

Part 1 General

1.01 Summary

- A. This section gives general requirements for Operator Interface Terminals where required under Sections 40 67 00, Control System Equipment Panels and Racks, and 40 69 00, Packaged Control Systems, as part of a complete control panel.

1.02 Submittals

- A. Submit shop drawings in accordance with the requirements of Section 01 33 23 of these Specifications. Specific submittal information shall include the following:

Part 2 Products

2.01 Operator Interface Terminals

- A. Provide an Operator Interface Terminal with required accessories for a fully functional unit. Installation on cabinet outer door shall maintain the rating of the control panel.
- B. General:
1. Function: Allows operator to monitor and control at PLC level.
 2. Type: SVGA TFT LCD.
 3. Parts: Screen, cabling, communication module, accessories.
 4. Environmental:
 5. Operator Temperature: 0 to 55 degrees C.
 6. Relative Humidity: 85 percent relative humidity, noncondensing.
- C. Features:
1. Installation: Front mount.
 2. Display Type: SVGA.
 3. Pixel Resolution: 800H by 600W.
 4. Dimensions: 12.36"W by 9.76"H by 2.56"D, inches, nominal.
 5. Touch Panel Type: Projected Capacitive with Multi-Touch.
- D. Communication Ports: Two Ethernet, one serial, USB, SD Card.

E. Accessories:

1. Offline editor, Windows compatible, if required.
2. Full documentation.
3. Download cable.
4. Power cords.

F. Manufacturers and Products:

1. Emerson QuickPanel+ 12" View/Control, Conformal Coated, Model IC755CSS12CDB-CT.
2. Emerson QuickPanel+ 15" View/Control, Conformal Coated, Model IC755CSS15CDB-CT (For retrofit only).

Part 3 Execution

3.01 Installation, General

- A. Install in full accordance with manufacturer's instructions and recommendations.
- B. Provide adequate clearance on all sides of Operator Interface Terminal for sufficient convection in consideration of heat radiation.

3.02 Identification

- A. Equipment shall be labeled on inside of door to match design documents and panel drawings, and in adherence to Moccasin Bend Environmental Campus Standards. Refer to requirements of Section 40 67 00 of these Specifications for label material, lettering, coloring, sizing, and mounting requirements.

END OF SECTION

Part 1 General

1.01 Summary

- A. This section gives general requirements for Programmable Logic Controllers where required under Sections 40 67 00, Control System Equipment Panels and Racks, and 40 69 00, Packaged Control Systems, as part of a complete control panel.

1.02 Submittals

- A. Submit shop drawings in accordance with the requirements of Section 01 33 23 of these Specifications. Specific submittal information shall include the following:
1. The Contractor shall furnish submittal data calculating the maximum power consumption on the load side of the power supply under full-load conditions and all downstream signals energized.
 2. The Contractor shall furnish line and load fuse sizes sufficient to protect the power supply and provide branch circuit protection to each signal group on I/O modules.
 3. The Contractor shall ensure all upstream circuit breakers and fuses are properly sized to accommodate the power supply under full-load conditions.
 4. The Contractor shall calculate heat load of the power supply system under full-load conditions for determining panel heating and cooling requirements of Section 40 67 00 of these Specifications.

Part 2 Products

2.01 Small Systems and Package Systems

- A. Small Systems and Package Systems are defined as processes that require minimal I/O (less than 75 signals), limited communication with the plant HMI, contain low-complexity programming logic, and have very limited interaction with other control systems. Secondary Clarifiers, Lift Station Pump Control Panels, and Remote I/O are included in this category. For these systems, the Emerson VersaMax CPUE05 or latest comparable chassis-based model is required. PROFINET will be used for all Remote I/O and HMI communications. Programming logic shall be in Ladder Diagram only.
- B. CPU: Model IC200CPUE05.
1. Supports up to 64 modules with up to 2048 I/O points

2. Can be either autoconfigured or configured from a programmer using configuration software
 3. 64KB of configurable memory for the application program, hardware configuration, registers, analog inputs, and analog outputs
 4. Programming in Ladder Diagram and Instruction List
 5. Non-volatile flash memory for program storage
 6. Battery backup for program, data, and time of day clock
 7. Run/Stop switch
 8. Floating point (real) data functions
 9. Embedded RS-232, RS-485, and Ethernet communications
 10. Supports EZ Program Store device
 11. 70mm (2.76") height when mounted on DIN rail with power supply
- C. Backplane: The VersaMax series does not utilize a separate backplane. I/O carriers snap together to form a complete system, with each carrier having a rotary switch to set the bus address manually. The I/O can also be addressed automatically from Proficy Machine Edition.
- D. Power Supply: The selected power supply quantity shall meet the calculated load (shall be provided by Contractor in a submittal) of the CPU, I/O modules, and any additional communication cards with a reserved capacity of 20% available. Supplementary power supplies require booster carriers and must use the same external power source as the Primary power supply.
1. 12VDC Input, Expanded 3.3VDC, Model IC200PWR202.
 2. 24VDC Input, Model IC200PWR001.
 3. 24VDC Input, Isolated, Model IC200PWR011.
 4. 24VDC Input, Isolated 3.3VDC, Model IC200PWR012.
 5. 24VDC Input, Expanded 3.3VDC, Model IC200PWR002 (Lift Stations).
 6. 120VAC Input, Expanded 3.3VDC Model IC200PWR102 (Lift Stations).
 7. Power Supply Booster Carrier (Lift Stations).
- E. I/O Modules: Each I/O module shall be limited to a singular I/O type (Discrete or Analog, Input or Output) The use of Mixed I/O modules (Discrete and Analog, or Input and Output) is not allowed unless provided as replacement on an existing

rack. All I/O modules require an I/O carrier for wiring termination. Quantities of each module type must meet the minimum spare I/O count requirement in Section I below. Usage of modules that are not preferred are acceptable only if approved by Owner or Engineer.

- F. Discrete Inputs: Discrete Input modules are required to use 24 VDC input from the field for all new installations. Quantities of each module type must meet the minimum spare I/O count requirement in Section J below.
1. 24 VDC Pos/Neg Logic (2 Groups of 8) 16 Points, Model IC200MDL640 (Preferred).
 2. 120 VAC (2 Groups of 8) 16 Points, Model IC200MDL240 (Preferred).
 3. 24 VDC Pos/Neg Logic (4 Groups of 8) 32 Points, Model IC200MDL650 (Lift Stations).
- G. Discrete Outputs: Discrete Output modules are required to use 24 VDC output to the field. Quantities of each module type must meet the minimum spare I/O count requirement as defined in Section J below.
1. 16 points, isolated relay, 120VAC/24VDC, 2 A, Model IC200MDL940 (preferred for Lift Stations).
 2. 8 points, isolated relay, 120VAC/24VDC, 2 A, Model IC200MDL930.
 3. 16 points, positive logic, 12/24 VDC,.5 A, Model IC200MDL740.
 4. 16 points, positive logic, with Electrical Short-Circuit Protection (ESCP), 24 VDC, .5 A, Model IC200MDL741.
- H. Analog Inputs and Thermocouple Inputs: Analog Input modules are preferred to use Isolated Current readings in Differential Input. Quantities of each module type must meet the minimum spare I/O count requirement in Section J below.
1. 15 Bit Differential Current 8 Channels, Model IC200ALG262 (Supported by PROFINET PNS only).
 2. 15 Bit Current 15 Channels, Model IC200ALG264 (Supported by PROFINET PNS only).
 3. 16 Bit RTD 4 Channels, Model IC200ALG620.
 4. 16 Bit Thermocouple 7 Channels, Model IC200ALG630.
 5. 16 Bit Voltage/Current Isolated 8 Channels, Model IC200ALG240 (Lift Stations).

- I. Analog Outputs: Analog Output modules are preferred to use Current readings. Quantities of each module type must meet the minimum spare I/O count requirement in Section J below.
1. 13 Bit Current 8 Channels, Model IC200ALG320.
 2. 13 Bit Current 8 Channels, Model IC200ALG326 (Supported by PROFINET PNS only) (In-Plant).
 3. Spare Points: General: Provide 10% spare I/O points for each I/O card type and 10% spare slots for backplane(s) in panel. (1 spare slot minimum).
 4. Communication Cards: Special purpose communication modules may be required to interface to other PLC's, field devices, existing equipment, HMI, Remote I/O, or DLR topologies.
 - a. Remote I/O: Ethernet Network Interface Unit (EGD and Modbus), Model IC200EBI001.
 - b. PROFINET NIU's: 2x RJ45 Copper Ethernet Connectors, Model IC200PNS001.
 - c. Controllers: Configurable User Memory, One 10MBps Ethernet (RJ45) and Two Serial Ports (RS-232 and RS-485), Model IC200CPUE05.
 5. Accessories: The following accessories may be required as part of a complete PLC hardware system.
 - a. Compact Terminal - Box Vertical Style, Model IC200CHS022 (Preferred).
 - b. Compact Terminal - Spring Clamp Vertical Style, Model IC200CHS025.
 - c. Connector - Connector Vertical Style, Model IC200CHS003(*)>.
 - d. Non-integrated Barrier Style, Model IC200CHS011(**).
 - e. Non-integrated Box Style, Model IC200CHS012 (**).
 - f. Integrated Box-Thermocouple Compensation, Model IC200CHS014(**).
 - g. Spring-Style Interposing I/O Terminals, Model IC200CHS015 (**).
 - h. Disconnect-Style Interposing I/O Terminals, Main Base, Model IC200CHS101 (**).
 - i. Disconnect-Style Interposing I/O Terminals, Expansion Base, Model IC200CHS102 (**).

- j. Relay-Style Interposing I/O Terminals, Main Base, Model IC200CHS111 (**)
- k. Relay-Style Interposing I/O Terminals, Expansion Base, Model IC200CHS112 (**).
- l. Interposing Fuse Style 16 Point, Model IC200CHS121.
- m. Interposing Fuse Style 16 Point, Expansion Base, Model IC200CHS122.
- n. Interposing Relay 16 Point, Model IC200CHS211.
- o. Interposing Relay 16 Point, Expansion Base, Model IC200CHS212.
- p. Barrier-Style Auxiliary I/O Terminal Strip, Model IC200TBM001.
- q. Box-Style Auxiliary I/O Terminal Strip, Model IC200TBM002.
- r. Spring-Style Auxiliary I/O Terminal Strip, Model IC200TBM005.
- s. Communications Carrier, Model IC200CHS006.
- t. Power Supply Booster Carrier, Model IC200PWB001.

(*) Connector-Style Carriers require Cables. Select from list below.

(**) Interposing terminals for use with Connector-Style Carrier.

2.02 Medium to Large Systems

- A. Medium to Large Systems are defined as processes that require CPU redundancy for critical systems, require complex program logic, or have extensive I/O (over 75 signals) including Remote I/O. For Medium systems, the Emerson RX3i CPE305 series PLC or latest comparable model is required. For Large or Redundant systems, the Emerson RX3i CPE330 series PLC or latest comparable model is required. PROFINET will be used for all Remote I/O and HMI communications. VersaMax Remote I/O racks are preferred for spacing and cost considerations. Refer to Section 2.01 Small Systems and Package Systems for VersaMax models.
- B. CPU: Model IC695CPE305.
 - 1. Plug-and-play addition of PROFINET-enabled devices makes it easy to securely connect machines, data and people.
 - 2. User-friendly environment that can increase design flexibility and improve engineering efficiency and productivity

3. Plug-and-play addition of PROFINET-enabled devices makes it easy to securely connect machines, data and people.
- C. CPU: Model IC695CPE330.
1. Programming tools such as tag-based programming, a library of reusable code and a test edit mode for improved online troubleshooting
 2. User-friendly environment that can increase design flexibility and improve engineering efficiency and productivity
 3. Plug-and-play addition of PROFINET-enabled devices makes it easy to securely connect machines, data and people
 4. Unique reflective memory technology keep CPUs synchronized with simple configuration, minimal impact to application performance, and bumpless switchover in case of failure
 5. High-speed processor and patented technology for faster throughput without information bottlenecks
 6. Support for high-density discrete I/O, universal analog (TC, RTD, Strain Gauge, Voltage and Current configurable per channel), isolated analog, high-density analog, high-speed counter, and motion modules
 7. Supports OPC UA Non-Transparent Server Redundancy
- D. Backplane: At a minimum, the selected backplane(s) will support the required quantity of I/O and other modules, including required spare I/O and spare slots.
1. 12-Slot Universal Backplane, Model IC695CHS012 (Preferred).
 2. 16-Slot Universal Backplane, Model IC695CHS016.
 3. 7-Slot Universal Backplane, Model IC695CHS007.
 4. 10-Slot Serial Expansion Backplane, Model IC694CHS392 (Preferred Model for Secondary Racks).
 5. 5-Slot Serial Expansion Backplane, Model IC694CHS398 (Preferred Model for Secondary Racks).
- E. Power Supply: The selected power supply shall meet the calculated load of the backplane, CPU, I/O modules, and any additional communication cards with a reserved capacity of 20% available.
1. 120/240 Vac 125Vdc 30W High-Capacity Serial Expansion, Model IC694PWR330 (Preferred).

2. 120/240 Vac 125Vdc 40W Multi-Purpose, Model IC695PSA140.
 3. 120/240 Vac 125Vdc 30W Serial Expansion, Model IC694PWR321.
- F. I/O Modules: The use of Mixed I/O modules is not allowed unless provided as a drop-in upgrade from legacy model. Quantities of each module type must meet the minimum spare I/O count requirement in Section L below.
- G. Discrete Inputs: Discrete Input modules are required to use 24 VDC input from the field, unless otherwise noted. Quantities of each module type must meet the minimum spare I/O count requirement in Section L below.
1. 24Vdc 32-Pt Pos/Neg Logic, Model IC694MDL660 (Preferred).
 2. 24Vdc 16-Pt Pos/Neg Logic, Model IC694MDL645.
 3. 125VAC 16-Pt Pos/Neg Logic, Model IC694MDL240.
- H. Discrete Outputs: Discrete Output modules are required to use 24 VDC output to the field, unless otherwise noted. Quantities of each module type must meet the minimum spare I/O count requirement in Section L below.
1. 25VAC/Vdc 4A 16-Pt N.O. Isolated Relay, Model IC694MDL916 (Preferred).
- I. Analog Inputs / RTD Thermocouple Inputs: Analog Input modules are preferred to use Isolated Current readings in Differential Input for remote sites. In-Plant usage shall be non-isolated. Signals wired to non-isolated modules require external signal isolators to protect the module. Quantities of each module type must meet the minimum spare I/O count requirement in Section L below.
1. 16 Channel Non-Isolated / 8 Channel Diff, Model IC695ALG616.
 2. 8 Channel Non-Isolated / 4 Channel Differential, Model IC695ALG608 (In Plant).
 3. 12 Channel Isolated Voltage/Current, Model IC695ALG112.
 4. 6 Channel Isolated Voltage/Current, Model IC695ALG106 (Lift Stations).
 5. 4 Channel Current, Model IC694ALG221 (In-Plant).
 6. Universal Module, Voltage, Current, Resistance, RTD, TC, Model IC695ALG600.
- J. Analog Outputs: Analog Output modules are preferred to use Current readings in Differential Input. Signals wired to non-isolated modules require external signal isolators to protect the module. Quantities of each module type must meet the minimum spare I/O count requirement in Section L below.

1. Current/Voltage 8 Channels, Model IC694ALG392 (Preferred).
 2. Current/Voltage 8 Channels, Model IC695ALG708.
- K. High Speed Counters: High Speed Counter modules are preferred to use positive logic (source) with inputs volt range selection of either 5VDC or 10-30VDC. Enhanced version is capable of supporting Differential Encoders, in addition to Single-Ended Encoders.
1. 12 inputs, 4 outputs, Model IC694APU300 (Preferred).
- L. Spare Points: Provide 25% spare I/O points for each I/O card type and 10% spare slots for backplane(s) in panel (1 spare slot minimum).
- M. Communication Cards: Special purpose communication modules may be required to interface to other PLC's, field devices, existing equipment, HMI, Remote I/O, or Device Level Ring topologies.
1. Serial Communications Module, 2 Ports, Model IC695CMM002.
 2. Serial Communications Module, 4 Ports, Model IC695CMM004.
 3. IEC 61850 Ethernet Communication Module, Model IC695ECM850.
 4. Ethernet Transmitter Module, Model IC695ETM001.
 5. Serial Bus Transmitter Module, Model IC695LRE001.
 6. Ethernet Network Interface Unit, Module Model IC695NIU001.
 7. PROFINET Controller Module, Model IC695PNC001.
 8. PROFINET Scanner Module, Model IC695PNS001.
 9. Genius Bus Module, Screw Terminals, Serial Ports, Model IC694BEM331.
- N. Accessories: The following accessories are required as part of a complete PLC hardware system.
1. Blank filler module, Model IC694ACC310 (As Required to fill all unused slots).
 2. Auxiliary Smart Battery Module, Model IC695ACC302 (One per CPU).
 3. High Density 32-pt Terminal Block, Model IC694TBB132 (as required for 32-point I/O cards).
 4. I/O Bus Terminator, Model IC693ACC307 (as required at End of Expansion Cable).

