APPENDIX 10A

I&C Design Specifications and Examples

The following specification are examples only. They are presented in Construction Specifications Institute (CSI) MasterFormat (MF04). Revise, add, or delete these specifications based on project-specific needs:

These specifications have not been reviewed or approved for wide use. They are provided as informational only. The design engineer may use this, but it should be thoroughly checked.

- 40 90 00 Instrumentation for Process Control
- 40 90 00A Loop Check-out Sheet
- 40 90 00B Instrument Certification Sheet
- 40 90 00C Final Control Element Certification Sheet
- 40 90 05 Control Loop Descriptions
- 40 91 10 Primary Elements and Transmitters
- 40 94 43 Programmable Automation Controller Control System
- 40 97 00 Control Auxiliaries
- 40 98 00 Control Panels and Enclosures
- 40 99 00 Surge Protection Devices for Instrumentation and Control Equipment

SPECIFICATION SECTION 40 90 00

INSTRUMENTATION FOR PROCESS CONTROL: BASIC REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Specification Section Includes:

1. Basic requirements for complete instrumentation system for process control.

B. Related Specification Sections include but are not necessarily limited to:

1. CSC Parts 1, 2, 3, 4, and 6.
2. Division 10 - Specialties.
3. Division 26 - Electrical.
4. **Specification Section 26 05 00 - Electrical: Basic Requirements**.
5. **Specification Section 26 05 16 - Wire and Cable: 600 Volt and Below**.
6. **Specification Section 40 91 10 - Primary Elements and Transmitters**.
7. **Specification Section 40 97 00 - Control Auxiliaries**.
8. **Specification Section 40 98 00 - Control Panels and Enclosures**.
9. **Specification Section 40 99 00 - Surge Protection Devices (SPD) for Instrumentation and Control Equipment**.
10. **Specification Section 46 46 13 - Tipping Buckets**.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. Canadian Standards Association (CSA).
2. FM Global (FM).
3. The Instrumentation, Systems, and Automation Society (ISA):
    a. S5.1, Instrumentation Symbols and Identification.
    b. S5.3, Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems.
    c. S5.4, Standard Instrument Loop Diagrams.
    d. S20, Standard Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
4. National Electrical Manufacturers Association (NEMA):
    a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

5. National Fire Protection Association (NFPA):
    a. 70, National Electrical Code (NEC).
6. National Institute of Standards and Technology (NIST).
7. Underwriters Laboratories, Inc. (UL):
    a. 913, Standard for Safety, Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.
    b. 508A, Industrial Control Panels.
8. Seattle Public Utilities:
    a. SPU Design Guidelines & Standards, Section 10 – Instrumentation and Control, SCADA.

B. Qualifications:
1. Instrumentation subcontractor:
    a. Experience:
        1) Have satisfactorily provided and installed instrumentation for process control systems for a minimum of five (5) projects of similar magnitude and function.

C. Miscellaneous:
1. Comply with electrical classifications and NEMA enclosure types shown on Drawings and defined in the Specification Sections.
2. Equipment and installation in hazardous areas shall be suitable for installation and use in hazardous areas.

1.03 DEFINITIONS

A. Hazardous Areas: Class I, II or III areas as defined in NFPA 70.

B. Highly Corrosive and Corrosive Areas: Rooms or areas identified on the Drawings or Specifications where there is a varying degree of spillage or splashing of corrosive materials such as water, wastewater or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.

C. Outdoor Area: Exterior locations where the equipment is normally exposed to the weather and including below grade structures, such as vaults, manholes, handholes and in-ground pump stations.

D. Intrinsically Safe Circuit: A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under test conditions as prescribed in UL 913.

E. Calibrate: To standardize a device so that it provides a specified response to known inputs.

1.04 SYSTEM DESCRIPTION

A. Control System Requirements:

1. The instrumentation system consists of all primary elements, transmitters, switches, controllers, indicators, panels, signal converters, power supplies, special or shielded cable, special grounding or isolation, auxiliaries, wiring, and other devices required to provide complete control of the facility as specified in the Contract Documents.

