CITY OF FORT WAYNE MASTER UPDATED: 3/20/17

SECTION 40 67 03

CoNTROL System EQUIPMENT PANEL CONSTRUCTION

1. ‑ GENERAL
	1. DESCRIPTION
		1. Scope:
			1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, start-up and place into satisfactory operation all process control panels and enclosures.
		2. Related Sections:

NTS: List below only sections covering products, construction and equipment that a user might expect to find in this section, but are specified elsewhere. Do not list administrative and procedural division 01 sections.

* + - 1. Section 03 30 00, Cast-In-Place Concrete.
			2. Section 05 05 33, Anchorage Systems.
			3. Section 26 05 53, Identification For Electrical Systems

NTS: List below sections covering appurtenances that are included in Control Panel that a user might expect to find in this section, but are specified elsewhere. Common Control Panel equipment include: Transient Voltage Surge Suppression (TVSS), Uninterruptable Power Supply (UPS), Panel Intrusion Switch, etc. Skid package equipment, Variable Frequency Drives

* + - 1. Section 40 61 13, Process Control System General Provisions.
			2. Section 40 61 16, Process Control Narrative
			3. Section 40 67 06, Miscellaneous Control Panel Devices
			4. Section 40 67 11, Miscellaneous Control Field Devices
			5. Section 40 67 70, Instrumentation Process Systems
	1. QUALITY ASSURANCE
		1. Standards, Codes and Regulations:
			1. Construction of panels and the installation and interconnection of all equipment and devices mounted within shall comply with applicable provisions of the following standards, codes and regulations:
				1. National Fire Protection Association 79, Annex “D” Standards, (NFPA).
				2. National Electrical Code, (NEC).
				3. National Electrical Manufacturer's Association Standards, (NEMA).
				4. American Society for Testing and Materials, (ASTM).
				5. Operational Safety and Health Administration Regulations, (OSHA).
				6. Underwriters’ Laboratory, Inc., (UL).
				7. State and Local code requirements.
				8. Where any conflict arises between codes or standards, the more stringent requirement shall apply.
			2. All materials and equipment shall be new and all panels shall be built in an Underwriters’ Laboratory, Inc. (UL) approved panel shop and bear the UL label.
		2. General Design Requirements:

NTS: 40 61 13 Process Control System General Provisions has a summary of control devices to be incorporated in the Control System.

* + - 1. Comply with the requirements of Section 40 61 13, Process Control System General Provisions.
			2. Comply with the control descriptions of Section 40 61 16, Process Control Narrative.
			3. Control Panel Design
				1. Provide individual layout drawings and schematics for each panel, console, and cabinet. All drawings and schematics shall be specific to Project and installed panel, console, and cabinet; typical drawings are not acceptable.
				2. Each device shall be detailed individually. Typical drawings are not acceptable.
				3. Drawing set shall reference P&ID tag number and functional name of components for each panel, console, or cabinet, as applicable.
				4. Devices to be labeled using the reference designator based on the line number within the drawing set when a P&ID tag number is not defined.
				5. Instrument details (scaling) shall only be shown on the PLC module drawing.
				6. DC distribution shall be on a separate drawing page independent of AC distribution. 24VDC power supplies shall be shown on the DC distribution page.
				7. Devices mounted on back panel shall be in incremental order left to right or top to bottom grouped with like devices.
				8. PLC I/O Module Connection Drawings. Limit one PLC module per 11x17 sheet.
				9. Communications Connections Drawings –

Provide individual communication connection drawing sheet for each network type.

Drawings shall show connections for PLC processors, Ethernet, ControlNet, DeviceNet, and Modbus network modules, remote I/O extension modules, and Operator Interface Terminal (OIT) units. Include any termination resistors and cabling necessary for complete systems.

* + 1. Factory Assembly and Testing:
			1. Comply with the requirements of Section 40 61 13, Process Control System General Provisions.
	1. SUBMITTALS

NTS: Detail the submittals by control panel name. Each control panel will require an independent submittal within the owners project management information system.