5. Expansion Cable, Model IC693CBL300 (One per Expansion Rack).

Part 3 Execution

3.01 Installation, General

- A. Install in full accordance with manufacturer's instructions and recommendations.
- B. Provide adequate clearance on all sides of chassis for sufficient convection in consideration of heat radiation.

3.02 Identification

- A. Equipment shall be labeled on subpanels to match design documents and panel drawings, and in adherence to Moccasin Bend Environmental Campus Standards. Refer to requirements of Section 40 67 00 of these Specifications for label material, lettering, coloring, sizing, and mounting requirements.

END OF SECTION

Part 1 General

1.01 Summary

This section gives general requirements for Remote Terminal Units where required under Sections 40 67 00, Control System Equipment Panels and Racks, and 40 69 00, Packaged Control Systems, as part of a complete control panel.

1.02 Submittals

- A. Submit shop drawings in accordance with the requirements of Section 01 33 23 of these Specifications. Specific submittal information shall include the following:
 1. The Contractor shall furnish submittal data calculating the maximum power consumption on the load side of the power supply under full-load conditions and all downstream signals energized.
 2. The Contractor shall furnish line and load fuse sizes sufficient to protect the power supply and provide branch circuit protection.
 3. The Contractor shall ensure all upstream circuit breakers and fuses are properly sized to accommodate the power supply under full-load conditions.
 4. The Contractor shall calculate heat load of the power supply system under full-load conditions for determining panel heating and cooling requirements of Section 40 67 00 of these Specifications.

Part 2 Products

2.01 Remote Terminal Units

- A. Remote Systems are defined as locations outside of the main treatment plant facility that typically require wireless messaging to communicate with the plant SCADA system, and the FIU's that serve as data concentrators to aggregate data for the plant HMI. Sites include but are not limited to Data Concentrators, Pump Stations, Combined Sewer Overflows (CSO's), Equalization Stations, Storm Stations, Metering Stations, and Regulators. The **Motorola ACE3680** series RTU/FIU or latest comparable model is required. MDLC will be used for all Remote I/O and RTU to FIU communications. Modbus TCP will be used for all FIU to HMI communications.
- B. CPU:
 1. Capable of redundancy via Ethernet connection
 2. 24 different types of I/O modules available, and each RTU has capacity to

- support up to 110 I/O modules
 - 3. Supports common protocols and enhanced MDLC protocol
 - 4. Transmit data over any of the following: analog/digital two-way radio, dial-up modem, point-to-point microwave, 3G/4G public or private, and Ethernet – simultaneously
 - 5. Enhanced security feature set, including Security Enforcement Policy, Built-in Firewall, Access Control, Role-Based Access Controls, Intrusion Detection System, Application Control Software, Encryption, Unused Port Deactivation, and Time-Window Commands
 - 6. Processor: 32-bit, 200 MHZ
 - 7. Memory: Flash: 32MB, DRAM: 128MB, SRAM plug-in board (optional): 4MB
 - 8. Realtime Clock: 2.5 seconds/day max drift
 - 9. Serial Port 1: Configurable RS-232C or RS-485
 - 10. Serial Port 2: RS-232C
 - 11. Plug-in Port 1: Supports Radio Modem, DPSK, FSK, DFM, RS-232, RS-485, Ethernet 10/100
 - 12. Plug-in Port 2: Supports Radio Modem, DPSK, FSK, DFM, RS-232, RS-485, Ethernet 10/100
 - 13. Ethernet Port: 01/100Mbps
 - 14. USB Host Port 1,2: Type A host full speed 12 Mps ports for MDLC over IP via MotorTRBO (Motorola product name) digital mode radio system.
 - 15. USB Device Port: Type B connector
 - 16. Internal Port: Ethernet 10/100 Mbps (for redundant CPU configuration)
 - 17. Operating Volts: 10.8 to 16 VDC
 - 18. Dimensions: 56mm W x 225mm H x 180mm D (2.2" W x 8.7" H x 7.1" D)
- C. Backplane: At a minimum, the selected backplane(s)/Frame(s) will support the required quantity of I/O and other modules, including required spare I/O and spare slots as required in Section J below.

- 1. Frames and Dimensions:
 - i. No I/O slots - PS and CPU only, wall mount, 117 W x 209 H x 198 D mm (4.61" x 5.30" x 7.80").
 - ii. 2 I/O slots - PS, CPU and up to 2 I/O modules, 194 W x 244 H x 198 D mm (7.64" x 9.61" x 7.80").
 - iii. 3 I/O slots - PS, CPU and up to 3 I/O modules, 234 W x 244 H x 198 D mm (9.21" x 9.61" x 7.80").
 - iv. 5 I/O slots - PS, CPU and up to 5 I/O modules, 314 W x 244 H x 198 D mm (12.36" x 9.61" x 7.80").
 - v. 7 I/O slots - PS, CPU and up to 7 I/O modules, 391 W x 244 H x 198 D mm (15.39" x 9.61" x 7.80").
 - vi. 8 I/O slots - PS, CPU and up to 8 I/O modules, 435 W x 244 H x 198 D mm (17" x 9.61" x 7.80").
- 2. I/O Expansion Frames and Dimensions:
 - i. 3 I/O slots - PS, CPU and up to 3 I/O modules, 234 W x 244 H x 198 D mm (9.21" x 9.61" x 7.80").
 - ii. 5 I/O slots - PS, CPU and up to 5 I/O modules, 314 W x 244 H x 198 D mm (12.36" x 9.61" x 7.80").
 - iii. 7 I/O slots - PS, CPU and up to 7 I/O modules, 391 W x 244 H x 198 D mm (15.39" x 9.61" x 7.80").

- iv. 8 I/O slots - PS, CPU and up to 8 I/O modules, 435 W x 244 H x 198 D mm (17" x 9.61" x 7.80").
3. Chassis and Descriptions:
- i. Small: For PS, CPU, 2 I/O slot frame, 1 radio (or 1 accessory box), and 6.5Ah backup battery, wall mount, 264 W x 365 H x 200 D** mm (11.02"x 14.17" x 7.88"*).
 - ii. Medium: For PS, CPU and 3 I/O slot frame, one radio and 6.5 Ah backup battery, wall mount, 335 W x 355 H x 198* D mm (17.64" x 18.43" x 7.80").
 - iii. Large: For PS, CPU and up to 7 I.O slot frame, two radios and 6.5 or 10 Ah backup battery, wall mount, 448 W x 468 H x 200* D mm (17.64" x 18.43" x 7.88").
4. Housing and Description:
- i. Small: NEMA 4/IP65 painted metal - up to 3 I/O slot frame one radio and 6.5 Ah backup battery, 380 W x 380 H x 210 D mm (15" x 15" x 8.26").
 - ii. Large: NEMA 4/IP65 painted metal - up to 7 I/O slot frame, 2 radios & 6.5 or 10 Ah, backup battery, 500 W x 500 H x 210 D mm (19.7" x19.7" x 8.26").
- D. Power Supply: The selected power supply shall meet the calculated load of the backplane, CPU, I/O modules, and any additional communication cards with a reserved capacity of 20% available.
1. 18-72 V DC with 12 V smart battery charger, Model 10.8-16 V DC.
 2. 100- 240 V AC, 50-60 Hz, Model 10.8-16 V DC low-tier.
 3. 100- 240 V AC, 50-60 Hz, w/ 12 V smart charger, Model 18-72 V DC.
 4. 100-240 V AC with 12 V smart battery charger, Model 100-240 V AC.
 5. Plug-In Power Supply 10.8-16V, Model 24V DC (from I/O module).
 6. 10.8-16 V DC, Model 10.8-16 V DC Expansion.
- E. I/O Modules: Quantities of each module type must meet the minimum spare I/O count requirement in Section K below.
- F. Discrete Inputs: Discrete Input modules are required to use 24 VDC input from the field. Quantities of each module type must meet the minimum spare I/O count requirement in Section K below. For 24VDC Input Modules, an optional Plug-in 24VDC module can be added to each group of 16 Inputs.
1. Shared Common, 16 Inputs can be used as Fast Counters, Model 16 In, 24VDC.
 2. Shared Common per 16 Inputs, 20 Inputs can be used as Fast Counters, Model 32 In, 24VDC.
 3. Isolated Groups with Shared Common, 16 Inputs can be used as Fast Counters, Model 16 In, 24VDC Isolated.
 4. Isolated Groups with Shared Common per 16 Inputs, 20 Inputs can be used as Fast Counters, Model 32 In, 24VDC Isolated.
 5. Two Isolated Groups of 6 and 1 group of 4 inputs, Model 16 In, 120VAC Isolated.
- G. Discrete Outputs: Discrete Output modules are required to use 24 VDC output to the field. Quantities of each module type must meet the minimum spare I/O count requirement in Section K below.

1. Electrically Energized, 3x Form C and 5x Form A, 24VDC, Model 8 Out, 24VDC.
 2. Electrically Energized, 6x Form C and 10x Form A, 24VDC, Model 16 Out, 24VDC.
 3. Electrically Energized, 12x Form A, 120VAC, Model 12 Out, 120VAC.
 4. Mechanically Latched, 3x Form C and 5x Form A, 24VDC, Model 8 Out, 24VDC, Latched.
 5. Mechanically Latched, 6x Form C and 10x Form A, 24VDC, Model 16 Out, 24VDC, Latched.
 6. Mechanically Latched, 12x Form A, 120VAC, Model 12 Out, 120VAC, Latched.
- H. Analog Inputs / RTD Thermocouple Inputs: Analog Input modules are required to use Isolated Inputs. Quantities of each module type must meet the minimum spare I/O count requirement in Section K below. For 24VDC Input Modules, an optional Plug-in 24VDC module can be added to each group of 8 Inputs.
1. 8 Isolated Analog Inputs, Model 8 In, 20mA.
 2. 8 Isolated Analog Inputs, Model 8 In, 5VDC.
 3. 16 Isolated Analog Inputs, 16 In, 20mA.
 4. 16 Isolated Analog Inputs, 16 In, 5VDC.
- I. Analog Outputs: Analog Output modules are required to use Current in Isolated Outputs. Quantities of each module type must meet the minimum spare I/O count requirement in Section K below.
1. Isolated, individually selectable as 20mA or 10VDC, Model 4 Out.
- J. Mixed I/O: Mixed modules are required to use 24 VDC output to the field. Quantities of each module type must meet the minimum spare I/O count requirement in Section K below.
1. Model 16 Discrete In/Out, 24VDC; Each group of 8 I/O can function as FET DO or dry contact DI, first 20 Inputs can be used as counters.
 2. Model 16 DI, 4 DO, 4 AI, 24VDC (*); DI's on Shared Common, first 12 DI's can be fast counters, DO's are Form C relay outputs, Isolated AI's.
 3. Model 32 Discrete In/Out, 24VDC; Each group of 8 I/O can function as MOSFET DO or dry contact DI, first 20 Inputs can be used as counters.
 4. Model 4 Out, 8 In (*); 8 Isolated Analog Inputs 24VDC, Isolated Outputs, individually selectable as 20mA or 10VDC.
- (*) One optional plug-in 24VDC module can be added to each mixed module.
- K. Spare Points: Provide 10% spare I/O for each I/O card type and one spare slot for backplane(s) in panel.
- L. Communication Cards: Special purpose communication modules may be required to interface to other PLC's, field devices, existing equipment, HMI, Remote I/O, or radios.
1. 32 bit 200 MHZ CPU, 1 per Expansion Frame Required, Model Expansion Module.
 2. 8 port RJ-45 at 10/100 Mbps, Model Expansion LAN Switch.

- M. Accessories: The following accessories may be required as part of a complete PLC hardware system.
1. Sealed Lead-Acid Battery, Model 6.5 Ah (As Required).
 2. Sealed Lead-Acid Battery, Model 10Ah (As Required).

Part 3 Execution

3.01 Installation, General

- A. Install in full accordance with manufacturer's instructions and recommendations.
- B. Provide adequate clearance on all sides of Remote Terminal Unit for sufficient convection in consideration of heat radiation.

3.02 Identification

- A. Equipment shall be labeled on subpanels to match design documents and panel drawings, and in adherence to Moccasin Bend Environmental Campus Standards. Refer to requirements of Section 40 67 00 of these Specifications for label material, lettering, coloring, sizing, and mounting requirements.

END OF SECTION

Part 1 General

1.01 Summary

- A. This section gives general requirements for Process Instrumentation Networks where required under Sections 40 67 00, Control System Equipment Panels and Racks, and 40 69 00, Packaged Control Systems, as part of a complete control panel.

1.02 Submittals

- A. Submit shop drawings in accordance with the requirements of Section 01 33 23 of these Specifications. Specific submittal information shall include the following:
1. The Contractor shall furnish fuse sizes sufficient to protect the device and provide branch circuit protection.
 2. The Contractor shall ensure a minimum of one spare copper Ethernet port is available for connection to a programming laptop.

Part 2 Products

2.01 Ethernet Switches, Lift Stations only

- A. Ethernet Switches are required to attach PLC's, OIT's, and other devices to the Control Network.
- B. Configuration: Unmanaged, Layer 2.
1. Features: DIN Rail mounted.
 2. Ports: Minimum of Five copper 10/100 Ethernet Ports.
 3. Manufacturers and Products:
 - a. Automation Direct, 5 Ports, Model SE-SW5U.

Part 3 Execution

3.01 Installation, General

- A. Install in full accordance with manufacturer's instructions and recommendations.
- B. Provide adequate clearance on all sides of power supply for sufficient convection in consideration of heat radiation.

- C. Adjust the output voltage to match the required voltage where field adjustment capability is provided on the unit.
- D. Ground the power supply chassis and -VDC terminal to a grounding terminal block or bus bar within the control panel.

3.02 Identification

- A. Equipment shall be labeled on subpanels to match design documents and panel drawings, and in adherence to Moccasin Bend Environmental Campus Standards. Refer to requirements of Section 40 67 00 of these Specifications for label material, lettering, coloring, sizing, and mounting requirements.

END OF SECTION

Part 1 General

1.01 Summary

- A. This section gives general requirements for Control System Equipment Panels and Racks where required by project Plans and Specifications.

1.02 References

- A. The following is a list of standards which may be referenced in this section and other subsections:
1. American National Standards Institute (ANSI).
 2. ASTM International (ASTM):
 - a. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
 - b. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - c. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
 - d. B32, Standard Specification for Solder Metal.
 - e. B88, Standard Specification for Seamless Copper Water Tube.
 3. Deutsche Industrie-Norm (DIN): VDE 0611, Specification for modular terminal blocks for connection of copper conductors up to 1,000V ac and up to 1,200V dc.
 4. Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
 5. International Society of Automation (ISA):
 - a. RP12.06.01, Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation Part 1: Intrinsic Safety.
 - b. S5.1, Instrumentation Symbols and Identification.
 - c. S5.4, Instrument Loop Diagrams.
 - d. S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.

- e. TR20.00.01, Specification Forms for Process Measurement and Control Instruments, Part 1: General.
6. International Conference on Energy Conversion and Application (ICECA).
7. National Electrical Code (NEC).
8. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. ICS 1, Industrial Control and Systems General Requirements.
9. National Fire Protection Association (NFPA): 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
10. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
11. Underwriters Laboratory, Inc. (UL): 508A, Standard for Safety, Industrial Control Panels.

1.03 Definitions

A. Abbreviations:

1. CTU: Central Terminal Unit.
2. FDT: Factory Demonstration Test.
3. HMI: Human-Machine Interface.
4. HVAC: Heating, Ventilating, and Air Conditioning.
5. I&C: Instrumentation and Control.
6. I/O: Input and Output.
7. IT: Information Technology.
8. O&M: Operation and Maintenance.
9. OT: Operational Technology.
10. OIU: Operator Interface Unit.
11. P&ID: Process and Instrument Diagram.