2. Application software for programmable automation controllers, Human Machine Interface, and Operator Interface Unit will be provided, configured, and programmed by the Owner.

B. All signals shall be directly linearly proportional to measured variable unless specifically noted otherwise.

C. Single Instrumentation Subcontractor:

1. Furnish and coordinate instrumentation system through a single instrumentation subcontractor:

   a. The instrumentation subcontractor shall be responsible for functional operations of all field control systems, supervision of installation, final connections, calibrations, preparation of Drawings, testing procedures and Operation and Maintenance Manuals, training, demonstration of substantial completion and all other aspects of the instrumentation system, except for those aspects specifically provided by others.

2. Coordinate instrumentation with other work to ensure that necessary wiring, conduits, contacts, relays, converters, and incidentals are provided in order to transmit, receive, and control necessary signals to other control elements, and the Owner's existing SCADA system.

3. Provide testing, commissioning, and troubleshooting support for Owner's programmer up to 24 hours. Additional hours may be requested by the Owner and will be funded on a time and materials basis.

D. See **Specification Section 46 46 13 - Tipping Buckets** for the proximity switches and other equipment associated with the tipping buckets that are being supplied by the tipping bucket supplier. Coordination between the tipping bucket supplier and control system supplier is required; see **Specification Section 46 46 13 - Tipping Buckets** for requirements confirming coordination through co-signature. Receive intrinsic safety devices from tipping bucket supplier and install in Main Control Panel. Provide intrinsic safety ground. Install as required and per supplier recommendations for complete, fully-functional, code-compliant installation.

E. See **Specification Section 23 31 00 - HVAC: Ductwork** for the sail-type flow switches associated with the HVAC supply and exhaust fans; coordinate provision and interface.

1.05 SUBMITTALS

A. Shop Drawings:

1. See CSC Part 3.1 for requirements for the submittal process.
2. Submittals shall be original printed material or clear unblemished photocopies of original printed material:
    a. Facsimile information is not acceptable.
    b. In addition to printed copies, provide an electronic copy of submittals in PDF format.
3. Limit the scope of each submittal to one (1) Specification Section:
    a. Each submittal must be submitted under the Specification Section containing requirements of submittal contents.
    b. Do not provide any submittals for **Specification Section 40 90 00 - Instrumentation for Process Control: Basic Requirements**.
4. Documentation of instrumentation subcontractor qualifications and experience as defined above.
5. Product technical data including:
    a. Equipment catalog cut sheets.
    b. Instrument data sheets:
        1) ISA S20 or approved equal.
        2) Separate data sheet for each instrument.
    c. Materials of construction.
    d. Minimum and maximum ranges, calibration information (in engineering units or as otherwise noted).
    e. Physical limits of components including temperature and pressure limits.
    f. Size and weight.
    g. Electrical power requirements and wiring diagrams.
    h. NEMA rating of housings.
    i. Submittals shall be marked with arrows to show exact features to be provided. Features and options not being provided shall be crossed out.
6. Loop diagrams per ISA S5.4 as specified in **Specification Section 40 98 00 - Control Panels and Enclosures**.
7. Comprehensive set of wiring diagrams as specified in **Specification Section 40 98 00 - Control Panels and Enclosures**.
8. Panel fabrication drawings as specified in **Specification Section 40 98 00 - Control Panels and Enclosures**.
9. PAC equipment drawings.

10. Nameplate layout drawings.
11. Engraving and escutcheon lettering legends.
12. Drawings, systems, and other elements are represented schematically in accordance with ISA S5.1 and ISA S5.3:
    a. The nomenclature, tag numbers, equipment numbers, panel numbers, and related series identification contained in the Contract Documents shall be employed throughout submittals.
13. All Shop Drawings shall be modified with as-built information/corrections.
14. All panel and wiring drawings shall be provided in both hardcopy and softcopy:
    a. Furnish electronic files on CD-ROM or DVD-ROM media.
    b. Drawings in AUTO CAD and PDF format.
15. Provide a parameter setting summary sheet for each field configurable device.
16. Certifications:
    a. Documentation verifying that calibration equipment is certified with NIST traceability.
    b. Approvals from independent testing laboratories or approval agencies, such as UL, FM or CSA:
        1) Certification documentation is required for all equipment for which the specifications require independent agency approval.
17. Testing reports: Source quality control reports.