* + 1. Provide the following in a single submittal for each control panel
			1. Electrical, instrumentation, and control drawings complete with control panel bill of materials. Included are the point-to-point wiring for field devices interfacing with systems control. Hard-wired field devices shall be included.
				1. Where a PLC is included with a remote rack in a separate enclosure, detail the enclosure name and reference on the communications connection drawing and submit independent control panel drawing sets.
			2. All component product data as specified in 40 61 13 Process Control System General Provisions.
	1. PRODUCT DELIVERY, STORAGE AND HANDLING
		1. Comply with the requirements of Section 40 61 13, Process Control System General Provisions.
	2. MAINTENANCE
		1. Extra Materials:
			1. Provide minimum of 5 or 10%, whichever greater, of each type fuse used on project.
			2. Provide minimum of 5 or 10%, whichever greater, of each type of indicating light for pilot lights used on project.
			3. Provide minimum of 20% spare terminals for AC distribution, to be shown as such on panel drawings.
			4. Provide minimum of 20% spare terminals for DC distribution, to be shown as such on panel drawings.
1. ‑ PRODUCTS
	1. ENCLOSURE MANUFACTURERS
		* 1. Hoffman
			2. Rittal
			3. Saginaw
	2. GENERAL CONSTRUCTION REQUIREMENTS
		1. Panels and enclosures shall meet the NEMA requirements for the type specified.
		2. Sizes shown are estimates. CONTRACTOR shall furnish panels and enclosures amply sized to house all equipment, instruments, front panel mounted devices, power supplies, power distribution panels, wiring, tubing and other components installed within, as required. Size panel for 35% spare capacity. Spare capacity calculated when useable space is greater than 6”.
		3. Panels shall be constructed using factory-fabricated enclosures.
		4. Follow all PLC manufacturer’s written installation requirements for layout of PLC-specific panels with regard to power, electrical grounding, and equipment/chassis grounding including manufacturer specified panel modifications, clearance for maintenance access and heat dissipation, and the like.
		5. Install instruments and devices, plumb, and wire panels at panel shop or other facility prior to shipment to job-site.
		6. Devices shall be mounted to the manufacturer’s panel. The bottom of the enclosure shall be free of all devices, including terminal strips, to provide ease of installation and testing as well as made available for conduit entry and wire routing.
		7. UPS’s shall be either mounted to the top or the bottom of the enclosure back panel.
		8. UPS shall be automatically bypassed upon loss of UPS output.
		9. Exterior door mounted devices shall be mounted at typical operator height for the installed location and environment. No device shall be mounted lower than 36”.
		10. Prior to final fabrication of panels, verify layout of front-of-panel devices with respect to rear- of-panel devices. Maintain minimum of 3 inches clearance between door and sub-panel mounted devices
		11. Equip with rubber-gasketed doors with continuous metal hinges.
		12. Equip doors with 3-point pad lockable latches.
		13. Enclosure interior shall be painted white.
		14. Adequately support and restrain all devices and components mounted on or within the panel to prevent any movement.

NTS: Designer to include routing of field wiring in Panel layout drawings. Top and Side entry shall be within five inches of the rear of the enclosure.

* + 1. Provide provisions for routing field wiring shall be included in the design.
		2. Provide all electrical and/or pneumatic components and devices, support hardware, fasteners, interconnecting wiring and/or piping required to make the control panels and/or enclosures complete and operational.
		3. For exterior enclosures there shall be no penetrations on the top of the enclosure included but not limited to conduit entry, antennae, etc.
		4. Locate and install all devices and components so that connections can be easily made and that there is ample room for servicing each item.
		5. All wiring to panel connections from field instruments, devices, and other panels shall be terminated at grouped terminal blocks, unless otherwise specified.
		6. Enclosures that are designed for primarily bottom entry field I/O conduits shall have vertically oriented din rail for the field I/O terminal blocks.
		7. Provide copper grounding studs and bus bars for all panel equipment.