12. PC: Personal Computer.
 13. PIC: Process Instrumentation and Control.
 14. PLC: Programmable Logic Controller.
 15. RTU: Remote Terminal Unit.
 16. SCADA: Supervisory Control and Data Acquisition.
- B. Enclosure: Control panel, console, cabinet, or instrument housing.
- C. Instructor Day: Eight hours of actual instruction time.
- D. Standard Software: Software packages that are independent of Project on which they are used. Standard software includes system software, supervisory control, and data acquisition (SCADA) software.
1. System Software: Application independent (non-project specific) software developed by digital equipment manufacturers and software companies. Includes, but is not limited to, operating systems; network support, web browsers, programming languages (C, C++, Visual C++, BASIC, Visual Basic, etc.); Office Suites (word processor, spreadsheet, database, etc.); e mail; security (firewall, antivirus; anti-spam, anti-spyware, etc.) debugging aids; and diagnostics.
 2. SCADA Software: Software packages independent of specific process control project on which they are used. Includes, but is not limited to, providing configuring and run-time capability for, data acquisition (I/O driver, OPC servers, etc.), monitoring, alarming, human-machine interface, supervisory control, data collection, data retrieval, trending, report generation, control, and diagnostics.
 3. Controller Programming Software: Software packages for the configuring of PLCs, RTUs, DCUs, SLDC, and fieldbus devices.
- E. Application Software: Software to provide functions unique to this Project and that are not provided by standard software alone, including but not limited to:
1. Configuring databases, tables, displays, historians, reports, parameter lists, ladder logic, function block, and control strategies required to implement functions unique to this Project.
 2. Programming in any programming or scripting language.
- F. Rising/Falling: Define action of discrete devices about their setpoint.
1. Rising: Contacts close when an increasing process variable rises through setpoint.

2. Falling: Contacts close when a decreasing process variable falls through setpoint.
3. Signal Types:
 - a. Analog Signal, Current Type:
 - 1) 4 to 20 mA dc signals conforming to ISA S50.1.
 - 2) Unless otherwise indicated for specific PIC subsection components, use the following ISA S50.1 options.
 - (a) Transmitter Type: Number 2, two-wire.
 - (b) Transmitter Load Resistance Capacity: Class L.
 - (c) Fully isolated transmitters and receivers.
 - b. Analog Signal, Voltage Type: 1 to 5 volts dc within panel where common high precision dropping resistor is used.
 - c. Discrete signals, two-state logic signals using dc or 120V ac sources as indicated.
 - d. Pulse Frequency Signals:
 - 1) Direct-current pulses whose repetition rate is linearly proportional to process variable.
 - 2) Pulses generated by contact closures or solid state switches.
 - 3) Power source less than 30V dc.
 - e. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

1.04 System Description

- A. Detailed Wiring Design: Panel wiring diagrams, interconnecting wiring diagrams, and loop wiring diagrams are included in Contract Drawings and designed to completely show control panel wiring, terminations, wire numbers, interfaces with other systems, hardwired functions, interlocks, and wiring of components to be provided.
- B. Design Requirements:
 1. Complete detailed design of PIC components and PIC drawings.

2. Provide consistent hardware and software functions for PIC. For example, provide functions in control logic, sequence controls, and display layouts in same or similar manner.
 3. PIC design as shown and specified includes:
 - a. Functional requirements, performance requirements, and component specifications.
 - b. P&IDs, block diagrams, and network diagrams.
 - 1) Typical drawings for installation details, control panel layouts, control panel schedules, PLC I/O module wiring, panel power, and control diagrams.
- C. Use a pre-qualified PIC System Integrator for at least the following Work:
1. For PIC Equipment and Ancillaries:
 - a. Completing detail design.
 - b. Submittals.
 - c. Equipment, enclosures, and ancillaries.
 - d. Instructions, details, and recommendations to, and coordination with Contractor for Certificate of Proper Installation.
 - e. Verify readiness for operation.
 - f. Verify correctness of final power and signal connections (lugging and connecting).
 - g. Adjusting and calibrating.
 - h. Starting up.
 - i. Testing and coordination of testing.
 - j. Training.
 2. Verify following Work not by PIC System Integrator is provided:
 - a. Correct type, size, and number of signal wires with their raceways.
 - b. Correct electrical power circuits and raceways.
 - c. Correct size, type, and number of PIC-related pipes, valves, fittings, and tubes.

- d. Correct size, type, materials, and connections of process mechanical piping for in-line primary elements.
3. Non-PIC Equipment Directly Connected to PIC Equipment:
- a. Obtain from Contractor, manufacturers' information on installation, interface, function, and adjustment.
 - b. Coordinate with Contractor to allow required interface and operation with PIC.
 - c. For operation and control, verify installations, interfacing signal terminations, and adjustments have been completed in accordance with manufacturer's recommendations.
 - d. Test to demonstrate required interface and operation with PIC.
 - e. Examples of items in this category, but not limited to the following:
 - 1) Valve operators, position switches, and controls.
 - 2) Chemical feed pump and feeder speed/stroke controls.
 - 3) Automatic samplers.
 - 4) Motor control centers.
 - 5) Adjustable speed and adjustable frequency drive systems.
 - (a) Examples of items not in this category:
 - (1) Internal portions of equipment provided under Division 26, Electrical, that are not directly connected to PIC equipment.
 - (2) Internal portions of package system instrumentation and controls that are not directly connected to PIC equipment.

1.05 Submittals

- A. Submit shop drawings in accordance with the requirements of Section 01 33 23 of these Specifications. Specific submittal information shall include the following:
- 1. Submit proposed Submittal breakdown consisting of sequencing and packaging of information in accordance with Project Schedule.
 - 2. Identify proposed items, options, installed spares, and other provisions for future work (for example, reserved panel space; unused components, wiring, and terminals).
 - 3. Legends and Abbreviation Lists:

- 1) Definition of symbols and abbreviations used; for example, engineering units, flowstreams, instruments, structures, and other process items used in nameplates, legends, data sheets, point descriptions, HMI displays, alarm/status logs, and reports.
 - 2) Use identical abbreviations in PIC subsections.
 - 3) Submit updated versions as they occur.
4. Activity Completion:
- 1) Action Submittals: Completed when reviewed and approved.
 - 2) Informational Submittals: Completed when reviewed and found to meet conditions of the Contract.

B. Action Submittals

1. Bill of Materials: List of required equipment.
 - a. Group equipment items by enclosure and field, and within an enclosure, as follows:
 - 1) PIC Components: By component identification code.
 - 2) Other Equipment: By equipment type.
 - b. Data Included:
 - 1) Equipment tag number.
 - 2) Description.
 - (a) Manufacturer, complete model number and all options not defined by model number.
 - 3) Quantity supplied.
 - 4) Component identification code where applicable.
 - 5) For panels, include panel reference number and name plate inscription.
 - c. Formats: Hard copy and Microsoft Excel.
2. Catalog Cuts: I&C components, electrical devices, and mechanical devices:
 - 1) Catalog information, marked to identify proposed items and options.
 - 2) Descriptive literature.

- 3) External power and signal connections.
 - 4) Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.
3. Component Data Sheets: Data sheets for I&C components.
- a. Format:
 - 1) Similar to ISA TR20.00.01.
 - 2) Microsoft Excel, one component per data sheet.
 - 3) Submit proposed format for Component Data Sheets before completing data sheets for individual components.
 - b. Content: Specific features and configuration data for each component, including but not limited to:
 - 1) Tag Number.
 - 2) Component type identification code and description.
 - 3) Location or service.
 - 4) Service conditions.
 - 5) Manufacturer and complete model number.
 - 6) Size and scale range.
 - 7) Setpoints.
 - 8) Materials of construction.
 - 9) Options included.
 - 10) Power requirements.
 - 11) Signal interfaces.
 - 12) Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.
 - c. Electronic Copies: Microsoft Excel.
4. Sizing and Selection Calculations:
- a. Primary Elements:

- 1) Complete calculations plus process data used. Example for Flow Elements:
 - (a) Minimum and maximum values, permanent head loss, and assumptions made.
 - b. Controller, Computing, and Function Generating Modules: Actual scaling factors with units and how they were computed.
 - c. Electronic Copies: Microsoft Excel, one file for each group of components with identical sizing calculations.
5. Preliminary Panel Elevation Drawings: Provide prior to submitting Panel Construction Drawings:
- a. Scale Drawings: Show dimensions and location of front of panel devices.
 - b. Panel Legend (Bill of Material): List front of panel devices by tag number. Include nameplate inscriptions, service legends, and annunciator inscriptions.
 - c. Submit electronic copies of Drawings.
6. Panel Construction Drawings:
- a. Scale Drawings: Show dimensions and locations of panel-mounted devices, doors, louvers, subpanels, internal and external.
 - b. Panel Legend (Bill of Material): List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
 - c. Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.
 - d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.
 - e. Construction Notes: Finishes, wire color schemes, wire ratings, wire, terminal block numbering, and labeling scheme.
 - f. Existing Panels: Refurbished panel drawings showing internal (back and side panels) and external (Enclosure) layout of modifications provided under this contract.

g. Submit electronic copies of Drawings.

7. Detailed Wiring Diagrams:

a. Refer to Drawings for Detailed Wiring Diagrams including:

- 1) Panel Wiring Diagrams for discrete control and power circuits.
- 2) Loop Wiring Diagrams showing individual wiring diagram for each analog or pulse frequency loop.
- 3) Interconnecting Wiring Diagrams showing electrical connections between equipment, consoles, panels, terminal junction boxes, and field-mounted components.

b. Prepare as-built redline markup of detailed wiring diagrams. Show terminal numbers on switch blocks, relays, and internal components.

c. Submit electronic copies of Drawings.

8. Panel Wiring Diagrams:

a. Cover wiring within a panel including, but not limited to, instrumentation, control, power, and communications, and digital networks.

b. Objectives: For use in wiring panels, making panel connections, and future panel trouble shooting.

c. Existing Panels: Refurbished panels wiring diagrams shall show existing and new panel wiring and components, clearly showing modifications provided under this contract.

d. Diagram Type:

1) Ladder diagrams where applicable. Include devices that are mounted in or on the panel that require electrical connections. Show unique rung numbers on left side of each rung.

2) Schematic drawings for wiring of circuits that cannot be well represented by ladder diagrams.

e. Item Identification: Identify each item with attributes listed.

1) Wires: Wire number and color. Cable number if part of multiconductor cable.

2) Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.

- 3) Components:
 - (a) Tag number, terminal numbers, and location ("FIELD", enclosure number, or MCC number).
 - (b) Switching action (open or close on rising or falling process variable), setpoint value and units, and process variable description (for example, Sump Level High).
- 4) I/O Points: PLC unit number, I/O tag number, I/O address, terminal numbers, and terminal strip numbers.
- 5) Relay Coils:
 - (a) Tag number and its function.
 - (b) On right side of run where coil is located, list contact location by ladder number and sheet number. Underline normally closed contacts.
- 6) Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).
- 7) Communications and Networks: Network type, address or node identification, port or channel number, and type of connector.
 - (a) Show each circuit individually. No "typical" diagrams or "typical" wire lists will be allowed.
 - (b) Ground wires, surge protectors, and connections.
 - (c) Wire and Cable Names: Show names and wire color for circuits entering and leaving a panel. Refer to Division 26, Electrical.
9. Loop Wiring Diagrams: Individual, end-to-end wiring diagram for each analog and discrete or equipment loop.
 - a. Conform to the minimum requirements of ISA S5.4.
 - b. Under Paragraph 5.3 of ISA S5.4, include the information listed under Subparagraphs 2 and 6.
 - c. Show loop components within a panel and identify each component, component terminals, and panel terminals.
 - d. If a loop connects to panels or devices not provided under this section and its subsections, such as control valves, motor control centers, package system panels, variable speed drives, include the following information:

- 1) Show the first component connected to within the panel or device that is not provided under this section and its subsections.
- 2) Identify the component by tag and description.
- 3) Identify panel and component terminal numbers.
- e. Drawing Size: Individual 11 inch by 17 inch sheet for each loop.
- f. Divide each loop diagram into areas for panel face, back-of-panel, field and PLC.
- g. One Drawing Per Loop: Show each loop individually. No "typical" loop diagrams will be allowed.
- h. Show:
 - 1) Terminal numbers, location of dc power supply, and location of common dropping resistors.
 - 2) Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.
 - 3) Tabular summary on each analog loop diagram:
 - (a) Transmitting Instruments: Output capability.
 - (b) Receiving Instruments: Input impedance.
 - (c) Loop Wiring Impedance: Estimate based on wire sizes and lengths shown.
 - (d) Total loop impedance.
 - (e) Reserve output capacity.
 - 4) Circuit and raceway schedule names.
10. Panel Power Requirements and Heat Dissipation: For control panels tabulate and summarize:
 - a. Required voltages, currents, and phases(s). Include calculations and list assumptions.
 - b. Maximum heat dissipations Btu per hour. Include calculations and list assumptions.
 - c. Maximum permissible internal temperature based on operating range of internal components.

- d. Computed maximum internal temperature. Include calculations and list assumptions. Include the impacts of internal heat generation, solar radiation and shielding.
 - e. Use the ambient parameters listed in this section for the applicable service condition.
11. Communications and Digital Networks Diagrams:
- a. Scope: Includes connections to telephone system, Ethernet network, remote I/O, and fieldbus (for example, Modbus, Profibus, Foundation Fieldbus, Device Net, etc.).
 - b. Format: Network schematic diagrams for each different type of network.
 - c. Show:
 - 1) Interconnected devices, both passive and active.
 - 2) Device names and numbers.
 - 3) Terminal numbers.
 - 4) Communication Media: Type of cable.
 - 5) Connection Type: Type of connector.
 - 6) Node and device address numbers.
 - 7) Wire and cable numbers and colors.
12. Radio System for Remote Sites:
- a. Scope: Includes radio equipment, antennas, transmission cable, surge protection devices, mounting hardware, and radio configuration software and configuration backup files.
 - b. Format: Bill of materials, installation details, and as-installed radio signal strength test results for each remote site.
13. Installation Details: Include modifications or further details required and define installation of I&C components. Installation details shall show power source, signal wiring, mounting racks, terminal junction boxes, surge protection, and specific details for each site.
14. Spares, expendables, and test equipment.
15. Testing Submittals.
16. Training Submittals.

17. SCADA Standard Software Submittal: List of Standard SCADA software to be provided or upgraded under this Contract including all version, licenses numbers and machine hosting the software.

C. Informational Submittals:

1. Operation and Maintenance Data: In accordance with Section 01 78 23, Operation and Maintenance Data, and in addition the following:
 - a. General:
 - 1) Provide sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for PIC components.
 - 2) Submittal Format: Both hard copy and electronic copies for all submittals. Refer to Article Submittal Format.
2. Final versions of Legend and Abbreviation Lists.
3. Process and Instrumentation Diagrams: Marked up copy of revised P&ID to reflect as-built PIC design.
4. Provide the following items as defined under heading Action Submittals:
 - a. Bill of materials.
 - b. Catalog cuts.
 - c. Instrument list.
 - d. Component data sheets.
5. Detailed Wiring Diagrams: As-built drawings.
 - a. Panel wiring diagrams.
 - b. Loop diagrams.
 - c. Interconnecting wiring diagrams.
6. Panel plumbing diagrams.
7. Applications software documentation.
8. Updated I/O lists for all upgraded PLCs. Provide in Excel and PDF format.

D. Manufacturer's O&M manuals for components, electrical devices, and mechanical devices:

1. Content for Each O&M Manual:

- a. Table of Contents.
 - b. Operations procedures.
 - c. Installation requirements and procedures.
 - d. Maintenance requirements and procedures.
 - e. Troubleshooting procedures.
 - f. Calibration procedures.
 - g. Internal schematic and wiring diagrams.
 - h. Component and I/O Module Calibration Sheets from field quality control calibrations.
2. Provide PDF file with linked index to all manuals.
 3. List of spares, expendables, test equipment and tools provided.
 4. List of additional recommended spares, expendables, test equipment, and tools. Include quantities, unit prices, and total costs.
 5. Provide Manufacturer's Certificate of Proper Installation where specified.
 6. Sequencing and Scheduling Submittal: Workplan for sequencing and scheduling of all In-Plant upgrades and remote sites upgrades as specified and shown on the drawings.
 7. Testing Related Submittals:
 8. Factory Demonstration Test:
 - a. Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
 - b. Final Test Procedures:
 - 1) Proposed test procedures, forms, and checklists.
 - 2) Capacity, Timing, and Simulation: Describe simulation and monitoring methods used to demonstrate compliance with capacity and timing requirements.
 9. Test Documentation: Copy of signed off test results.
 10. Functional Test:
 - a. Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.

- b. Final Test Procedures: Proposed test procedures, forms, and checklists.
- c. Test Documentation:
 - 1) Copy of signed-off test results.
 - 2) Completed component calibration sheets.
- 11. Performance Test:
 - a. Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
 - b. Final Test Procedures: Proposed test procedures, forms, and checklists.
 - c. Test Documentation: Copy of signed-off test results.
- 12. Owner Training Plan: In accordance with Section 01 43 33, Manufacturer Services.
- 13. Backup RTU Programs: Provide to Owner on removable flash drive or external hard drive the following program files as loaded into the remote site RTU panels:
- 14. PLC programs.
- 15. OIT programs.
- 16. Radio Configuration files.