B. Operation and Maintenance Manuals:
1. See CSC Part 3.1 for requirements for the submittal process:
    a. The mechanics and administration of the submittal process.
2. See CSC Part 3.1 for the content of the Project Operation and Maintenance Manual.

1.06 SITE CONDITIONS

A. See Material Application Schedule in **Specification Section 26 05 00 - Electrical: Basic Requirements** and Area Environmental Designation and Classification Schedule on Drawing Sheet 156 for required types and materials.

PART 2 - PRODUCTS

2.01 NEMA TYPE REQUIREMENTS

A. See Material Application Schedule in **Specification Section 26 05 00 - Electrical: Basic Requirements** and Area Environmental Designation and Classification Schedule on Drawing Sheet 156 for required types and materials.

B. Provide enclosures/housing for control system components in accordance with Material Application Schedule in **Specification Section 26 05 00 - Electrical: Basic Requirements** and Area Environmental Designation and Classification Schedule on Drawing Sheet 156.

1. Areas designated as Class I hazardous, Groups A, B, C, or D as defined in NFPA 70:
    a. NEMA Type 7 unless all electrical components within enclosure or component utilizes intrinsically safe circuitry:
        1) Utilize intrinsically safe circuits to the maximum extent practical and as depicted in the Contract Documents.
2. Inside control cabinet: NEMA Type 12.
3. Areas designated to be subject to temporary submersion: NEMA 6P or 7.

2.02 PERFORMANCE AND DESIGN REQUIREMENTS

A. Instrumentation Performance Criteria:
1. Performance: All instruments and control devices shall perform in accordance with manufacturer's specifications.

2.03 ACCESSORIES

A. Provide identification devices for instrumentation system components in accordance with **Specification Section 10 14 00 - Identification Devices**.

B. Provide corrosion resistant spacers to maintain 1/4-IN separation between equipment and mounting surface in wet areas, on below grade walls and on walls of liquid containment.

PART 3 - EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Do not remove shipping blocks, plugs, caps, and desiccant dryers installed to protect the instrumentation during shipment until the instruments are installed and permanent connections are made.

3.02 INSTALLATION

A. Wherever feasible, use bottom entry for all conduit entry to instruments and junction boxes. Provide weep holes in conduits where necessary to prevent liquid buildup.

B. Install electrical components per Division 26.

C. Panel-Mounted Instruments:
1. Mount and wire so removal or replacement may be accomplished without interruption of service to adjacent devices.
2. Locate all devices mounted inside enclosures so terminals and adjustment devices are readily accessible without use of special tools and with terminal markings clearly visible.

D. See **Specification Section 26 05 16 - Wire and Cable: 600 Volt and Below**.

3.03 FIELD QUALITY CONTROL

A. Maintain accurate daily log of all startup activities, calibration functions, and final setpoint adjustments:
1. Documentation requirements include the utilization of the forms located immediately following the end of this Specification Section:

a. Loop Check-out Sheet.

b. Instrument Certification Sheet.

c. Final Control Element Certification Sheet.

B. Instrumentation Calibration:

1. Verify that all instruments and control devices are calibrated to provide the performance required by the Contract Documents.

2. Calibrate all field-mounted instruments after the device is mounted in place to assure proper installed operation.

3. Calibrate in accordance with the manufacturer's specifications.

4. Check the calibration of each transmitter and gage across its specified range at 0, 25, 50, 75, and 100 percent:

a. Check for both increasing and decreasing input signals to detect and document any hysteresis.

5. Replace any instrument which cannot be properly adjusted or calibrated.

6. Stroke control valves to verify control action, feedback, and positioner settings.

7. Calibration equipment shall be certified by an independent agency with traceability to NIST:

a. Certification shall be certified within one (1) year of the date of use.

b. Use of equipment with expired certifications shall not be permitted.