NTS: Designer to have a detail in the drawings for specific signal interfaces required with the project.

* + 1. Standard Signal Interfaces:
			1. Unless otherwise specified, discrete input and output signals shall conform to the following:
				1. Isolated non-powered (dry) contact closure.
				2. Dry contacts shall be powered from panel or device receiving signal.
			2. Unless otherwise specified, analog input and output signals shall conform to the following:
				1. 4-20 mAdc.
				2. For 2-wire, loop-powered transmitters, provide fused, isolated-type 24Vdc power supply at panel for driving of devices. Size power supply for 30% spare capacity.
				3. Where isolation is required for interfacing with particular equipment supplied, provide necessary I/I converters. Provide I/I converters where impedance capabilities of new or existing signal transmitter will be exceeded by addition of PLC input.
				4. Intrinsically safe barriers shall be installed according to code.
			3. DC Discrete Input module shall be used for PLC enclosure mounted devices status monitoring. Field devices and interposing relays shall not use the DC module.
		2. Provide CAT 6 patch panel as required for each network.
	1. IDENTIFICATION
		1. Reference 26 05 53 Identification for Electrical Systems
		2. All conductors must be labeled no matter the length. Exception grounding conductors.
		3. Control panel enclosures shall apply an Arc-flash Safety Signs.
			1. Warning signs shall be adhesive-backed polyester.
			2. Warning signs shall read, “Warning – Arc Flash and Shock Hazard. Appropriate PPE Required.” Arc flash warning signs shall indicate the flash protection boundary, incident energy in calories per square centimeter, hazard level, description of required protective clothing, shock hazard, limited approach boundary, restricted approach boundary, prohibited approach boundary, and equipment name.
	2. INDOOR PANELS AND ENCLOSURES NOT IN CLASSIFIED OR CORROSIVE ENVIRONMENTS
		1. Construction Features:
			1. Control panels located inside control or electrical room areas shall be NEMA 12 rated.
				1. Fabricate enclosures using minimum 14-gage steel for wall or frame mounted enclosures and minimum 12-gage for free standing enclosures. Steel shall be free of pitting and surface blemishes.
				2. Continuously weld all exterior seams and grind smooth. Also, surface grind complete removal of corrosion, burrs, sharp edges and mill scale.
				3. Reinforce sheet steel with steel angles where necessary to adequately support equipment and ensure rigidity and to preclude resonant vibrations.
				4. Panel shall be flat within 1/16-inch over a 24-inch by 24-inch area, or flat within 1/8-inch for a larger surface. Flatness shall be checked by using a 72-inch long straight edge. Out-of-flatness shall be gradual, in one direction only, and shall not consist of obvious depressions or a series of wavy sections.
				5. Use pan type construction for doors. Door widths shall not exceed 36-inches.
				6. Mount doors with full-length heavy-duty piano hinge with stainless steel hinge pins.
				7. Multiple door enclosure hinges should be overlapping and paired on opposite sides.
				8. Provide oil resistant gasket completely around each door or opening.
				9. Provide handle‑operated, oil-tight, key‑lockable three-point stainless steel latching system with rollers on latch-rods for easy door closing.
				10. Use stainless steel fasteners throughout.
				11. Provide interior mounting panels and shelves constructed of minimum 12-gage steel with a white enamel finish.
				12. Provide print pocket with white enamel finish.
				13. Provide enclosure mounting supports as required for floor, frame, or wall mounting.
				14. Provide all holes and cutouts for installation of conduit and equipment. Cable and piping to enter the enclosure through the bottom, unless otherwise noted. All conduit and piping openings and all conduits shall be sealed water­tight.
				15. Completely clean all interior and exterior surfaces so they are free of corrosive residue, oil, grease and dirt. Zinc phosphatize for corrosion protection.
				16. Provide one extra quart of touch-up paint for each exterior finish color.
	3. INDOOR/OUTDOOR PANELS AND ENCLOSURES IN CORROSIVE ENVIRONMENTS
		1. Construction Features:
			1. Control panels located in field shall be NEMA 4X rated.
				1. Panels shall be Type 316L stainless steel construction with a minimum thickness of 12-gage for all surfaces (except those areas requiring reinforcement) having a smooth brushed finish.
				2. Stainless steel screw clamp assemblies on three sides of each door.
				3. Rolled lip around three sides of door and along top of enclosure opening.
				4. Hasp and staple for padlocking.
				5. Provide a clear plastic, gasketed lockable hinged door to encompass all non-NEMA 4 front of panel instruments.
				6. Provide 3-inch high channel base assembly, with solid bottom, drilled to mate the panel to its floor pad.
				7. Floor Pad: Refer to Part 3 of this Section.
	4. INDOOR/OUTDOOR PANELS AND ENCLOSURES IN CLASS 1 DIVISION 1 RATED AREAS
		1. Construction Features:
			1. Control panels located in class 1 division 1 rated areas shall be NEMA 7:
				1. General: Explosion-proof control enclosures shall be used to house monitoring and measuring devices in hazardous environments. Enclo­sures shall be suitable for use in NEC Class 1, Groups C and D or Class II, Groups E, F and G applica­tions and comply with UL and CSA standards.
				2. Required Features:

Light weight and corrosion resistant copper-free aluminum.

Integral, cast-on mounting lugs.

Left side door hinges.

Viewing windows sized to suit internally mounted components.

Stainless steel cover bolts.

Cad-plated steel mounting pans.

* + - * 1. Manufacturers: Provide explosion-proof control enclosures of one of the following:

Adalet.

Or equal.

* 1. PANEL ACCESSORIES
		1. Provide the following convenience accessories for each control panel:
			1. Duplex receptacle
				1. Provide duplex receptacle interior of the enclosure on the back panel of the plc enclosure.
				2. If enclosure has a swing out panel then the receptacle shall be mounted interior of the enclosure on the swing out panel.
			2. One or more 120 VAC LED light fixtures and protective plastic shield to span across the width of the panel but not less than two-thirds the width of the panel, as a minimum.
			3. Furnish a door limit switch actuated panel LED light.
			4. Include a door intrusion switch. One per PLC enclosure mounted on the inside top of panel door wired to PLC input. Alarm to be transmitted to SCADA.
			5. Service light with switch and duplex receptacle shall have its own circuit breaker.

NTS: Do not provide strip heaters in potentially hazardous situation.

* 1. CONTROL OF ENVIRONMENT:
		1. Outdoor Panels:
			1. Provide adequately sized automatically controlled 120 VAC strip heaters to maintain tempera­ture inside each enclosure above 40ºF to maximum of 80ºF when the outside temperature is -20ºF through 40º F.
			2. Provide automatically controlled closed loop ventila­tion fans or closed loop air conditioners with filtered air louvers if required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the enclo­sure. Air conditioner shall have a minimum capacity of 4,000 BTU. Housing shall be constructed of corrosion resistant materials.
			3. Provide thermostats to automatically control heating and cooling requirements without need of manual opera­tion of a heating/cooling transfer switch.
			4. Provide documentation if any of the above is deemed unnecessary.
			5. High temperature limit switch shall be included and monitored by the PLC.
			6. Low temperature limit switch shall be included and monitored by the PLC.

NTS: Modify to suit the installed location. Areas such as filter gallery where chlorine and high humidity is present.