1.06 Coordination

- A. Coordinate with the Owner on the following items:
 - 1. IP Addresses.
 - 2. Modbus Node ID's.
 - 3. Device logins and passwords.
 - 4. Critical Alarms required for remote alarm notification.
 - 5. Refer to the following Supplemental
 - a. Supplement 1 - HMI and Historian Standards
 - b. Supplement 2 - PLC and Tag naming Standards

- c. Supplement 3 - Loop Status Report, Calibration Sheet & I&C Valve Adjustment Sheet

1.07 Delivery, Storage, and Handling

1. In accordance with Section 01 61 16 General Equipment Stipulations.
2. Prior to shipment, include corrosive inhibitive vapor capsules in shipping containers, and related equipment as recommended by capsule manufacturer.
3. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.
4. Cover panels and other elements that are exposed to dusty construction environments.

1.08 Extra Materials

1. As specified in PIC subsections.
2. In computing spare parts quantities based on specified percentages, round up to nearest whole number.
3. Spare Parts:

Description	Percent of Each Type and Size Used	Not Less Than
DC Power Supplies	20	1
Fuses	20	5
Relays	20	4
Surge Suppressors (each Type)	10	2
PLC CPU	20	1
PLC Communication Module	10	1
PLC RIO Module	10	1
PLC Analog Input Module	10	1
PLC Discrete Input Module	10	1
PLC Discrete Output Module	10	1
PLC Power Supply Module	10	1
Touchscreen (OIT)	10	1
Protocol Converter	10	1
Field Ethernet Switch	10	1
Core Network Ethernet Switch	10	1
Core Network Firewall	10	1
UPS	10	1

4. Expendables: For following items provide manufacturer's recommended 2 year supply, unless otherwise noted.
 - a. Vapor Corrosion Inhibitor capsules, 2-year supply per panel/RTU backplane provided.

Part 2 Products

2.01 General

- A. Provide PIC functions shown on Drawings and required in PIC subsections for each system and loop. Furnish equipment items required in PIC subsections. Furnish materials, equipment, and software, whether indicated or not, necessary to effect required system and loop performance.
 - B. First Named Manufacturer: PIC design is based on first named manufacturers of equipment, materials, and software.
 - a. If an item is proposed from other than first named manufacturer, obtain approval from Engineer for such changes in accordance with the General Conditions, Article 6.05 Substitutes and "Or Equals".
 - b. If proposed item requires, but not limited to, different installation, wiring, raceway, enclosures, intrinsically safe barriers, and accessories, provide such equipment and work.
2. Like Equipment Items:
 - a. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.
 - b. Implement same or similar functions in same or similar manner. For example, control logic, sequence controls, and display layouts.

2.02 Nameplates and Tags

- A. All field equipment, panel enclosures, and components shall be labeled to match design documents and panel drawings, and in adherence to Moccasin Bend Environmental Campus Standards.

Location	Background Color	Lettering Color	Lettering Height	Plate Size (Minimum)	Material and Mounting
Nameplate, Panel Door	Black	White	1/2"	2" x 12"	Laminated plastic, Stainless Steel Screws
Nameplate, Component, Panel Face	Black	White	3/16"	1" x 3"	Laminated plastic, Adhesive-backing
Nameplate, Component, Back of Panel	Black	White	3/16"	3/4" x 1-1/2"	Laminated plastic, Adhesive-backing
Legend Plate, Pushbuttons Lights, and Switches	White	Black	3/16"	2-1/4" Square	Laminated plastic, Keyed to component, secured by mounting nut
Legend, Component, Subpanel mounted	Black	White	3/16"	3/4" x 1-1/2"	Laminated plastic, Adhesive-backing
Nametags, Field Equipment	N/A	N/A	3/16"	5/8" x 2-1/2"	304 Stainless Steel, Stamped, 18-gauge stainless wire or screws.

2.03 Electrical Requirements

- A. Electrical Raceways: As specified under Division 26, Electrical.
- B. Wiring External to PIC Equipment:
 - 1. Special Control and Communications Cable: Provided by PIC System Integrator as noted in Component Specifications and PIC subsections.
 - 2. Other Wiring and Cable: As specified under Division 26, Electrical.
- C. I&C and electrical components, terminals, wires, and enclosures UL recognized or UL listed.
- D. Wires within Enclosures:
 - 1. AC Circuits:
 - a. Type: 600 volt, Type MTW stranded copper.
 - b. Size: For current to be carried, but not less than No. 18 AWG.
 - 2. Analog Signal Circuits:
 - a. Type: 600 volt stranded copper, twisted shielded pairs or triad with a 100 percent, aluminum-polyester shield, rated 60 degrees C.
 - b. Panels with Circuits Less Than 600 volts: Rated at 600 volts. Belden No. 18 AWG Type 9341, Triad Belden No. 1121A.

- c. Size: No. 18 AWG, minimum.
 - 3. Other dc Circuits.
 - a. Type: 600 volt, Type MTW stranded copper.
 - b. Size: For current carried, but not less than No. 18 AWG.
 - 4. Special Signal Circuits: Use manufacturer's standard cables.
 - 5. Wire Identification: Numbered and tagged at each termination.
 - a. Wire Tags: Machine printed, heat shrink.
 - b. Manufacturers:
 - 1) Brady Perma Sleeves.
 - 2) Tyco Electronics.
- E. Terminate and identify wires entering or leaving enclosures as follows:
- 1. Analog and discrete signal, terminate at numbered terminal blocks.
 - 2. Special signals terminated using manufacturer's standard connectors.
 - 3. Identify wiring in accordance with requirements under Division 26, Electrical.

2.04 Terminal Blocks for Enclosures:

- A. General: Terminal blocks shall be utilized for all wires entering or leaving a control panel. Special signals must be terminated using Manufacturer's standard connectors. Provide 10% spare installed terminals within the control panel, with a minimum of 5 terminals. All PLC I/O must be wired to terminal blocks, regardless of destination. Limit terminations to one wire for field wires entering enclosures, and two wires for internal panel wiring. Terminal blocks shall be DIN rail mounted with electronically printed wire markers. Manufacturer-supplied jumper bars are preferred where power distribution is required between blocks. Use the Manufacturer model below as a guide and select the proper model number based on wire size, voltage, and usage. Ground terminals shall be green and yellow, while Intrinsically Safe terminals shall be blue. Two-level terminal blocks are allowed only for Lift Stations, and panel retrofits where spacing is a concern.
- B. Connection Type: Screw compression clamp.
- C. Compression Clamp:
 - a. Complies with DIN VDE 0611.

- b. Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
 - c. Guides strands of wire into terminal.
- D. Screws: Hardened steel, captive and self-locking.
- E. Current Bar: Copper or treated brass.
- a. Product:
 - 1) Allen-Bradley, Jumper, Screw-Type Model 1492-CJJ5-10, or similar for compatibility with selected terminal blocks.
 - 2) Allen-Bradley, Jumper, Screw-Type, Model 1492-CJJ12-10, or similar for compatibility with selected terminal blocks.
- F. Insulation:
- a. Thermoplastic rated for minus 55 to plus 110 degrees C.
 - b. Two funneled shaped inputs to facilitate wire entry.
2. Mounting:
- a. Standard DIN rail.
 - b. Terminal block can be extracted from an assembly without displacing adjacent blocks.
 - c. End Stops: Minimum of one at each end of rail.
 - 1) Allen-Bradley, End Anchor, Model 1492-EAJ35.
 - 2) Allen-Bradley, End Barrier, Model 1492-N37.
 - d. Wire preparation: Stripping only permitted.
- G. Jumpers: Allow jumper installation without loss of space on terminal or rail.
- H. Marking System:
- a. Terminal number shown on both sides of terminal block.
 - b. Allow use of preprinted and field marked tags.
 - c. Terminal strip numbers shown on end stops.
 - d. Mark terminal block and terminal strip numbers as shown on Panel Control Diagrams and Loop Diagrams.

e. Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.

I. Terminal Block, General-Purpose (25 Amp):

- a. Rated Voltage: 600V AC/DC.
- b. Rated Current: 25 amp.
- c. Wire Size: 22 AWG to 12 AWG.
- d. Wire Range: 2.5mm.
- e. Color: Grey body.
- f. Spacing: 0.20 inch, maximum.
- g. Manufacturer and Product:
 - 1) Allen-Bradley, 2-level, Model 1492-JD3 (Lift Stations Only).
 - 2) Allen-Bradley, Model 1492-J3.

J. Terminal Block, General-Purpose (35 Amp):

1. Rated Voltage: 600V AC/DC.
2. Rated Current: 35 amp.
3. Wire Size: 22 AWG to 10 AWG.
4. Wire Range: 4mm.
5. Color: Grey body.
6. Spacing: 0.24 inch, maximum.
 - a. Manufacturer and Product:
 - 1) Allen-Bradley, Model 1492-J4.

K. Terminal Block, Ground:

- a. Wire Size: 22 AWG to 10 AWG.
- b. Wire Range: 4mm.
- c. Color: Green and yellow body.
- d. Spacing: 0.24 inch, maximum.

e. Grounding: Ground terminal blocks electrically grounded to the mounting rail.

f. Manufacturer and Product:

1) Allen-Bradley, Model 1492-JG4.

L. Terminal Block, Fused, 24V dc:

a. Rated Voltage: 10...57 AC/DC.

b. Rated Current: 15 amp.

c. Wire Size: 30 AWG to 12 AWG.

d. Color: Black w/ LED.

e. Fuse: 0.25 inch by 1.25 inches.

f. Indication: Red LED.

g. Spacing: 0.36 inch, maximum.

h. Manufacturer and Product:

1) Allen-Bradley, Model 1492-H5.

M. Terminal Block, Fused, 120V ac:

a. Rated Voltage: 110-600 VAC.

b. Rated Current: 30 amp.

c. Wire Size: 16 AWG to 4 AWG.

d. Color: Grey body.

e. Fuse: 0.41 inch by 1.5 inches.

f. Indication: Neon Lamp 110V ac.

g. Leakage Current: 2.0 mA, maximum.

h. Spacing: 0.71 inch, maximum

i. Manufacturer and Product:

1) Allen-Bradley, Model 1492-FB2C30-L (Lift Stations).

N. Bus Bar:

a. Material: Copper full sized throughout length.

- b. Neutral: Insulated, rated same as phase bus bars with at least one terminal screw for each branch circuit.
- c. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.
- d. Lugs and Connection Points:
 - e. Suitable for either copper or aluminum conductors.
 - f. Solderless main lugs for main, neutral, and ground bus bars.
 - g. Subfeed or through-feed lugs as shown.
- h. Manufacturers and Products:
 - i.

O. Power Distribution Block:

- a. Material: Copper full sized throughout length.
 - 1) Neutral: Insulated, rated same as phase bus bars with at least one terminal screw for each branch circuit.
 - b. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.
 - c. Lugs and Connection Points:
 - 1) Solderless main lugs for main, neutral, and ground bus bars. Subfeed or through-feed lugs as shown.
 - 2) Subfeed or through-feed lugs as shown.
 - d. Manufacturers and Products:
 - 1) Square-D, Power Distrib. Block, 3-P, 335A Copper, Model 9080LBA364108.

P. Circuit Breakers

- 1. General: Circuit breakers are required to safely power down individual components without affecting other equipment. Each control panel is required to have a Main Circuit Breaker for de-energizing the panel. No more than two devices may be connected to a branch circuit breaker. Amperage will vary depending on individual requirements of downstream equipment. Select the appropriate voltage and amperage specific to your application.

2. Manufacturer and Product:

- a. Square-D Full size Circuit Breaker, 15 or 20 Amp as required, Model QOU Series.
- b. Allen-Bradley Miniature Circuit Breaker, 50 Amp, Model 1492-SPM1C500 (Lift Stations).
- c. Allen-Bradley Miniature Circuit Breaker, 20 Amp, Model 1492-SPM1C200 (Lift Stations).
- d. Allen-Bradley Miniature Circuit Breaker, 10 Amp, Model 1492-SPM1C100 (Lift Stations).
- e. Allen-Bradley Miniature Circuit Breaker, 5 Amp, Model 1492-SPM1C050 (Lift Stations).
- f. Allen-Bradley Miniature Circuit Breaker, 2 Amp, Model 1492-SPM1C020 (Lift Stations).
- g. Allen-Bradley 480VAC, 125 Amp, Model 140G-G2C3D12 (Lift Stations).

Q. Grounding of Enclosures:

1. Furnish isolated copper grounding bus for signal and shield ground connections.
2. Ground this ground bus at a common signal ground point in accordance with National Electrical Code requirements.
3. Single Point Ground for Each Analog Loop:
 - a. Locate signal ground at dc power supply for loop.
 - b. Use to ground wire shields for loop.
 - c. Group and ground wire shields in following locations:
 - 1) Locate signal ground at dc power supply for loop.
 - 2) Use to ground wire shields for loop.
4. Ground terminal block rails to ground bus.

R. Analog Signal Isolators:

1. Furnish signal isolation for analog signals that are sent from one enclosure to another.

2. Do not wire in series instruments on different panels, cabinets, or enclosures.

S. Wiring Interface: Terminate and identify wiring entering or leaving enclosures.

1. Analog and Discrete Signal Wires: Terminate at numbered terminal blocks as shown on the wiring diagrams.
2. Wiring for Special Signals: Terminate communications, digital data, and multiplexed signals using manufacturer's standard connectors for the device to which the signals terminate.

T. Electrical Transient Protection:

1. General:
 - a. Function: Protect elements of PIC against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
 - b. Surge suppressors are not shown for external analog transmitters. Determine quantity and location, and show in Shop Drawings. Refer to example wiring in installation details in Drawings.
 - c. Provide, install, coordinate, and inspect grounding of surge suppressors at:
 - 1) Connection of ac power to PIC equipment including panels, consoles assemblies, and field-mounted analog transmitters and receivers.
 - 2) At the field and panel, console, or assembly connection of signal circuits that have portions of the circuit extending outside of a protective building.
2. Surge Suppressor Types: Reference Section 40 78 56, Isolators, Intrinsically-Safe Barriers, and Surge Suppressors.
3. Installation and Grounding of Suppressors:
 - a. As shown. See Surge Suppressor Installation Details.
 - b. Grounding equipment, installation of grounding equipment, and terminations for field mounted devices are provided under Division 26, Electrical.

U. Interposing Relays:

1. Provide an interposing relay in the circuit for each discrete output (DO).

2. Provide relays meeting the requirements in Section 40 78 53, Relays.

V. Accessories (Non-Climate Controlled):

1. Heater, Thermostat/Hygrostat:

a. General: Panels mounted outdoors or in non-climate-controlled areas must maintain internal temperature above the minimum rating of all components, including PLC's and power supplies. In addition, the heater should maintain the panel temperature below 65% humidity or the lowest rated panel component to prevent condensation from forming. Provide minimum clearance around heater as shown in the manufacturer's enclosure heaters spec sheet for proper circulation and safety.

b. Manufacturers and Products:

- 1) Hoffman, Heater, Touch-Safe, Model DAH Series.
- 2) Hoffman, Thermostat, 120VAC, Fahrenheit, Model THERM16F.
- 3) Hoffman, Hygrostat, Model AMHUM.

2. Breather and Drains: Furnish with NEMA 250, Type 4 and 4X panels:

a. General: Control Panels located outdoors are required to have a breather vent / drain to limit liquid buildup and condensation. Provide a suitable Explosion-proof version for use in Hazardous Environments.

b. Manufacturer and Product:

- 1) Crouse-Hinds, ½" Stainless Steel, Combination Breather / Drain, Model ECD15

W. Accessories (All Panels):

1. 120 AC Outlet:

a. General: Control Panels are required to have a minimum of one service outlet for use by maintenance staff. A dedicated UPS outlet is also required in panels with a UPS. Each outlet will be individually protected by a circuit breaker. Provide GFCI version for maintenance staff where panels are located in wet or outdoor environments.

b. Manufacturers and Products:

- 1) Allen-Bradley, DIN Rail mounted, 15 Amp, Model 1492-REC15.