8. Calibration equipment shall be at least three (3) times more accurate as the device being calibrated.

C. Loop check-out requirements are as follows:

1. Check control signal generation, transmission, reception and response for all control loops under simulated operating conditions by imposing a signal on the loop at the instrument connections:

a. Use actual signals where available.

b. Closely observe controllers, indicators, transmitters, displays, alarm and trip units, and other control components:

1) Verify that readings at all loop components are in agreement.

2) Make corrections as required:

a) Following any corrections, retest the loop as before.

2. Stroke all control valves, from the local control station and from the local operator interface.

3. Check all interlocks to the maximum extent possible.

4. In addition to any other as-recorded documents, record all calibration changes on all affected Contract Documents and turn over to the Owner.

D. Provide verification of system assembly, power, ground, and I/O tests.

E. Verify existence and measure adequacy of all grounds required for instrumentation and controls.

F. Perform Start-up and Training as defined in this Section and other Sections:

1. See **Specification Section - 40 98 00 - Control Panels and Enclosures** for description of control cabinet testing requirements, which includes many tests for the complete system.

END OF SPECIFICATION SECTION 40 90 00

Loop Check-out Sheet

City of Seattle
Seattle Public Utilities

Project Name:	Project Location:	Page of
Project Owner:	Regulatory Agency Project No. (if applicable):	
Project No.:	Date:	

LEAK AND TERMINATION/CONTINUITY CHECKS

DESCRIPTION	FIELD					CONTROL CAB	
	LEAK CHECK(1)			TERM/CONT CHECK(2)		TERM/CONT CHECK(2)	
	Device Tag No.	Process Conn.	Signal Tube	Device Tag No.	Termination Ident.	Device Tag No.	Termination Ident.

1. Leak check for pneumatic signal tubing to be per ISA-PR7.1.
2. Termination/continuity check includes check at terminated equipment for: (a) correct polarity, (b) appropriate signal generation, transmission and reception, and (c) correct shield & ground terminations.

OPERATOR INTERFACE CHECK-OUT

MONITORING POINTS OBSERVED

PARAMETER TYPE	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.
PROCESS VAR						
EQUIP STATUS						
ALARM POINT						

OPERATOR CONTROL FUNCTIONS CHECKED

FUNCTION TYPE	TAG NO.	LOCATION	TAG NO.	LOCATION	TAG NO.	LOCATION

AS LEFT SETTINGS

TAG NO.	SWITCH & ALARM SP	CONTROLLERS			
		Gain	Reset, rpm	Deriv. (rate), min	PV Set Point

Describe all interlocks checked, equipment started/stopped, valves/operators stroked. Describe modes of operation checked, and location of operator interface (local/remote).

I certify that the control loop referenced on this page has been completely checked and functions in accordance with applicable drawings and specifications.

Certified by:_____ Date:_____
(Work Performed By)

Witnessed by: _____ Date: _____

City of Seattle
Seattle Public Utilities

Instrument Certification Sheet

Project Name:	Project No::
Project Owner:	Regulatory Agency Project No. (if applicable):
Project No:	Date:
Control Loop No.:	
Instrument Tag No.	Transmitter/gauge span:
Manufacturer:	Switch set-point:
Model No.	Switch dead band:
Serial No.	Switch range:

TRANSMITTERS AND INDICATORS

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	INPUT	OUTPUT	ERROR (% of span)	INPUT	OUTPUT	ERROR (% of span)
0%						
25%						
50%						
75%						
100%						
Other (if applicable)						
Other (if applicable)						

SWITCHES

	INCREASING INPUT			DECREASING INPUT		
ACTUATION POINT	INPUT	OUTPUT	ERROR (% of range)	INPUT	OUTPUT	ERROR (% of range)
High (Increasing input)						
Low (Decreasing input)						

Maximum allowable error (per Contract Documents): _____

Remarks: _____

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?

