects the load and the power supply from possible damage by over current. When the output current rises above 105% of the rated output current, the protection function is to be triggered decreasing the output voltage. When the output current falls within the rated range, the overload protection function is to be automatically cleared. The DC-DC converter shall be **Omron model S82S-7305**, or equal.
- P. 120 VAC Surge Arrestor: A 120 VAC three-stage surge protector shall be provided on the main leads of each panel. The surge protector shall include a first stage inline inductor, a second stage MOV to ground with a thermal fuse, and a third stage array of MOVs to provide a small amount of capacitance. The unit shall be DIN rail-mounted. The MOV shall include green LED to indicate the status of the second stage MOV. Provide two (2) spare units for each panel. The unit shall be rated for 120 VAC and shall be either **Advance Surge Supressor model TSP-WG6-120VAC-10A-01**, **Control Concepts 'Islatrol Elite' model IE-110**, or equal.
- Q. Intrinsic Safety Relay: The intrinsic safety relay shall provide isolation of 2-wire 24 VDC circuits in a hazardous location. The safety relays for 4-20 ma analog circuits shall be capable of driving up to a 500-ohm load and pass HART protocol signals to the field devices. The relays shall be Turk model MK33, or equal.
- R. Miscellaneous Parts:
1. Each panel shall be provided with a large steel folding shelf, 12 inches deep by 18 inches wide, **Hoffman model A-ASHLF1218**, or equal, installed on the panel door as shown on the Drawings..
 2. Each panel shall be provided with a data pocket holder 1 inch deep by 12 inches wide by 12 inches high, **Hoffman model A-DP2**, or equal, installed on the panel door as shown on the Drawings.
 3. Cabinet heater shall be a forced air ventilation enclosed heater with 450-watt wire wound heating element, 120 VAC power cord and cap, creep action thermostat set for 40 degrees F on and 60 degrees F off, enclosed in a metal housing. The unit shall be a UL-listed device suitable for installation in non-UL-listed enclosures. The unit shall be Hi Heat Industries Inc. Model E040100A8, or equal.
 4. Incandescent lighting package with integral door switch and convenience receptacle. Provide mounting spacers as required.
- S. Labor and Workmanship: Panels shall be fabricated, piped, and wired by fully qualified workmen who are properly trained, experienced, and supervised.

2.3 MARKING

- A. Control panels shall be marked with the following information that is plainly visible after installation:

[CONSULTANT]-[DATE]
[PROJECT]

CONTROL PANELS
PAGE 40 95 13-8

1. Manufacturer's name
2. Supply voltage
3. Short-circuit rating of the main breaker
4. Name of the project and site
5. Enclosure rating

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Preparation for Shipment and Shipping
 1. Panels shall be crated for shipment using a heavy framework and skids. Panel sections shall be cushioned to protect the finish of the instruments and panel during shipment. Instruments that are shipped with the panel shall further have suitable shipping stops and cushioning material installed to protect parts that could be damaged due to mechanical shock. Each separate panel unit shall be provided with removable lifting lugs to facilitate handling.
 2. All control panel factory testing and inspection shall be performed prior to shipping.
 3. Control panels shall be installed in accordance with Section 40 90 00 – Process Control and Instrumentation Systems.

3.2 PENETRATIONS

- A. All penetrations in underground vaults or NEMA 4X areas shall be bottom entry.

3.3 CONTROL PANEL SIGNAL AND CONTROL CIRCUIT WIRING

- A. Wiring Installation: All wires shall be run in plastic wireways except (1) field wiring, (2) wiring between mating blocks in adjacent sections, (3) wiring from components on a swing out panel to components on a part of the fixed structure, and (4) wiring to panel mounted components. Wiring run from components on a swing out panel to other components on a fixed panel shall be made up in tied bundles. These bundles shall be tied with nylon wire ties and shall be secured to panels at both sides of the "hinge loop" so that conductors are not strained at the terminals.
- B. Wiring run to control devices on the front panels shall be tied together at short intervals with nylon wire ties and be secured to the inside face of the panel using adhesive mounts.
- C. Enclosures Wiring: All wiring shall be run in liquidtight flexible conduit (LFMC), unless otherwise noted on the Drawings. All enclosure wiring and raceways shall be installed by the panel builder in the shop.
- D. Wiring to rear terminals on panel mount instruments shall be in plastic wireways secured to horizontal brackets above or below the instruments in about the same plane as the rear of the instruments.

- E. Shop Drawings shall show conformance to the above wiring installation requirements.
- F. Wire Marking: Each signal, control, alarm, and indicating circuit conductor connected to a given electrical point shall be designated by a single unique number as shown on the Contract Drawings. These numbers shall be marked on all conductors at every terminal.

3.4 CALIBRATION, TESTING, AND INSTRUCTION

- A. General: Calibration, testing, and instruction shall be performed in accordance with Section 40 90 00 – Process Control and Instrumentation Systems.
- B. Inspection and Approval
 - 1. Panel fabricator shall conduct the following tests prior to arrival of the ENGINEER or before shipment, if the ENGINEER chooses not to witness factory testing.
 - a. All status, control, analog and alarm circuits rung out to determine their operability.
 - b. All electrical power circuits checked for continuity and where applicable, operability.
 - c. Any other test required to place the panel in an operating condition.
 - 2. It shall be the responsibility of the CONTRACTOR to furnish all necessary testing devices and sufficient manpower to perform the tests required by the ENGINEER.
 - 3. Field Testing: Each control panel shall be tested again for functional operation in the field after the connection of external conductors and prior to equipment startup.

END OF SECTION 40 95 13