- 2) Allen-Bradley, DIN Rail mounted, 15 Amp, GFCI, Model 1492-REC15G.
2. Panel Lighting:
- a. General: Provide one panel light for every four feet of horizontal space. The light shall be wired to a panel entry/intrusion switch for automatic lighting. Panel lighting shall not utilize the UPS circuit for power. Provide branch circuit breaker dedicated to panel lighting.
 - b. Manufacturers and Products:
 - 1) Super Bright LEDs, 12" light bar, warm white LED, Model LBFA-WW12.
 - 2) Super Bright LEDs, Adjustable Mounting Clip, Model LBFA-MC3.
 - 3) Super Bright LEDs, Interconnect Jumper, 72" long, Model LBFA-I183.
 - 4) Banner, LED Light Bar, Model WLB32ZC570PBQM.
 - 5) Banner, Quick-connect Cordset, Model LQMAC-306.
 - 6) Hoffman, Door Switch, Model ALFSWD.
3. Corrosion Protection:
- a. General: Provide a minimum of one corrosion inhibitor per control panel. Protection by one or more inhibitors shall cover entire volume of cabinet for a minimum of one year prior to replacement.
 - b. Manufacturers and Products:
 - 1) Northern Technologies Intl., Model Zerust Series.
 - 2) Hoffman, Model A-HCI Series.
4. Air Conditioner:
- a. General: Panels mounted outdoors or in non-climate-controlled areas must maintain internal temperature below the maximum rating of all components, including PLC's and power supplies. Perform heat dissipation calculations to determine if the panel requires active cooling from an Air Conditioner. Select an appropriately sized Air Conditioner unit based on the BTU's/hour of heat dissipation required.
 - b. Manufacturers and Products:

- 1) nVent, Include outdoor and heater options; match steel type and paint color of control panel, Model SpectraCool G-Series.
5. Heat Exchanger:
 - a. General: Panels mounted in temperature extremes, dusty/dirty areas, washdown locations, or corrosive environments located outdoors or in non-climate-controlled areas must maintain internal temperature below the maximum rating of all components, including PLC's and power supplies. Perform heat dissipation calculations to determine if the panel requires active cooling from a Heat Exchanger. Select an appropriately sized Heat Exchanger unit based on the BTU's/hour of heat dissipation required.
 - b. Manufacturers and Products:
 - 1) nVent, Heat Exchanger, Model ClimaGuard TX-Series.

2.05 Source Quality Control

2.06 General:

1. Engineer may actively participate in many of the tests.
2. Engineer reserves right to test or retest specified functions.
 - a. Engineer's decision will be final regarding acceptability and completeness of testing.
3. Procedures, Forms, and Checklists:
 - a. Except for Unwitnessed Factory Test, conduct tests in accordance with, and documented on, Engineer accepted procedures, forms, and checklists.
 - b. Describe each test item to be performed.
 - c. Have space after each test item description for sign off by appropriate party after satisfactory completion.
4. Required Test Documentation: Test procedures, forms, and checklists signed by Engineer and Contractor.
 - a. Conducting Tests:
 - b. Provide special testing materials and equipment.
 - c. Wherever possible, perform tests using actual process variables, equipment, and data.

- d. If not practical to test with real process variables, equipment, and data provide suitable means of simulation.
- e. Define simulation techniques in test procedures.
- f. Test Format: Cause and effect.
 - 1) Person conducting test initiates an input (cause).
 - 2) Specific test requirement is satisfied if correct result (effect), occurs.

B. Unwitnessed Factory Test:

- 1. Scope: Inspect and test PIC to ensure it is operational, ready for FDT.
- 2. Location: PIC System Integrator's facility.
- 3. Integrated Test:
 - a. Interconnect and test PIC, except for primary elements and smaller panels.
 - b. Exercise and test functions.
 - c. Provide stand-alone testing of smaller panels.
 - d. Simulate inputs and outputs for primary elements, final control elements, and panels excluded from test.

C. Factory Demonstration Tests (FDT):

- 1. Notify Engineer of test schedule 4 weeks prior to start of test.
- 2. Scope:
 - a. Test entire PIC, with exception of primary elements, final control elements, and certain smaller panels, to demonstrate it is operational.
 - b. Factory test all panels, and all RTU back panels and new panel enclosures, which includes the applications software (programming) and network connections between the systems. Simulate each I/O point and test the control logic per Loop Specifications.
 - c. Submit a detailed factory test plan for approval by the Engineer and the Owner. An approved test plan is a prerequisite to scheduling the factory test.
- 3. Location: PIC System Integrator's facility.

4. Correctness of wiring from panel field terminals to PLC system input/output points and to panel components.
 - a. Simulate each discrete signal at terminal strip.
 - b. Simulate correctness of each analog signal using current source.
 - c. For all applications software (Programming): Demonstrate user interface at the OIU level (where applicable) and at the HMI level. Provide all needed computer hardware and software licenses to adequately demonstrate all modifications in the factory prior to installation in the field.
5. Operation of communications between the PLC, OIU, VTScada, and pump control panel.
6. Loop-Specific Functions: Demonstrate functions shown on P&IDs, control diagrams, and loop specifications:
 - a. One of each type function; for example, if there are filter backwash sequence control for several identical filters, demonstrate controls for one filter.
 - b. One of each type of function in each panel; for example, but not limited to annunciator operation, controller operation, and recorder operation.
 - c. All required and shown functions for 100 percent of loops.
7. Non-Loop-Specific Functions:
 - a. Capacity: Demonstrate that PIC systems have required spare capacity for expansion. Include tests for both storage capacity and processing capacity.
 - b. Timing: Include tests for timing requirements.
 - c. Diagnostics: Demonstrate online and offline diagnostic tests and procedures.
8. Review all graphic screens with the Engineer for the remote sites OIU graphics, one of each type and VTScada graphics. Simulate both analog and discrete field inputs at the field terminal blocks of each control panel and RTU back panel and observe response on the SCADA HMI graphic screens and OIU. Simulate discrete outputs, analog outputs, and set points at the HMI graphic displays and OIU and observe response at the field terminal blocks. Test control logic per the loop specifications.
9. Correct deficiencies found and complete prior to shipment to Site.

10. Failed Tests:
 - a. Repeat and witnessed by Engineer.
 - b. With approval of Engineer, certain tests may be conducted by PIC System Integrator and witnessed by Engineer as part of Functional Test.
11. Make following documentation available to Engineer at test site both before and during FDT:
 - a. Drawings, Specifications, Addenda, and Change Orders.
 - b. Master copy of FDT procedures.
 - c. List of equipment to be tested including make, model, and serial number.
 - d. Approved hardware Shop Drawings for equipment being tested.
 - e. Approved preliminary software documentation Submittal.
12. Daily Schedule for FDT:
 - a. Begin each day with meeting to review day's test schedule.
 - b. End each day with each meeting to review day's test results and to review or revise next day's test schedule.

Part 3 Execution

3.01 Examination

- A. For equipment not provided by PIC System Integrator, but that directly interfaces with PIC, verify the following conditions:
 1. Proper installation.
 2. Calibration and adjustment of positioners and I/P transducers.
 3. Correct control action.
 4. Switch settings and dead bands.
 5. Opening and closing speeds and travel stops.
 6. Input and output signals.

3.02 Installation

- A. Material and Equipment Installation: Follow manufacturers' installation instructions, unless otherwise indicated or directed by Engineer.
- B. Wiring connected to PIC components and assemblies, including power wiring in accordance with requirements in Division 26.
- C. Electrical Raceways: As specified in Division 26.
- D. Mechanical Systems:
 - 1. Copper and Stainless Steel Tubing Support: Continuously supported by aluminum tubing raceway system.
 - 2. Plastic Tubing Support: Except as shown on Drawings, provide continuous support in conduit or by aluminum tubing raceway system.
 - 3. Install conduit for plastic tubing and tubing raceways parallel with, or at right angles to, structural members of buildings. Make vertical runs straight and plumb.
 - 4. Tubing and Conduit Bends:
 - a. Tool-formed without flattening, and of same radius.
 - b. Bend Radius: Equal to or larger than conduit and tubing manufacturer's recommended minimum bend radius.
 - c. Slope instrument connection tubing in accordance with installation details.
 - d. Do not run liquid filled instrument tubing immediately over or within a 3 foot plan view clearance of electrical panels, motor starters, or mechanical mounting panel without additional protection. Where tubing must be located in these zones, shield electrical device to prevent water access to electrical equipment.
 - e. Straighten coiled tubing by unrolling on flat surface. Do not pull to straighten.
 - f. Cut tubing square with sharp tubing cutter. Deburr cuts and remove chips. Do not gouge or scratch surface of tubing.
 - g. Blow debris from inside of tubing.
 - h. Make up and install fittings in accordance with manufacturer's recommendations. Verify make up of tube fittings with manufacturer's inspection gauge.

- i. Use lubricating compound or TFE tape on stainless steel threads to prevent seizing or galling.
 - j. Run tubing to allow but not limited to, clear access to doors, controls and control panels; and to allow for easy removal of equipment.
 - k. Provide separate support for components in tubing runs.
 - l. Supply expansion loops and use adapters at pipe, valve, or component connections for proper orientation of fitting.
 - m. Keep tubing and conduit runs at least 12 inches from hot pipes.
 - n. Locate and install tubing raceways in accordance with manufacturer's recommendations. Locate tubing to prevent spillage, overflow, or dirt from above.
 - o. Securely attach tubing raceways to building structural members.
5. Enclosure Lifting Rings: Remove rings following installation and plug holes.

E. Field Finishing: Refer to Division 09.

3.03 Field Quality Control

A. General:

1. Coordinate PIC testing with Owner and affected Subcontractors.
2. Notify Engineer of Performance Test schedule 4 weeks prior to start of test.
3. Engineer may actively participate in tests.
4. Engineer reserves right to test or retest specified functions.
5. Engineer's decision will be final regarding acceptability and completeness of testing.

B. Onsite Supervision:

1. Require PIC System Integrator to observe PIC equipment installation to extent required in order to provide Certificates of Proper Installation.
2. Require PIC site representative to supervise and coordinate onsite PIC activities.
3. Require PIC site representative to be onsite while onsite work covered by this section and PIC subsystems is in progress.

C. Testing Sequence:

1. Provide Functional Tests and Performance Tests for facilities as required to support staged construction and startup of plant.
2. Refer to 01 43 33 Manufacturer Services for testing requirements and 01 75 16 Starting of Systems for startup requirements.
3. Completion: When tests (except Functional Test) have been completed and required test documentation has been accepted.

D. Testing:

1. Prior to Facility Startup and Performance Evaluation period for each facility, inspect, test, and document that associated PIC equipment is ready for operation.
2. Preparation for Testing: Performed by PIC System Integrator to test and document PIC is ready for operation.
3. Loop/Component Inspections and Tests:
 - a. These inspections and tests will be spot checked by Engineer.
 - b. Check PIC for proper installation, calibration, and adjustment on loop-by-loop and component-by-component basis.
 - c. Provide space on forms for signoff by PIC System Integrator.
 - d. Use loop status report to organize and track inspection, adjustment, and calibration of each loop and include the following:
 - 1) Project name.
 - 2) Loop number.
 - 3) Tag number for each component.
 - 4) Checkoffs/Signoffs for Each Component:Tag/identification.
 - 5) Installation.
 - 6) Termination wiring.
 - 7) Termination tubing.
 - 8) Calibration/adjustment.
 - 9) Checkoffs/Signoffs for the
 - 10) Loop:Panel interface terminations.
 - 11) I/O interface terminations with PLCs.

- 12) I/O Signals for PLCs are Operational: Received/sent, processed, adjusted.
- 13) Total loop operational.
- 14) Space for comments.
- 15) Component calibration sheet for each active I&C component (except simple hand switches, lights, gauges, and similar items) and each PLCs I/O module and include the following:
 - (a) Project name.
 - (b) Loop number.
 - (c) Component tag number or I/O module number. Component code number for I&C elements.
 - (d) Manufacturer for I&C elements.
 - (e) Model number/serial number for I&C elements.
 - (f) Summary of Functional Requirements; For Example:
 - (1) Indicators and recorders, scale and chart ranges.
 - (2) Transmitters/converters, input and output ranges.
 - (3) Computing elements' function.
 - (4) Controllers, action (direct/reverse) and control modes (P, I, D).
 - (5) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).
 - (6) I/O Modules: Input or output.
 - (g) Calibrations, for example, but not limited to:
 - (1) Analog Devices: Actual inputs and outputs at 0, 10, 50, and 100 percent of span, rising and falling.
 - (2) Discrete Devices: Actual trip points and reset points.
 - (3) Controllers: Mode settings (P&ID).
 - (4) I/O Modules: Actual inputs or outputs of 0, 10, 50, and 100 percent of span, rising and falling.
 - (5) Space for comments.

- e. Maintain loop status reports, valve adjustment sheets, and component calibration sheets at Site, and make them available to Engineer at all times.
 - f. Engineer reviews loop status sheets and component calibration sheets and spot-check their entries periodically, and upon completion of Preparation for Testing. Correct deficiencies found.
 - g. FDT-Repeat:
 - 1) Repeat FDT onsite with installed PIC equipment and software.
 - 2) As listed in PIC subsections, certain portions of FDT may not require retesting.
 - 3) In general, this test shall not require witnessing. However, portions of this test, as identified by Engineer during original FDT shall be witnessed.
 - h. Forms: See Loop Status Report, Instrument Calibration Sheet, and I&C Valve Adjustment Sheet referenced in Article Supplements.
4. Functional Test:
- a. Scope: Confirm PIC, including applications software, is ready for operation.
 - b. Refer to PIC subsections for additional requirements.
 - c. Completed when Functional Test has been conducted and Engineer has spot-checked associated test forms and checklists in field.
5. Required Test Documentation: Test procedures, forms, and checklists. Signed by Engineer and Contractor except for Functional Test items signed only by Contractor.

E. Performance Test During and After Facility Startup:

1. Once a facility's Functional Test has been completed and that facility has been started up, perform a witnessed Performance Test on associated PIC equipment to demonstrate that it is operating as required by Contract Documents. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.
2. Loop-specific and non-loop-specific tests same as required for FDT except that entire installed PIC tested using actual process variables and functions demonstrated.

3. Perform local and manual tests for each loop before proceeding to remote and automatic modes.
4. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.
5. Make updated versions of documentation required for Performance Test available to Engineer at Site, both before and during tests.
6. Make O&M data available to Engineer at Site both before and during testing.
7. Follow daily schedule required for FDT.
8. Determination of Ready for Operation: When Functional Test has been completed.

3.04 Manufacturer Services

- A. Manufacturer's Representative: As required by each PIC subsection.
- B. See Section 01 43 33, Manufacturer Services.

3.05 Training

- A. General:
 - a. Provide an integrated training program for Owner's personnel.
 - b. Perform training to meet specific needs of Owner's personnel.
 - c. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
 - d. Provide instruction on one working shift as needed to accommodate the Owner's personnel schedule.
 - e. Owner reserves the right to reuse videotapes of training sessions.
- B. Operations and Maintenance Training:
 1. General
 - a. Operations and Maintenance Training: For Owner's operations personnel on operation of I&C components.

- b. Training Session Duration: One instructor days.
- c. Number of Training Sessions: Two.
- d. Location: Each Project Site.
- e. Course Objective: Develop skills needed to use I&C components and functions to monitor and control the plant on a day-to-day basis and routing maintenance.
- f. Content: Conduct training on loop-by-loop basis.
 - 1) Loop Functions: Understanding of loop functions, including interlocks for each loop.
 - 2) Loop Operation: For example, adjusting process variable setpoints, AUTO/MANUAL control transfer, AUTO and MANUAL control, annunciator acknowledgement and resetting.
 - 3) Interfaces with PIC subsystems.
 - 4) Component calibration.
 - 5) Adjustments: For example, controller tuning constants, current switch trip points, and related items.
 - 6) Troubleshooting and diagnosis for equipment and software.
 - 7) Replacing lamps, chart paper, and fuses.
 - 8) I&C components removal and replacement.
 - 9) Periodic preventive maintenance.

C. Cleaning

- 1. Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

3.06 Protection

- A. Use corrosion-inhibiting vapor capsules in enclosures to protect electrical, instrumentation, and control devices, including spare parts, from corrosion.
- B. Periodically replace capsules based on capsule manufacturer's recommendations.

3.07 Supplements

- A. Supplements listed below, following "End of Section," are part of this Specification.

1. Supplement 1 - HMI and Historian Standards.
2. Supplement 2 - PLC and Tag naming Standards.
3. Supplement 3 - Loop Status Report, Instrument Calibration Sheet, I&C Valve Adjustment Sheet.

END OF SECTION

Part 1 General

1.01 Summary

- A. This section gives general requirements for Free-Standing Panels where required under Sections 40 67 00, Control System Equipment Panels and Racks, and 40 69 00, Packaged Control Systems, as part of a complete control panel. The Integrator is solely responsible for selecting the appropriate panel style, material, and NEMA rating for a specific environment. Panels shall be sized appropriately with 20% spare capacity (unused white space) on the subpanel. Provide louvers, vents, washable filters, fans, thermostat, heater, or Air Conditioner to maintain temperature range noted for each area. Subpanels shall be painted steel unless otherwise noted. Dead-front doors and swingout panels shall be provided if required for safety or security on a specific project. Hoffman and Saginaw are preferred manufacturers.