Certified by:_____ Date Certified:_____

Witnessed by: _____ Date: _____

City of Seattle
Seattle Public Utilities

Final Control Element Certification Sheet

Project Name:	Project:
Project Owner:	Regulatory Agency Project No. (if applicable):
Project No.	Date:
Control Loop No.:	

Tag No.	Actuator:	Pneumatic: _ Electric: _____
Description:	Positioner:	Direct: _____ Reverse: _
Manufacturer:	Positioner:	Input: _____ Output: _____
Model No.	I/P Converter:	Input: _____ Output: _____
Serial No.	Valve to	_____ on air failure
	Valve to	_____ on power failure

I/P CONVERTER

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	INPUT	OUTPUT	ERROR (% of span)	INPUT	OUTPUT	ERROR (% of span)
0%						
25%						
50%						
75%						
100%						

Specified I/P converter accuracy: _____ % of span.

FINAL CONTROL ELEMENT

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	INPUT	TRAVEL	ERROR (% of full travel)	INPUT	TRAVEL	ERROR (% of full travel)
0%						
25%						
50%						
75%						
100%						

Remarks:_____

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?

Certified by:_____ Date Certified:_____

Witnessed by: _____ Date: _____

SPECIFICATION SECTION 40 90 05

CONTROL LOOP DESCRIPTIONS

PART 1 - GENERAL

1.01 SUMMARY

A. Specification Section Includes:

1. Instrumentation control loops.
2. The intent of including this specification section is to describe how the site will operate; the Owner will use this to accomplish the programming (application software development).

B. Related Specification Sections include but are not necessarily limited to:

1. CSC Parts 1, 2, 3, 4, and 6.
2. Specification Section 40 90 00 - Instrumentation for Process Control: Basic Requirements.

1.02 QUALITY ASSURANCE

A. See **Specification Section 40 90 00 - Instrumentation for Process Control: Basic Requirements**.

1.03 SYSTEM DESCRIPTION

A. Instrumentation drawings in conjunction with the control strategies described below work together to clarify the North Henderson NPDES Basin 44 and Martha Washington Lake NPDES Basin 45 control system operational requirements.

B. The Owner will provide all application software development (this includes programming of the Opto 22 PAC) required to implement the functional requirements of the control loops.

C. The control loop descriptions provide the functional requirements of the control loops represented in the Contract Documents.

D. The control loop descriptions are not intended to be an inclusive listing of all elements and appurtenances required to execute loop functions, but are rather intended to supplement and complement the Drawings and other Specification Sections:

1. The control loop descriptions shall not be considered equal to a bill of materials.
2. The control loop descriptions will be implemented by the Owner.

E. SPU software standards will be followed for communications with this site, including the following:

1. Programmable Automation Controller (PAC) address assignment.
2. Communications configuration.
3. Secured operator access to all process setpoints.

F. Process control logic will reside and be executed in the PAC as much as possible.

G. Supervisory process control functionality will follow SPU software standards. In general, SPU staff (with appropriate security access rights) can change applicable process control, process alarm, control modes, etc. from the operator interface unit (OIU) system, the changes are communicated to the PAC, the PAC confirms back to the OIU system when the change has been implemented, and the change appears on the OIU system.

H. Alarm management functionality will follow SPU software standards.

I. Data collection, archiving, reporting, displaying and functionality will follow SPU software standards.

J. OIU display layout, color conventions, navigation, security access rights, and control functionality will follow SPU software standards.

1.04 SUBMITTALS

A. See CSC Part 3.1 for requirements for the submittal process.

B. For submittals associated with Start-up and Testing see **Specification Section 40 01 01 - Commissioning / Facility Start-Up**.

1.05 OVERVIEW

A. Combined sewer flow is conveyed from Basin 44 to Basin 45 and on to Basin 46. From Basin 46 flows are conveyed to the King County Henderson Pump Station.