* + 1. Indoor Panels:
			1. Provide adequately sized, automatically controlled 120 VAC strip heaters to maintain temperature 10ºF above ambient for condensa­tion preven­tion inside panels.
			2. Provide automatically controlled closed loop ventila­tion fans or closed loop air conditioners with filtered air louvers if required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the enclo­sure. Air conditioner shall have a minimum capacity of 4,000 BTU.
			3. Provide documentation if any of the above is deemed unnecessary.
			4. High temperature limit switch shall be included and monitored by the PLC.
	1. WIRING:
		1. In addition to NEC and NEMA requirements, wiring shall conform to following:
			1. Power: 12 AWG stranded minimum, type MTW, 600 V.
			2. Control: 14 AWG stranded minimum, type MTW, 300 V.
			3. Analog Signal: Shielded twisted pair, 16 AWG with 18AWG drain.
		2. Wire color code:
			1. AC hot conductor: Black.
			2. AC neutral conductor: White.
			3. Grounding conductor: Green.
			4. AC control conductor, powered from within panel: Red.
			5. AC control conductor, powered from remote source: Yellow.
			6. DC (+) power conductor, discrete signal: Blue.
			7. DC (-) power conductor, discrete signal: White with Blue Tracer.
			8. DC control conductor, discrete signal: Blue.
			9. Twisted pair cable (+) signal conductor, analog signal: White or Clear.
			10. Twisted pair cable (-) signal conductor, analog signal: Black.
			11. Twisted pair power, analog signal: Red
		3. Design control panels to keep 480-vac power, 120-vac power and discrete signals, and analog and other low voltage signals separated.
			1. Do not run 480-vac power, 120-vac power and discrete signals, or analog or other low voltage signals in the same conduit or wire-duct.
			2. Where 480-vac power, 120-vac power and discrete signals, or analog or other low voltage signals must cross, they shall do so at right angles.
		4. Wire Duct:
			1. Wire duct shall be minimum 4 inches (100mm) tall.
			2. Wherever feasible plastic wire duct with cover shall be used for routing of wire within control panel.
			3. Size wire duct to be no more than 50% full. Including wires that are routed from the field.
			4. Maintain minimum 2” clearance between wire duct and terminals.
			5. Wire duct shall be placed in consideration for field wiring and enclosure entry. Consult drawings and electrical contractor for proposed entry.
			6. Shall be white.
			7. Provide wire duct around the entire perimeter of the enclosure back panels outer edge to accommodate planned and future field wiring.
		5. Wiring outside of wire duct.
			1. Wiring outside of ducts shall be minimally used.
			2. Wiring outside of ducts internal to the enclosure shall be restrained by use of plastic wire-ties.
			3. Wiring outside of ducts external to the enclosure shall be restrained by use of plastic hook and loop fasteners (Velcro).
			4. Restrain wiring a minimum of every six inches.
			5. Provide abrasion protection for wires passing through holes or across abrasive metal edges.
			6. Adhesive type wire fasteners shall not be used on the enclosure back panel. Hard screw type shall be employed.
		6. Wiring of PLC analog signals shall use twisted pair cables.
		7. All PLC I/O points including spare points and spare cards shall be landed on terminal blocks grouped next to each other. Cards shall not be split between DIN rails.
	2. TERMINATIONS:
		1. Wiring within control panel shall be continuous and terminated only at terminal blocks or equipment terminals. Splices or butt connectors shall not be used within panel.
		2. No more than one wire shall be terminated at any one terminal.
		3. Wiring of PLC I/O modules shall be wired independently to terminal blocks.
		4. Field terminal blocks shall be mounted a minimum of 45mm off back pane (high rise DIN rail).
		5. Make external connections by way of numbered terminal blocks on numbered terminal strips.
		6. Terminal blocks shall be labeled individually at each termination.
		7. When signals are powered from remote location, switched terminal blocks shall be used where conductors enter or leave panel.
		8. When signals are powered from within panel, fused multi-tiered terminal blocks shall be used where conductors enter or leave panel.
		9. Provide integral bussing system on terminal block array where more than two terminations require common source or drain connection. Wire jumpered terminations shall not be acceptable. Bussing system shall be screw type.