1.02 Submittals

- A. Submit shop drawings in accordance with the requirements of Section 01 33 23 of these Specifications. Specific submittal information shall include the following:
1. The Contractor shall calculate heat load of the control panel under full-load conditions for determining panel heating and cooling requirements of Section 40 67 00 of these Specifications.

Part 2 Products

2.01 Outdoor, Non-Corrosive (20°-104°F)

- A. At a minimum, all outdoor panels shall be rated NEMA 4X 304 Stainless, painted white, and lockable. Provide polycarbonate enclosures for harsh chemical environments where stainless steel would be less suitable. Refer to the Corrosive section for fiberglass enclosures. Include a breather vent / drain for each outdoor enclosure, as noted in the Panel Accessories section.
- B. Manufacturers and Products:
1. Hoffman, 2-door, Floor Stands, 72"x72"x24", 4x, Stainless, Clamps, Model A60H3612SS

2.02 Indoor, Conditioned (60°-80°F)

- A. Panels shall be NEMA 12, painted steel, with optional locking capability.
- B. Manufacturers and Products:

1. Hoffman, Free-Standing, 72"x30"x18", NEMA 12, Painted Steel, Handle, Model A723018FS.

2.03 Indoor, Not Conditioned (20°-104°F)

- A. Panels shall be NEMA 12, painted steel, with optional locking capability.
- B. Manufacturers and Products:
 1. Hoffman, Free-Standing, 72"x30"x18", NEMA 12, Painted Steel, Handle, Model A723018FS.

2.04 Corrosive (20°-104°F)

- A. The Integrator is solely responsible for selecting the appropriate material and NEMA rating for a specific environment. Panels shall be NEMA 4X and lockable.
- B. Manufacturers and Products:
 1. Hoffman, Free-Standing, 72"x30"x18", NEMA 12, Painted Steel, Handle, Model A723018FS.

Part 3 Execution

3.01 Installation, General

- A. Install in full accordance with manufacturer's instructions and recommendations.
- B. All panel penetrations must incorporate devices or covers that meet or exceed the panel rating to prevent derating the enclosure.

3.02 Identification

1. Control Panel shall be labeled to match design documents and panel drawings, and in adherence to Moccasin Bend Environmental Campus Standards. Refer to requirements of Section 40 67 00 of these Specifications for label material, lettering, coloring, sizing, and mounting requirements.

END OF SECTION

Part 1 General

1.01 Summary

- A. This section gives general requirements for Power Supplies where required under Sections 40 67 00, Control System Equipment Panels and Racks, and 40 69 00, Packaged Control Systems, as part of a complete control panel.

1.02 Submittals

- A. Submit shop drawings in accordance with the requirements of Section 01 33 23 of these Specifications. Specific submittal information shall include the following:
1. The Contractor shall furnish submittal data calculating the maximum power consumption on the load side of the UPS under full-load to determine battery runtime.
 2. The Contractor shall furnish line and load fuse sizes sufficient to protect the power supply and provide branch circuit protection.
 3. The Contractor shall ensure all upstream circuit breakers are properly sized to accommodate the UPS under full-load conditions.
 4. The Contractor shall calculate heat load of the UPS system under full-load conditions for determining panel heating and cooling requirements of Section 40 67 00 of these Specifications.

Part 2 Products

2.01 Uninterruptible Power Supply (Lift Stations only)

- A. Provide isolated, regulated uninterrupted ac output power during a complete or partial interruption of incoming line power.
1. Capacity: As noted.
 - a. Input Power:
 - 1) 120V ac single-phase, 60 Hz, unless otherwise noted.
 - 2) Connections: Manufacturer's standard, unless otherwise noted.
 - b. Output Power:
 - 1) 120V ac single-phase, 60 Hz, unless otherwise noted.
 - 2) Connections: Manufacturer's standard, unless otherwise noted.

- c. On-line Efficiency: 85 percent minimum, unless otherwise noted.
- d. Backup Runtime:
 - 1) Full Load: 9 minutes minimum, unless otherwise noted.
 - 2) Half Load: 20 minutes minimum, unless otherwise noted.
 - 3) Continuous no-break power with no measurable transfer time.
- e. Sine-Wave Output Voltage Total Harmonic Distortion (THD): Plus or minus 6 percent or less.
- f. Input Voltage Range: Plus 15 percent, minus 20 percent.
- g. Output Voltage Regulation: Plus or minus 3 percent nominal.
- h. Operating Temperature: 0 degree to 40 degrees C (32 degrees to 104 degrees F).
- i. Operating Relative Humidity: 0 percent to 95 percent without condensation.
- j. Enclosure: Freestanding, unless otherwise noted.
- k. Ports:
 - 1) Six NEMA 5-15R (battery backup).
 - 2) Three NEMA 5-15R (Surge Protected).
 - 3) Two USB Charging Ports.
- l. Manufacturers and Products: (Type 1)
 - 1) APC, Model BE850M2.

Part 3 Execution

3.01 Installation, General

- A. Install in full accordance with manufacturer's instructions and recommendations.
- B. Provide adequate clearance on all sides of UPS for sufficient convection in consideration of heat radiation.
- C. Panel enclosure lights and heaters shall not be powered from the load side of the UPS.

- D. For free-standing UPS units, provide a fabricated metal stand with cinch straps to secure UPS to the stand.

3.02 Identification

- A. Equipment shall be labeled on subpanels to match design documents and panel drawings, and in adherence to Moccasin Bend Environmental Campus Standards. Refer to requirements of Section 40 67 00 of these Specifications for label material, lettering, coloring, sizing, and mounting requirements.

END OF SECTION

Part 1 General

1.01 Summary

- A. This section gives general requirements for Packaged Control Systems where required by project Plans and Specifications.

1.02 References

- A. The following is a list of standards which may be referenced in this section and other subsections:
1. American National Standards Institute (ANSI).
 2. Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
 3. National Electrical Code (NEC).
 4. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. ICS 1, Industrial Control and Systems General Requirements.
 - 1) ICS 2, Industrial Control Devices, Controllers and Assemblies.
 - 2) AB 1, Molded Case Circuit Breakers and Molded Case Switches.
 5. National Fire Protection Association (NFPA): 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities. 70, National Electrical Code (NEC).
 6. Underwriters Laboratory, Inc. (UL): 508A, Standard for Safety, Industrial Control Panels. 698A, Hazardous Control Panels.

1.03 Definitions

- A. Abbreviations:
1. PIC: Process Instrumentation and Control.
 2. PLC: Programmable Logic Controller.
 3. RTU: Remote Terminal Unit.
 4. SCADA: Supervisory Control and Data Acquisition.

1.04 System Description

- A. Assemble panels and install instruments, plumbing, and wiring in equipment manufacturer's factories.
 - 1. Test panels and panel assemblies for proper operation prior to shipment from equipment manufacturer's factory.

1.05 Submittals

- A. Action Submittals
 - 1. Bill of material, catalog information, descriptive literature, wiring diagrams, and Shop Drawings for components of control system.
 - 2. Catalog information on electrical devices furnished with system.
 - 3. Shop Drawings, catalog material, and dimensional layout drawings for control panels and enclosures.
 - 4. Panel elementary diagrams of prewired panels. Include in diagrams control devices and auxiliary devices, for example, relays, alarms, fuses, lights, fans, and heaters.
 - 5. Plumbing diagrams of pre-plumbed panels and interconnecting plumbing diagrams.
 - 6. Interconnection wiring diagrams that include numbered terminal designations showing external interfaces.
 - 7. Panel Power Requirements and Heat Dissipation: As defined in Section 40 67 00, Control System Equipment Panels and Racks.
 - 8. Intrinsic Safety Data: Provide calculations, tables and other data that document entity method application to each circuit using intrinsic safety as a means of dealing with classified area requirements. Include intrinsic safety parameters for devices (maximum voltage allowed, maximum current allowed, internal capacitance, internal inductance, etcetera) and barriers (open circuit voltage, short circuit current, allowed capacitance, and allowed inductance) for all devices in all circuits.
 - 9. Programmable Controller Submittals:
 - a. Hardware Documentation:
 - 1) Provide the following for all elements of the PLC:

- (a) Block Diagram: A diagram showing all major system components. Identify components by manufacturer and model number. Show interconnecting cables diagrammatically.
 - (b) Bill of Materials: A list of all PLC components. Group components by type and include:
 - (c) Component manufacturer, model number, and part number.
 - (d) Component description.
 - (e) Quantity supplied.
 - b. Software Design Submittal: Provides a detailed description on the application program during applications program development and well before submission of the Preliminary Software Documentation. Include all PLC and OIU applications software.
10. Informational Submittals: Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturer Services.

1.06 Coordination

- A. Coordinate with the Owner on the following items:
 - 1. IP Addresses.
 - 2. Modbus Node ID's.
 - 3. Device logins and passwords.
 - 4. Critical Alarms required for remote alarm notification.

1.07 Delivery, Storage, and Handling

- A. Prior to shipment, include corrosive inhibitive vapor capsules in shipping containers, and related equipment as recommended by capsule manufacturer.

Part 2 Products

2.01 General

- A. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), UL 508 or 698A, state and local codes, and applicable sections of NEMA, ANSI, and ICECA.
- B. Conform to NEMA ratings as specified in individual equipment sections.
- C. Cutouts shall be cut, punched, or drilled and finished smoothly with rounded edges.

2.02 Nameplates and Tags

- A. All field equipment, panel enclosures, and components shall be labeled to match design documents and panel drawings, and in adherence to Moccasin Bend Environmental Campus Standards.

Location	Background Color	Lettering Color	Lettering Height	Plate Size (Minimum)	Material and Mounting
Nameplate, Panel Door	Black	White	1/2"	2" x 12"	Laminated plastic, Stainless Steel Screws
Nameplate, Component, Panel Face	Black	White	3/16"	1" x 3"	Laminated plastic, Adhesive-backing
Nameplate, Component, Back of Panel	Black	White	3/16"	3/4" x 1-1/2"	Laminated plastic, Adhesive-backing
Legend Plate, Pushbuttons Lights, and Switches	White	Black	3/16"	2-1/4" Square	Laminated plastic, Keyed to component, secured by mounting nut
Legend, Component, Subpanel mounted	Black	White	3/16"	3/4" x 1-1/2"	Laminated plastic, Adhesive-backing
Nametags, Field Equipment	N/A	N/A	3/16"	5/8" x 2-1/2"	304 Stainless Steel, Stamped, 18-gauge stainless wire or screws.

2.03 Programmable Controllers

- A. As defined in Section 40 63 43, Programmable Logic Controllers, Section 2.01.

2.04 Ethernet Network Switches

- A. As defined in Section 40 66 36, Process Instrumentation Networks, Section 2.01.

2.05 Control Panels

- A. As defined in Section 40 63 43, Section 40 67 16, Free-Standing Panels, and Section 40 67 19, Wall-Mounted Panels.

- B. UL Listing Mark for Enclosures: Mark stating "Listed Enclosed Industrial Control Panel" per UL 508A, or UL698A if required.
- C. Safety-Related Nameplates: As required by applicable codes and standards including NFPA 79 and UL 508A. Provide a warning nameplate on all control panel enclosures with circuits with more than one electrical supply. For example, any panel with dry contacts in a circuit powered elsewhere.
- D. I&C and electrical components, terminals, wires, and enclosures UL recognized or UL listed.
- E. Control Panels with Three-Phase Power Supplies and Motor Starters:
 - 1. Interlock main circuit breaker with panel door.
 - 2. Mount logic controls, branch circuit breakers, overload reset switches, and other control circuit devices.
 - a. Mount operator controls and indications on front access door.
 - 3. Circuit Breakers:
 - a. In accordance with NEMA AB 1.
 - b. Breakers, except Motor Branch Breakers: Molded case thermal magnetic.
 - c. 42,000 ampere RMS symmetrical rating, minimum at 480 volts, unless otherwise specified in package system equipment specification sections.
 - d. Tripping: Indicate with operator handle position.
 - e. Magnetic Motor Starters:
 - 1) Full voltage, NEMA ICS 2, Class A, Size O minimum.
 - 2) Include three-pole bimetallic or eutectic alloy thermal overload relays sized for each motor.
 - 3) Manual reset type with reset button mounted on panel door.
 - 4) Motor Control: 120V ac (except intrinsically safe circuits where applicable).
 - f. Power Control Transformer:
 - 1) Sufficient capacity to serve connected load, including 200VA for duplex outlet plus 100VA (minimum).

- 2) Limit voltage variation to 15 percent during contact pickup.
 - 3) Fuse one side of secondary winding and ground the other.
 - 4) Furnish primary winding fuses in ungrounded conductors.
4. Power Monitoring Relay:
- a. Protect three-phase equipment from single phasing, phase imbalance, or phase reversal.
 - b. Separate, isolated contact outputs to stop motors and activate alarm light during abnormal conditions.
 - c. Transient Voltage Protection: 10,000 volts.
 - d. Manufacturer and Product: Furnas; Class 47.
5. Power Distribution Blocks: Furnish to parallel feed tap on branch circuit protective devices. Do not "leap frog" power conductors.
6. Terminations for Power Conductors: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

2.06 Relays

- A. As defined in Section 40 78 53, Relays.

2.07 Intrinsic Safety and Surge Protection

- A. As defined in Section 40 78 56, Isolators, Intrinsically-Safe Barriers, and Surge Suppressors.

2.08 Power Supplies

- A. As defined in Section 40 78 59, Power Supplies.

2.09 Selector Switches, Pushbuttons, and Indicating Lights

- A. As defined in Section 40 78 19, Switches and Push Buttons, and Section 40 78 16, Indicating Lights.

2.10 Operator Interface Terminals

- A. As defined in Section 40 62 63, Operator Interface Terminals (OIT).

2.11 Electrical Requirements

- A. Electrical Raceways: As specified under Division 26, Electrical.

- B. Wiring External to Control Panel Equipment:
 - 1. Wiring and Cable: As specified under Division 26, Electrical.
- C. I&C and electrical components, terminals, wires, and enclosures UL recognized or UL listed.
- D. Wires within Enclosures:
 - 1. AC Circuits:
 - a. Type: 600 volt, Type MTW stranded copper.
 - b. Size: For current to be carried, but not less than No. 18 AWG.
 - 2. Analog Signal Circuits:
 - a. Type: 600 volt stranded copper, twisted shielded pairs or triad with a 100 percent, aluminum-polyester shield, rated 60 degrees C.
 - b. Panels with Circuits Less Than 600 volts: Rated at 600 volts. Belden No. 18 AWG Type 9341, Triad Belden No. 1121A.
 - c. Size: No. 18 AWG, minimum.
 - 3. Other dc Circuits.
 - a. Type: 600 volt, Type MTW stranded copper.
 - b. Size: For current carried, but not less than No. 18 AWG.
 - 4. Special Signal Circuits: Use manufacturer's standard cables.
 - 5. Wire Identification: Numbered and tagged at each termination.
 - a. Wire Tags: Machine printed, heat shrink.
 - b. Manufacturers:
 - 1) Brady Perma Sleev.
 - 2) Tyco Electronics.
- E. Terminate and identify wires entering or leaving enclosures as follows:
 - 1. Analog and discrete signal, terminate at numbered terminal blocks.
 - 2. Special signals terminated using manufacturer's standard connectors.
 - 3. Identify wiring in accordance with requirements under Division 26, Electrical.

F. Terminal Blocks for Enclosures:

1. General: Terminal blocks shall be utilized for all wires entering or leaving a control panel. Special signals must be terminated using Manufacturer's standard connectors. Provide 10% spare installed terminals within the control panel, with a minimum of 5 terminals. All PLC I/O must be wired to terminal blocks, regardless of destination. Limit terminations to one wire for field wires entering enclosures, and two wires for internal panel wiring. Terminal blocks shall be DIN rail mounted with electronically printed wire markers. Manufacturer-supplied jumper bars are preferred where power distribution is required between blocks. Use the Manufacturer model below as a guide and select the proper model number based on wire size, voltage, and usage. Ground terminals shall be green and yellow, while Intrinsically Safe terminals shall be blue. Two-level terminal blocks are allowed only for Lift Stations, and panel retrofits where spacing is a concern.
2. Connection Type: Screw compression clamp.
3. Compression Clamp:
 - a. Complies with DIN VDE 0611.
 - b. Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
 - c. Guides strands of wire into terminal.
4. Screws: Hardened steel, captive and self-locking.
5. Current Bar: Copper or treated brass.
 - a. Product:
 - 1) Allen-Bradley, Jumper, Screw-Type Model 1492-CJJ5-10, or similar for compatibility with selected terminal blocks.
 - 2) Allen-Bradley, Jumper, Screw-Type, Model 1492-CJJ12-10, or similar for compatibility with selected terminal blocks.
6. Insulation:
 - a. Thermoplastic rated for minus 55 to plus 110 degrees C.
 - b. Two funneled shaped inputs to facilitate wire entry.
7. Mounting:
 - a. Standard DIN rail.