B. CSO Facility 8 and 8A provide control of excess combined sewer flow within Basin 44.

C. CSO Facility 29A provides control of excess combined sewer flow within Basin 45.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 COMMON FUNCTIONS

A. The following COMMON functions will follow SPU software standards:

1. Common analog I/O functions:
    a. Conditioning.
    b. Alarming.
    c. Scaling.
    d. Trending.
    e. Flow totalization. When associated instrument is out of service use last good value for totalization and mark historical data accordingly.
    f. Alarm set point dead bands.
    g. Calculated analog values.
    h. Instrument or equipment calibration mode (operate mode, maintenance mode, alarm inhibit, timed monitoring in maintenance mode, data collection management when in maintenance mode, etc.).

2. Common discrete I/O functions:
    a. Alarming (alarms specified below).
    b. Nuisance tripping.
3. Common control functions:
    a. Level control using PAC resident proportional, integral, derivative (PID) controller.
    b. Bumpless transfer (between control modes: auto, manual, local, remote, PID modes, etc.).
    c. Tracking of set point, process variable, equipment status (opened, closed, position, mode, etc.).
4. Common gate control functions:
    a. Local/remote mode monitoring, and OIU auto/manual mode monitoring and control.
    b. Position monitoring (open, in transition, closed, position).
    c. Equipment failure monitoring and alarming:
        1) FAULT.
        2) Fail to OPEN (within preset time delay).
        3) Fail to CLOSE (within preset time delay).
        4) Gate position from set point deviation alarm.
5. Common monitoring functions:
    a. Accessing information on the OIU (number of mouse clicks for navigation, diagnostics information, etc.).
    b. Communications:
        1) Status.
        2) Failure.
        3) Power failure and restore.
6. Common instrument functions:
    a. Redundant instruments provide level measurements.
    b. Both instruments calibrated for the same range in engineering units (see **Specification Section 40 91 10 - Primary Elements and Transmitters**).
    c. Both instruments configured to fail high (where possible).
    d. Level transmitter with the highest reading is used for level control function (where applicable).
    e. PAC logic generates an alarm when the difference between the two values exceeds an operator adjustable value (initially set at 0.5 foot).
    f. When one instrument is in calibrate mode the other will be used for control.

g. Individual instrument high and low out-of-range alarming.

h. If the deviation between the two levels is less than or equal to an operator adjustable deviation set point (initially set at 0.25 feet), then average the two levels and use the average as the level.

i. If the deviation between the two levels is greater than the operator adjustable deviation setpoint, then after a time delay of 60 seconds, generate an alarm message reading “Level signals not matching”.

j. A selector switch shall be available for each level system being monitored to allow the operator to manually select either level transmitter or the automatic mode for level input to the control system.

3.02 CSO 8 AND 8A CONTROL LOOPS

A. Loop 4403: Lake Line Control Gate:

1. Reference:

a. P&ID: Sheets 171, 172, 173, and 201.

b. Hydraulic Schematic: Sheet 009.

c. Hydraulic Profile: Sheet 010.

2. Key Elements:

a. CSO 8 Storage Transfer Weir: (MH 067-272).

b. NPDES 44A Overflow Structure: (MH 067-274).

c. CSO 8 Storage Pipe (existing).

d. CSO 8A Lake Line Control Gate: (SG-4403).

e. CSO 8A Effluent Control Structure: MH 067-345.

f. CSO 8A Recirculation Weir.

g. CSO 8A Storage Tank.

h. Level element in the Effluent Control Structure (LT-4403).

i. Level element in MH 074-212 in Basin 45 (LT-4570).

j. Level element in Pump Station 10 Wet Well.

k. CSO 8A Storage Tank Drain Pumps (P-4411, P-4412, P-4413).

3. System description:

a. Regulates the discharge of combined sewer flows through the Lake Line from Basin 44 to Basin 45.

4. Process data logging:

a. The following points are logged to the process data historian:

1) Command output signal sent to SG-4403.

2) Feedback for gate position of SG-4403.

3) LT-4403A (pressure sensor) and LT-4403B (ultrasonic sensor) level signals measuring the level in CSO 8A Effluent Control Structure.

5. Operation:

a. General description:

1) Under low flow conditions, the SG-4403 located in the new MH 067-343 will remain fully open, allowing all combined sewage to continue south to Basin 45.