		10. Provide knife disconnect-type terminal blocks with test sockets for all analog loops.
		11. Include provisions for grounding of shields on shielded twisted pair cables entering or leaving panel. Cable shields shall be grounded at terminal block end only. Shields shall run entire length of cable within panels. Running of twisted pairs without shields within panels is not permissible.
		12. Provide separate terminal strips for each of the following types of signals.
			1. 480-vac power circuits. 480-vac power circuits shall not be included in PLC enclosure.
			2. 120-vac power circuits.
			3. 120 vac discrete signals.
			4. 24 or 48 vdc discrete signals.
			5. Analog signals.
			6. Serial or parallel digital communication signals.
			7. Intrinsically safe circuits.
	3. POWER DISTRIBUTION:
		1. Panels having 480 vac power supply:
			1. 480-vac power circuits shall not be included in PLC enclosure.
			2. Provide internal main circuit breaker to isolate power to panel.
			3. Provide circuit breakers for all motor starters provided.
			4. If panel includes separate 120 vac control power supply, provide auxiliary contact to isolate control power when main circuit breaker is opened.
			5. 480 / 120 control power transformer requirements:
				1. PLC enclosure shall not have transformers in the panel.
				2. Both primary leads shall be fused.
				3. First secondary lead shall be fused.
				4. Second secondary lead shall be grounded.
		2. Panels having 120 vac power supply:
			+ 1. Provide circuit breaker within control panel for incoming power.
		3. Provide separately fused power supply to each major panel component.
		4. Panels using modular I/O devices.
			1. Provide separately fused power circuit for panel powered I/O signals entering panel from field devices.
			2. Provide individually fused circuit for each I/O point on a multi-tiered fused terminal block.
			3. Include digital transient surge suppressor/varistor installed in parallel with output contact at terminal strip for each PLC output signal driving an inductive load including but not limited to:
				1. Relays.
				2. Solenoids.
				3. Motor starters.
				4. Motors.
		5. Motor Protection Relays (MPR):
			1. Listed manufacturers may utilize specifically designed relays manufactured by third parties for monitoring of pump alarm signals. Such relays, where required, shall be installed into control panels. Relays do not need to be provided by pump manufacturer dependent upon manufacturer selected and signal being monitored. Coordinate relay provision, type, mounting requirements, and wiring requirements with Contractor.
	4. SOURCE QUALITY CONTROL
		1. In-Factory Inspection.
			1. Verify following in accordance with approved submittals:
				1. Panel dimensions.
				2. Equipment layout.
				3. Wiring.
				4. Wire and terminal identification.
			2. Verify proper access to equipment for maintenance.
			3. Verify proper access to field wire and fiber optic termination points.
			4. Inspect for neatness of wiring and wire harness construction.
1. ‑ EXECUTION
	1. INSTALLATION
		1. Install equipment in conformance with NEC.
		2. Unless otherwise noted, install indoor freestanding enclosures on 4-inch concrete pad. Extend pad 4-inches beyond outside dimensions of base, all sides. Lay grout after panel sills have been securely fastened down. Exception: Enclosures with casters.

NTS: Outdoor enclosures include standard detail for the reinforced concrete pedestal.

For indoor enclosures designer shall include verbiage to meet requirements of installation in paragraph below.

* + 1. Unless otherwise noted, install outdoor enclosures panels on a reinforced concrete pedestal.
		2. Install anchor bolts and anchor in accordance with Section 05 05 33, Anchorage Systems.
		3. Install and interconnect all equipment, devices, electrical hardware, instrumentation and controls and process controller components into and out of and among the enclosures as indicated on the Drawings.
	1. TESTING AND ADJUSTMENTS
		1. Perform system testing and make any adjustments necessary in accordance with this Section, Section 40 61 13, Process Control System General Provisions.
		2. Perform power supply, voltage adjustments to tolerances required by the appurte­nant equipment.

 + + END OF SECTION + +