- b. Terminal block can be extracted from an assembly without displacing adjacent blocks.
 - c. End Stops: Minimum of one at each end of rail.
 - 1) Allen-Bradley, End Anchor, Model 1492-EAJ35.
 - 2) Allen-Bradley, End Barrier, Model 1492-N37.
 - d. Wire preparation: Stripping only permitted.
8. Jumpers: Allow jumper installation without loss of space on terminal or rail.
9. Marking System:
- a. Terminal number shown on both sides of terminal block.
 - b. Allow use of preprinted and field marked tags.
 - c. Terminal strip numbers shown on end stops.
 - d. Mark terminal block and terminal strip numbers as shown on Panel Control Diagrams and Loop Diagrams.
 - e. Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.
10. Terminal Block, General-Purpose (25 Amp):
- a. Rated Voltage: 600V AC/DC.
 - b. Rated Current: 25 amp.
 - c. Wire Size: 22 AWG to 12 AWG.
 - d. Wire Range: 2.5mm.
 - e. Color: Grey body.
 - f. Spacing: 0.20 inch, maximum.
 - g. Manufacturer and Product:
 - 1) Allen-Bradley, Model 1492-J3
11. Terminal Block, General-Purpose (35 Amp):
- a. Rated Voltage: 600V AC/DC.
 - b. Rated Current: 35 amp.
 - c. Wire Size: 22 AWG to 10 AWG.

- d. Wire Range: 4mm.
 - e. Color: Grey body.
 - f. Spacing: 0.24 inch, maximum.
 - g. Manufacturer and Product:
 - 1) Allen-Bradley, Model 1492-J4
12. Terminal Block, Ground:
- a. Wire Size: 22 AWG to 10 AWG.
 - b. Wire Range: 4mm.
 - c. Color: Green and yellow body.
 - d. Spacing: 0.24 inch, maximum.
 - e. Grounding: Ground terminal blocks electrically grounded to the mounting rail.
 - f. Manufacturer and Product:
 - 1) Allen-Bradley, Model 1492-JG4.
13. Terminal Block, Fused, 24V dc:
- a. Rated Voltage: 10...57 AC/DC.
 - b. Rated Current: 15 amp.
 - c. Wire Size: 30 AWG to 12 AWG.
 - d. Color: Black w/ LED.
 - e. Fuse: 0.25 inch by 1.25 inches.
 - f. Indication: Red LED.
 - g. Spacing: 0.36 inch, maximum.
 - h. Manufacturer and Product:
 - 1) Allen-Bradley, Model 1492-H5.
14. Terminal Block, Fused, 120V ac:
- a. Rated Voltage: 110-600 VAC.
 - b. Rated Current: 30 amp.

- c. Wire Size: 16 AWG to 4 AWG.
- d. Color: Grey body.
- e. Fuse: 0.41 inch by 1.5 inches.
- f. Indication: Neon Lamp 110V ac.
- g. Leakage Current: 2.0 mA, maximum.
- h. Spacing: 0.71 inch, maximum
- i. Manufacturer and Product:
 - 1) Allen-Bradley, Model 1492-FB2C30-L.

15. Bus Bar:

- a. Material: Copper full sized throughout length.
- b. Neutral: Insulated, rated same as phase bus bars with at least one terminal screw for each branch circuit.
- c. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.
- d. Lugs and Connection Points:
 - 1) Suitable for either copper or aluminum conductors.
 - 2) Solderless main lugs for main, neutral, and ground bus bars.
 - 3) Subfeed or through-feed lugs as shown.
- e. Manufacturers and Products:
 - 1) Allen-Bradley, Power Feed, Bus Bar Offset Lug, Model 1492-AAT1LP.

16. Power Distribution Block:

- a. Material: Copper full sized throughout length.
- b. Neutral: Insulated, rated same as phase bus bars with at least one terminal screw for each branch circuit.
- c. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.
- d. Lugs and Connection Points:

- 1) Suitable for either copper or aluminum conductors.
- 2) Solderless main lugs for main, neutral, and ground bus bars.
- 3) Subfeed or through-feed lugs as shown.

e. Manufacturers and Products:

- 1) Square-D, Power Distrib. Block, 3-P, 335A Copper, Model 9080LBA364108.

G. Circuit Breakers

1. General: Circuit breakers are required to safely power down individual components without affecting other equipment. Each control panel is required to have a Main Circuit Breaker for de-energizing the panel. No more than two devices may be connected to a branch circuit breaker. Amperage will vary depending on individual requirements of downstream equipment. Select the appropriate voltage and amperage specific to your application.
2. Manufacturer and Product:
 - a. Square-D Full size Circuit Breaker, 15 or 20 Amp as required, Model QOU Series.

H. Grounding of Enclosures:

1. Furnish isolated copper grounding bus for signal and shield ground connections.
2. Ground this ground bus at a common signal ground point in accordance with National Electrical Code requirements.
3. Single Point Ground for Each Analog Loop:
 - a. Locate signal ground at dc power supply for loop.
 - b. Use to ground wire shields for loop.
 - c. Group and ground wire shields in following locations:
 - 1) Locate signal ground at dc power supply for loop.
 - 2) Use to ground wire shields for loop.
4. Ground terminal block rails to ground bus.

I. Analog Signal Isolators:

1. Furnish signal isolation for analog signals that are sent from one enclosure to another.
 2. Do not wire in series instruments on different panels, cabinets, or enclosures.
- J. Wiring Interface: Terminate and identify wiring entering or leaving enclosures.
1. Analog and Discrete Signal Wires: Terminate at numbered terminal blocks as shown on the wiring diagrams.
 2. Wiring for Special Signals: Terminate communications, digital data, and multiplexed signals using manufacturer's standard connectors for the device to which the signals terminate.
- K. Electrical Transient Protection:
1. 1. General:
 - a. Function: Protect elements of PIC against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
 - b. Surge suppressors are not shown for external analog transmitters. Determine quantity and location, and show in Shop Drawings. Refer to example wiring in installation details in Drawings.
 - c. Provide, install, coordinate, and inspect grounding of surge suppressors at:
 - 1) Connection of ac power to PIC equipment including panels, consoles assemblies, and field-mounted analog transmitters and receivers.
 - 2) At the field and panel, console, or assembly connection of signal circuits that have portions of the circuit extending outside of a protective building.
 2. Surge Suppressor Types: Reference Section 40 78 56, Isolators, Intrinsically-Safe Barriers, and Surge Suppressors.
 3. Installation and Grounding of Suppressors:
 - a. As shown. See Surge Suppressor Installation Details.
 - b. Grounding equipment, installation of grounding equipment, and terminations for field mounted devices are provided under Division 26, Electrical.

L. Interposing Relays:

1. Provide an interposing relay in the circuit for each discrete output (DO).
2. Provide relays meeting the requirements in Section 40 78 53, Relays.

M. Accessories (Non-Climate Controlled):

1. Heater, Thermostat/Hygrostat:
 - a. General: Panels mounted outdoors or in non-climate-controlled areas must maintain internal temperature above the minimum rating of all components, including PLC's and power supplies. In addition, the heater should maintain the panel temperature below 65% humidity or the lowest rated panel component to prevent condensation from forming. Provide minimum clearance around heater as shown in the manufacturer's enclosure heaters spec sheet for proper circulation and safety.
2. Manufacturers and Products:
 - a. Hoffman, Heater, Touch-Safe, Model DAH Series.
 - b. Hoffman, Thermostat, 120VAC, Fahrenheit, Model THERM16F.
 - c. Hoffman, Hygrostat, Model AMHUM.
3. Breather and Drains: Furnish with NEMA 250, Type 4 and 4X panels:
 - a. General: Control Panels located outdoors are required to have a breather vent / drain to limit liquid buildup and condensation. Provide a suitable Explosion-proof version for use in Hazardous Environments.
 - b. Manufacturer and Product:
 - 1) Crouse-Hinds, ½" Stainless Steel, Combination Breather / Drain, Model ECD15

N. Accessories (All Panels):

1. 120 AC Outlet:
 - a. General: Control Panels are required to have a minimum of one service outlet for use by maintenance staff. A dedicated UPS outlet is also required in panels with a UPS. Each outlet will be individually protected by a circuit breaker. Provide GFCI version for maintenance staff where panels are located in wet or outdoor environments.
 - b. Manufacturers and Products:

- 1) Allen-Bradley, DIN Rail mounted, 15 Amp, Model 1492-REC15.
 - 2) Allen-Bradley, DIN Rail mounted, 15 Amp, GFCI, Model 1492-REC15G.
2. Panel Lighting:
- a. General: Provide one panel light for every four feet of horizontal space. The light shall be wired to a panel entry/intrusion switch for automatic lighting. Panel lighting shall not utilize the UPS circuit for power. Provide branch circuit breaker dedicated to panel lighting.
 - b. Manufacturers and Products:
 - 1) Super Bright LEDs, 12" light bar, warm white LED, Model LBFA-WW12.
 - c. Super Bright LEDs, Adjustable Mounting Clip, Model LBFA-MC3.
 - d. Super Bright LEDs, Interconnect Jumper, 72" long, Model LBFA-I183.
 - e. Banner, LED Light Bar, Model WLB32ZC570PBQM.
 - f. Banner, Quick-connect Cordset, Model LQMAC-306.
 - g. Hoffman, Door Switch, Model ALFSWD.
3. Corrosion Protection:
- a. General: Provide a minimum of one corrosion inhibitor per control panel. Protection by one or more inhibitors shall cover entire volume of cabinet for a minimum of one year prior to replacement.
 - b. Manufacturers and Products:
 - 1) Northern Technologies Intl., Model Zerust Series.
 - 2) Hoffman, Model A-HCI Series.
4. Air Conditioner:
- a. General: Panels mounted outdoors or in non-climate-controlled areas must maintain internal temperature below the maximum rating of all components, including PLC's and power supplies. Perform heat dissipation calculations to determine if the panel requires active cooling from an Air Conditioner. Select an appropriately sized Air Conditioner unit based on the BTU's/hour of heat dissipation required.
 - b. Manufacturers and Products:

- 1) nVent, Include outdoor and heater options; match steel type and paint color of control panel, Model SpectraCool G-Series.

5. Heat Exchanger:

- a. General: Panels mounted in temperature extremes, dusty/dirty areas, washdown locations, or corrosive environments located outdoors or in non-climate-controlled areas must maintain internal temperature below the maximum rating of all components, including PLC's and power supplies. Perform heat dissipation calculations to determine if the panel requires active cooling from a Heat Exchanger. Select an appropriately sized Heat Exchanger unit based on the BTU's/hour of heat dissipation required.
- b. Manufacturers and Products:
 - 1) nVent, Heat Exchanger, Model ClimaGuard TX-Series.

Part 3 Execution

3.01 Enclosure Internal Wiring

- A. As defined in Section 2.03 above.

3.02 Protection

- A. Use corrosion-inhibiting vapor capsules in enclosures to protect electrical, instrumentation, and control devices, including spare parts, from corrosion.
- B. Periodically replace capsules based on capsule manufacturer's recommendations.

END OF SECTION

Part 1 General

1.01 Summary

- A. This section gives general requirements for Indicators and Meters where required under Sections 40 67 00, Control System Equipment Panels and Racks, and 40 69 00, Packaged Control Systems, as part of a complete control panel.

1.02 Submittals

- A. Submit shop drawings in accordance with the requirements of Section 01 33 23 of these Specifications. Specific submittal information shall include the following:
 - 1. The Contractor shall furnish fuse sizes sufficient to protect the devices and provide branch circuit protection.

Part 2 Products

2.01 Process Display

- A. Process Displays will be used to show the current value of an analog signal on a panel's outer door or inner door. The rating of the Process Display must meet or exceed the NEMA rating of the panel. Provide Hazardous Area model when used in hazardous locations.
- B. Manufacturers and Products:
 - 1. Precision Digital, Loop Powered, 0.7 » 5-digit top line, 8-digit bottom line, Model PD6600 Series.

Part 3 Execution

3.01 Installation, General

- A. Install in full accordance with manufacturer's instructions and recommendations.
- B. Provide adequate clearance on all sides of device for sufficient convection in consideration of heat radiation.

3.02 Identification

1. Equipment shall be labeled on subpanels and inside of doors to match design documents and panel drawings, and in adherence to Moccasin Bend Environmental Campus Standards. Refer to requirements of Section 40 67 00 of these Specifications for label material, lettering, coloring, sizing, and mounting requirements.

END OF SECTION

Part 1 General

1.01 Summary

- A. This section gives general requirements for Indicating Lights where required under Sections 40 67 00, Control System Equipment Panels and Racks, and 40 69 00, Packaged Control Systems, as part of a complete control panel.

1.02 Submittals

- A. Submit shop drawings in accordance with the requirements of Section 01 33 23 of these Specifications.

Part 2 Products

2.01 Indicating Lights

- A. Control Devices are typically mounted on outer doors of control panels. IP 66 (minimum) rated devices are required in outdoor or washdown areas. Pilot Lights require the following components for a complete indicator: Lens, Legend Plate, Mounting Latch, Lamp Module, and Contact Block(s).
1. Size: 22.5 mm.
 2. Contact Rating: 10 Amps.
 3. Voltage: As required.
 4. Lens Color: As noted in specifications.
 5. Lamp Module: Integrated LED.
 6. Ingress Rating: To match or exceed the Control Panel rating to prevent derating the enclosure.
 7. Manufacturer and Product:
 - a. Allen-Bradley, Model 800F Series.

Part 3 Execution

3.01 Installation, General

- A. Install in full accordance with manufacturer's instructions and recommendations.

3.02 Identification

1. Indicating Lights shall be labeled on outside and inside of panel doors to match design documents and panel drawings, and in adherence to Moccasin Bend Environmental Campus Standards. Refer to requirements of Section 40 67 00 of these Specifications for label material, lettering, coloring, sizing, and mounting requirements.

END OF SECTION

Part 1 General

1.01 Summary

- A. This section gives general requirements for Switches and Push Buttons where required under Sections 40 67 00, Control System Equipment Panels and Racks, and 40 69 00, Packaged Control Systems, as part of a complete control panel.

1.02 Submittals

- A. Submit shop drawings in accordance with the requirements of Section 01 33 23 of these Specifications.

Part 2 Products

2.01 Switches

- A. Control Devices are typically mounted on outer doors of control panels. IP 66 (minimum) rated devices are required in outdoor or washdown areas. Selector Switches require the following components for a complete switch: Switch, Legend Plate, Mounting Latch, Lamp Module (illuminated Switches only), and Contact Block(s). E-STOPS require a Self-Monitoring Contact Block for improved safety. Refer to Manufacturer catalog for Momentary Selector Switch models.
- B. Size 22.5mm.
1. Contact Rating: 10 Amps.
 2. Voltage: As required.
 3. Lamp Module: Integrated LED, if required.
 4. Ingress Rating: To match or exceed the Control Panel rating to prevent derating the enclosure.
 - a. Manufacturers and Products:
 - 1) Allen-Bradley, Model 800F Series.

2.02 Push Buttons

- A. Control Devices are typically mounted on outer doors of control panels. IP 66 (minimum) rated devices are required in outdoor or washdown areas. Push Buttons require the following components for a complete indicator: Button, Legend Plate, Mounting Latch, Lamp Module (illuminated Buttons only), and Contact Block(s). E-STOPS require a Self-Monitoring Contact Block for improved safety.

- B. Size: 22.5mm.
1. Contact Rating: 10 Amps.
 2. Voltage: As required.
 3. Push Button Color:
 - a. ON or START: Red.
 - b. OFF or STOP: Black.
 4. Ingress Rating: To match or exceed the Control Panel rating to prevent derating the enclosure.
 5. Manufacturers and Products:
 - a. Allen-Bradley, Model 800F Series.

Part 3 Execution

3.01 Installation, General

- A. Install in full accordance with manufacturer's instructions and recommendations.

3.02 Identification

- A. Switches and Push Buttons shall be labeled on inside and outside of panel doors to match design documents and panel drawings, and in adherence to Moccasin Bend Environmental Campus Standards. Refer to requirements of Section 40 67 00 of these Specifications for label material, lettering, coloring, sizing, and mounting requirements.