2) During periods of high flow, the programmable automation controller (PAC) will modulate SG-4403 using PID control to maintain the level to a user defined set point in the CSO 8A Effluent Control Structure. The set point will initially be set at 0.5 inch below the crown of the Lake Line. The control intent is to utilize the full available capacity of the downstream Lake Line without overloading the Lake Line.

3) The PAC will override the Lake Line Control Gate PID control and fully close the gate when LT-4570 in MH 074-212 reaches a user defined high level. A high level at MH 074-212 indicates insufficient capacity in the Lake Line downstream of Pump Station 10. The gate will not open (return to modulating mode) until level in the Pump Station10 Wet Well reduces to low level.

4) While the Lake Line Control Gate modulates or is closed completely, excess flow will back up behind the control gate until it reaches the crest of the existing CSO 8 Storage Tank Transfer Weir, located in MH 067-272. Flow that overtops this weir will begin filling the existing CSO 8 Storage Pipe. Once this storage is almost full, flow will overtop the CSO 8A Storage Tank Transfer Weir in the CSO 8A Influent Control/44B Overflow Structure and begin to fill the CSO 8A Storage Tank.

5) When high flows from Basin 44 begin to recede, the Lake Line Control Gate will continue to modulate to maintain the set point in CSO 8A Effluent Control Structure. Stored flow in CSO 8 Storage Pipe will drain back through the flap gate in the CSO 8 Storage Transfer Weir wall, located in MH 067-272. Ultimately, when the CSO 8 Storage Pipe has been drained completely, the Lake Line Control Gate will move to a fully open position.

6) When any one or all of the Storage Tank Drain Pumps is called to operate, the PAC will override the Lake Line Control Gate PID control and maintain the gate in a fully open position. See Loop 4410 - CSO 8A Storage Tank Drain Pumps.

b. System operation with equipment failure:

1) In the event that SG-4403 fails to modulate or close, excess flow will be discharged into the Lake Line. This will cause the Lake Line to surcharge until the level reaches the CSO 8A Recirculation

Weir in the CSO 8A Effluent Control Structure. Excess flow will then be diverted into the CSO 8A Storage Tank.

2) In the event that SG-4403 fails to remain in the fully open position when the Storage Tank Drain Pumps operate, excess flow upstream of the gate will be diverted to CSO 8 Storage Pipe.

3) In the event of utility power failure, standby power will be provided for SG-4403 and SG-4405 by a UPS. This will provide enough power to move the gate to predefined gate position. When power is restored, the PAC will resume automatic gate control.

c. Manual control functions:

1) OIU: Gate position control.

2) PAC: None.

d. Automatic control functions:

1) PID control of SG-4403 from PAC.

2) When gate actuator control is in REMOTE, PAC logic controls SG-4403 positioning through a feedback loop.

e. Process control interlocks:

1) Actuator configured to fail in last position:

a) On PAC failure.

b) On loss of PAC position control signal.

c) On self-diagnostic FAULT condition.

2) Power failure – SG-4403 shall move to operator-adjustable set point, initially set at 12.5% open.

6. OIU indication, alarming and operator set points:

a. OIU Display:

1) Gate OIU AUTO/MANUAL control mode selection and status indication.

2) SG-4403 PID controller faceplate (includes displaying Lake Line level process set point, Lake Line level process variable, and SG-4403 position).

3) Operator entered Lake Line level control setpoint via the SG-4403 PID controller faceplate (initially set at set at 0.5 inch below the crown of the Lake Line), and SG-4403 position control output.

4) Lake Line level (0-36 inches), dynamically filled symbol with digital readout in engineering units, LT-4403.

5) The following status of SG-4403, as provided by digital data communications:

a) LOCAL/REMOTE.

b) Gate Position (0-100%).

c) Gate Open.

d) Gate Closed.

e) Gate in Transition.

f) Gate Fault.

b. Alarms:

1) Level Alarm High, CSO 8A Effluent Control Structure.