END OF SECTION

Part 1 General

1.01 Summary

- A. This section gives general requirements for Relays where required under Sections 40 67 00, Control System Equipment Panels and Racks, and 40 69 00, Packaged Control Systems, as part of a complete control panel. Refer to Specification Section 40 78 56 for Intrinsically-Safe Relays.
1. Safety Relays shall conform to NFPA 70 and 79 Standards and have a separate monitoring circuit with pulsed signal for monitoring wire breaks or faulty contactor/safety actuator.

1.02 Submittals

- A. Submit shop drawings in accordance with the requirements of Section 01 33 23 of these Specifications.

Part 2 Products

2.01 Relays, Non-Latching

- A. The following specifications are for standard control relays. The specifications are to be used as a guide for minimum requirements of relays used with inductive loads.
- B. Relay Mounting: Plug-in type socket.
1. Relay Enclosure: Furnish dust cover.
 2. Socket Type: Screw terminal interface with wiring.
 3. Socket Mounting: Rail.
 4. Contact Arrangement: 2 Form C contacts (DPDT).
 5. Contact Rating: 10 amps.
 6. Contact Material: Gold or silver.
 7. Coil Voltage: As noted or shown.
 8. Socket Type: 8 pin.
 9. Coil Power: 1.5VA.
 10. Expected Mechanical Life: 10,000,000 operations.

11. Expected Electrical Life at Rated Load: 100,000 operations.
12. Indication Type: LED indicator lamp, if specified.
13. Push-to-Test: If required.
14. Seal Type: Hermetically sealed case.
15. Manufacturers and Products:
 - a. DC Relays: Allen-Bradley, 24VDC coil, Model 700-HA32Z24 with 700-HN125 socket (8-pin tube) (Lift Stations).
 - b. DC Relays: Finder, 24VDC coil, Model 55.32.8.024.0040.
 - c. AC Relays: Finder, 120VAC coil, Model 55.32.8.120.0040 with 94.02 socket (8-pin).

2.02 Relays, Time Delay

1. Time Delay Relays are capable of various input voltages, timing ranges, and functions. Select the appropriate model number according to the specific project requirements.
2. Mounting: DIN rail.
3. Width: 17.5mm.
4. Time Scales: Six, from 0.1 seconds to 24 hours.
5. Contacts Rating: 1 – 16 amps.
6. Voltage: 12-240VAC/VDC.
7. Manufacturers and Products:
 - B. Finder, Model 80 Series.
 1. Relays, Safety
 2. Safety Relays provide protection from Hazardous conditions, including unguarded moving machinery, unsafe operating conditions, emergency stop functions, or equipment interlocks. Select the appropriate model number according to the specific project requirements.
 3. Mounting: DIN rail.
 4. Manufacturers and Products:

- 1) Allen-Bradley, single function, screw terminals, Auto/Man Reset, Model 440R Series.

2.03 Relays, Overload

1. Overload Relays are paired with a contactor to create a motor starter. The Overload Relay is designed to trip and open the circuit in the event of an electrical, thermal, or power overload. Select the appropriate model number according to the motor and contactor characteristics and required Trip Class.
2. Manufacturers and Products:
 - 1) Allen-Bradley, 3-P, 60-120 Amps, test/reset, Solid-State, Model 193-EEVE (Lift Stations).

Part 3 Execution

3.01 Installation, General

- A. Install in full accordance with manufacturer's instructions and recommendations.

3.02 Identification

- A. Relays shall be labeled on subpanels to match design documents and panel drawings, and in adherence to Moccasin Bend Environmental Campus Standards. Refer to requirements of Section 40 67 00 of these Specifications for label material, lettering, coloring, sizing, and mounting requirements.

END OF SECTION

Part 1 General

1.01 Summary

- A. This section gives general requirements for Isolators, Intrinsically-Safe Barriers, and Surge Suppressors where required under Sections 40 67 00, Control System Equipment Panels and Racks, and 40 69 00, Packaged Control Systems, as part of a complete control panel.
1. All intrinsically safe conduits will be marked to clearly indicate that the conduit contains intrinsically safe circuits. Grounding as specified by the intrinsically safe barrier manufacturer will be installed in conformance with manufacturer specifications.
 2. The Entity Concept allows interconnection of intrinsically safe apparatus with associated apparatus not specifically examined in combination as a system when the approved values of V_{oc} (or U_o), I_{sc} (or I_o) and P_o for the associated apparatus are less than or equal to V_{max} (U_i) and I_{max} (I_i) for the intrinsically safe apparatus and the approved values of C_a (C_o) and L_a (L_o) for the associated apparatus are greater than $C_i + C_{cable}$ and $L_i + L_{cable}$, respectively, for the intrinsically safe apparatus.
 3. Capacitance and inductance of the field wiring from the intrinsically safe equipment to the associated apparatus shall be calculated and must be included in the system calculations as shown above. Cable capacitance, C_{cable} , plus intrinsically safe equipment capacitance, C_i must be less than the marked capacitance, C_a (or C_o), shown on any associated apparatus used. The same applies for inductance (L_{cable} , L_i and L_a or L_o , respectively). Where the cable capacitance and inductance per foot are not known, the following values shall be used: $C_{cable} = 60 \text{ pF/ft.}$, $L_{cable} = 0.2 \mu\text{H/ft.}$

1.02 Submittals

- A. Submit shop drawings in accordance with the requirements of Section 01 33 23 of these Specifications. Specific submittal information shall include the following:
1. The Contractor shall furnish submittal data calculating the Intrinsically Safe system as noted in Section 1.01 above.

Part 2 Products

2.01 Signal Isolators

- A. Signal Isolators are required for Analog Input or Analog Output signals that are wired to non-isolated PLC modules for proper separation of signals to prevent a failure on one analog circuit from affecting other analog circuits on the same PLC module.
- B. Manufacturers and Products:
- C. Acromag, Signal Isolator, Single Channel Input and Output, Model 631T Series.
 - 1. Acromag, Signal Isolator, Dual Channel Input and Output, Model 632T Series.

2.02 Signal Splitters

- A. Signal Splitters are required for Analog Input signals that are routed to more than one device, like a PLC and a panel process display. The signal splitter isolates the Analog Input signal and splits it into two isolated analog output current signals. The devices must have a means to set the zero and span of each output signal independent from the Analog Input signal.
- B. Manufacturers and Products:
 - 1. Acromag, Signal Splitter, Single Input, Dual Output, Model 633T Series.

2.03 Surge Suppressors, 120VAC Power Supply (Type 1)

- A. Surge Suppressors are required for incoming 120VAC line power to all control panels for protection of downstream equipment.
 - 1. Mounting: Panel interior.
- B. Manufacturers and Products:
- C. Phoenix Contact, 120VAC, 20 Amp, includes base, Model 2907918.
 - 1. ASCO, 120VAC, 15 Amp, 252120NF015AN3N0.

2.04 Surge Suppressors, 3-Phase AC Power Supply (Type 1)

- a. Surge Suppressors are required for incoming 3-Phase AC line power to all control panels for protection of downstream equipment.
- b. Mounting: Panel exterior.
- c. Rating: NEMA 4X, or as required to prevent derating enclosure.

- d. Manufacturers and Products:
- e. 3-wire, 240VAC Delta, Model SDSA2040D.
 - 1) 3-wire, 480VAC Delta, Model SDSA4040D.
 - 2) 4-wire, 600VAC Delta, Model SDSA3650D.
 - 3) 4-wire, 208Y/120VAC, Model SDSA2040.
 - 4) 4-wire, 480Y/277VAC, Model SDSA4040.
 - 5) 4-wire, 600Y/347VAC, Model SDSA3650.

2.05 Surge Suppressors, Analog Signals Lines, Panel Mounted (Type 2)

- A. Provide surge suppression for all analog inputs and outputs. Provide surge suppression for all analog spares.
 - 1. Manufacturers and Products:
 - a. Phoenix Contact, 2-ch, 2-wire 24VDC circuits, Model 2838228 and required base, Model 2839224.
 - b. Asco, 1-ch, 3-stage hybrid protection for 36VDC circuits, Model 105D036S10KAN3DO.
 - c. Asco, 2-ch, 3-stage hybrid protection for 36VDC circuits, Model 175D036S10KLPCBO.
 - 1) Accessories for Asco Models:
 - d. ASCO, DIN-Rail Mounting kit, Model 11604KITPC (Optional).
 - e. ASCO, Replacement Base, Model PCB1BWKEY.

2.06 Surge Suppressors, Field Mount at Two-Wire Instruments: (Type 3)

- A. Surge Suppressors are required to be encapsulated in stainless steel pipe nipples. Select appropriate pipe size to match conduit in field.
- B. Manufacturers and Products:
 - 1. 1/2" conduit, capped on one end, Phoenix Contact, Model 2818122.
 - 2. 1/2" conduit, In-line mounting, ASCO, Model 157D036S10KXW5R0.
 - 3. 1/2" conduit, capped on one end, ASCO, Model 157D036S10KXW5S0.
 - 4. 3/4" conduit, In-line mounting, ASCO, Model 157D036S10KXW6M0.

5. 3/4" conduit, capped on one end, ASCO, Model 157D036S10KXW6P0.

2.07 Surge Suppressors, Field Mount at Four-Wire Instruments (Type 4)

- A. Surge Suppressors shall include 120VAC power surge protection and 24VDC signal surge protection with 10 ohm resistors on signal lines, all in enclosure.
- B. Rating: NEMA 4X, minimum.
- C. Manufacturers and Products:
 1. Polymeric enclosure, Phoenix Contact, Model 5603514.
 2. Polymeric enclosure, ASCO, Model 265120NF015LD5J0.
 3. 304 Stainless enclosure, ASCO, Model 265120NF015LD5H0.
 4. Fiberglass enclosure, ASCO, Model 265120NF015LD5F0.

2.08 Surge Suppressors, Data Cable (Type 5)

- A. Signals that are routed outdoors shall have a surge protector on each end to protect both devices.
- B. Manufacturers and Products:
 1. Phoenix Contact, PROFIBUS-DP, Model 2880642.
 2. Phoenix Contact, RS-232 v.24, 9-Pin, DIN Rail, Model 2803069.
 3. Phoenix Contact, RS-485 v.24, 9-Pin, DIN Rail, Model 2920612.
 4. Phoenix Contact, RS-485, with TTL level, Terminals, DIN Rail, Model 2749398.

2.09 Surge Suppressors, Radio Cable (Type 6)

- A. Surge Suppressors are required for coax antenna cables that are routed outdoors.
- B. Manufacturers and Products:
 1. Polyphaser, Type N F/F connectors, bulkhead, 220-1000 MHz
 2. Model IS-B50LN-C2.

2.10 Intrinsically-Safe Relays

- A. Intrinsically Safe Relays are required to limit electrical energy in Hazardous environments for discrete devices, including Float Switches in wetwells. The device must be capable of configuring NO/NC output contact mode, Wire Break

detection, and Short Circuit monitoring. Monitor discrete signals that originate in hazardous area and are used in a safe area.

B. Manufacturers and Products:

1. Turck, 2-channel, DIN Rail, Model IM1-22Ex-R.
2. Phoenix Contact, 1-channel, DIN Rail, Model 2865340.
3. MTL, 2-channel, DIN Rail, Model MTL7789+.

2.11 Intrinsically-Safe Barriers

A. Intrinsically Safe Barriers are required to limit electrical energy in Hazardous environments for analog devices, including submersible pressure (level) transducers in wetwells. Monitor analog signals that originate in hazardous area and are used in a safe area.

B. Manufacturers and Products:

1. Phoenix Contact, 1-channel, 24VDC supply, DIN Rail, Model 2865340.
2. MTL, 1-channel, 24VDC supply, DIN Rail, Model MTL7787+.

Part 3 Execution

3.01 Installation, General

A. Install in full accordance with manufacturer's instructions and recommendations.

3.02 Identification

A. Equipment shall be labeled on subpanels to match design documents and panel drawings, and in adherence to Moccasin Bend Environmental Campus Standards. Refer to requirements of Section 40 67 00 of these Specifications for label material, lettering, coloring, sizing, and mounting requirements.

END OF SECTION

Part 1 General

1.01 Summary

- A. This section gives general requirements for Power Supplies where required under Sections 40 67 00, Control System Equipment Panels and Racks, and 40 69 00, Packaged Control Systems, as part of a complete control panel.

1.02 Submittals

- A. Submit shop drawings in accordance with the requirements of Section 01 33 23 of these Specifications. Specific submittal information shall include the following:
1. The Contractor shall furnish submittal data calculating the maximum power consumption on the load side of the power supply under full-load conditions and all downstream signals energized.
 2. The Contractor shall furnish line and load fuse sizes sufficient to protect the power supply and provide branch circuit protection.
 3. The Contractor shall ensure all upstream circuit breakers and fuses are properly sized to accommodate the power supply under full-load conditions.
 4. The Contractor shall calculate heat load of the power supply system under full-load conditions for determining panel heating and cooling requirements of Section 40 67 00 of these Specifications.

Part 2 Products

2.01 Power Supplies, Redundant

- A. Provide a power supply system properly sized for equipment full-load demands and an additional 20% spare capacity on one power supply. Include a backup power supply and redundancy module. Wire the alarm contact from the redundancy module to the PLC for remote status monitoring.
- B. Manufacturers and Products:
1. Rhino, 24VDC out at 80 Watts, DIN Rail, Model PSH-24-80.
 2. Rhino, 24VDC out at 120 Watts, DIN Rail, Model PSH-24-120.
 3. Rhino, 24VDC out at 240 Watts, DIN Rail, Model PSH-24-240.
 4. Rhino, 24VDC out at 480 Watts, DIN Rail, Model PSH-24-480.

5. Rhino, 24VDC out at 240 Watts, DIN Rail, Model PS-PSV24-240 (Lift Stations).
6. Rhino, Redundancy module, Model PSM24-REM360S.

2.02 Power Supplies, Non-Redundant

- A. Provide a power supply system properly sized for equipment full-load demands. Include spare Analog Input PLC signals where half of the signals require 24VDC supply when calculating appropriate power demand.
- B. Manufacturers and Products:
 1. Puls, 24-48VDC out at 30 Watts, Class 2, Model ML30.241.
 2. Automation Direct, 24VDC out at 240 Watts, Class 2, Model PS-PSV-240 (Lift Stations).

Part 3 Execution

3.01 Installation, General

- A. Install in full accordance with manufacturer's instructions and recommendations.
- B. Provide adequate clearance on all sides of power supply for sufficient convection in consideration of heat radiation.
- C. Adjust the output voltage to match the required voltage where field adjustment capability is provided on the unit.
- D. Ground the power supply chassis and -VDC terminal to a grounding terminal block or bus bar within the control panel.

3.02 Identification

- A. Power Supplies shall be labeled on subpanels to match design documents and panel drawings, and in adherence to Moccasin Bend Environmental Campus Standards. Refer to requirements of Section 40 67 00 of these Specifications for label material, lettering, coloring, sizing, and mounting requirements.

END OF SECTION

Part 1 General

1.01 Summary

- A. This section gives general requirements for Variable Frequency Drives (VFD's) where required under Sections 40 67 00, Control System Equipment Panels and Racks, and 40 69 00, Packaged Control Systems, as part of a complete system.

1.02 Submittals

- A. Submit shop drawings in accordance with the requirements of Section 01 33 23 of these Specifications.

Part 2 Products

2.01 Variable Frequency Drives with Profinet Redundancy

- A. Manufacturers and Products:

1. Danfoss/Vacon, Model OPTE9-V, Dual-Port Ethernet board.
 - a. Compatible with:
 - 1) NXP
 - (a) 100 INDUSTRIAL.
 - (b) 100 FLOW.
 - (c) 100 X.
 - (d) 20 (Option Card Mounting Kit required).
 - (e) 20 X.
 - (f) 20 Cold Plate.
 2. ABB/GE, Model FPNO-21, Dual-Port Ethernet Module.
 - a. Compatible with:
 - 1) ACS380.
 - 2) ACS480.
 - 3) ACS580.
 - 4) ACH580.

- 5) ACQ580.
 - (a) ACS880.
 - 6) DCS880.
 - 7) DCT880.
3. Yaskawa
 4. Schneider Electric (Square D)
 5. Siemens

Part 3 Execution

3.01 Installation, General

- A. Install in full accordance with manufacturer's instructions and recommendations.

3.02 Identification

- A. Variable Frequency Drives shall be labeled to match design documents and panel drawings, and in adherence to Moccasin Bend Environmental Campus Standards. Refer to requirements of Division 26, Electrical of these Specifications for label material, lettering, coloring, sizing, and mounting requirements.

END OF SECTION