2) Gate Fault.

c. Operator set points:

1) CSO 8A Effluent Control Structure level control set point (initially set at 20-inches).

2) Level alarm set point for LT-4403 initially set at 25-inches.

B. Loop 4405: CSO 8A Storage Tank Isolation Gate:

1. Reference:

a. P&ID: Sheets 171, 172, 173, and 201.

b. Hydraulic Schematic: Sheet 009.

c. Hydraulic Profile Sheet: Sheet 010.

2. Key Elements:

a. CSO 8A Storage Tank.

b. CSO 8A Storage Tank Isolation Gate: (SG-4405).

c. CSO 8A Influent Control/44B Overflow Structure.

d. CSO 8A Storage Tank Transfer Weir.

e. NPDES 44B Overflow Weir.

f. NPDES 44A Overflow Structure: (MH 067-274).

g. CSO 8 Storage Pipe (existing).

h. Level element in the Storage Tank (LT-4410).

3. System description:

a. Regulates the discharge of excess combined sewer flows from CSO 8 Storage Pipe to CSO 8A Storage Tank.

4. Process data logging:

a. The following points are logged to the process data historian:

1) Command output signal sent to SG-4405.

2) Feedback for position of SG-4405.

3) LT-4404A (pressure sensor) and LT-4404B (ultrasonic sensor) level signals measuring the level in NPDES 44A Overflow Structure.

4) LT-4410A (pressure sensor) and LT-4410B (ultrasonic sensor) level signals measuring the level in CSO 8A Storage Tank.

5. Operation:

a. General description:

1) CSO 8A Storage Tank Isolation Gate (SG-4405) will normally be in a fully open position.

2) When the level in CSO 8 Storage Pipe reaches the CSO 8A Storage Tank Transfer Weir in the CSO 8A Influent Control/44B Overflow Structure excess flow will overtop the weir and begin to fill the CSO 8A Storage Tank.

3) When the CSO 8A Storage Tank is full (tank level at 20.5 feet NAVD 88), SG-4405 located at the CSO 8A Influent Control/44B Overflow Structure will close, preventing the tank from overfilling. The gate will not open until the CSO 8A Storage Tank level reduces to the gate open set point, initially set at 19.5 feet.

4) When SG-4405 closes, excess flow will be stored in the remaining storage capacity in CSO 8 Storage Pipe until the level reaches the crest of the existing NPDES 44A Overflow Weir.

5) Any flow passing over the weir will enter Lake Washington through the Basin 44 Outfall as a CSO.

b. System operation with equipment failure:

1) In the event that SG-4405 does not remain open until the level in CSO 8A Storage Tank reaches the tank full level or if the gate does not open when the level in CSO 8A Storage Tank has dropped to the gate open set point then excess flow will be stored in any remaining storage capacity in CSO 8 Storage Pipe.

2) In the event that SG-4405 does not close when the level in CSO 8A Storage Tank reaches the tank full level then excess flow will continue to be diverted into the CSO 8A Storage Tank. The level in the CSO 8A Storage Tank and the CSO 8A Influent Control/44B Overflow Structure will be the same. When the level reaches the NPDES 44B Overflow Weir crest excess flow will then be conveyed to the NPDES 44B as a CSO.

3) In the event of utility power failure, standby power will be provided by a UPS. This will provide enough power to move the gate to a closed gate position. The gate will not close unless the level in the tank reaches the tank full level. When power is restored, the PAC will resume automatic gate control.

c. Manual control functions:

1) OIU: Gate position control.

2) PAC: None.

d. Automatic control functions:

1) Feedback control of SG-4405 from PAC.

2) When gate actuator control is in REMOTE, PAC logic controls gate SG-4405 positioning through a step function.

e. Process control interlocks:

1) Actuator configured to fail in last position:

a) On PAC failure.

b) On loss of PAC position control signal.

c) On self-diagnostic FAULT condition.

6. OIU indication, alarming and operator set points:

a. OIU Display:

1) Gate OIU AUTO/MANUAL control mode selection and status indication.

2) Operator entered Storage Tank level control set point.

3) The following status of SG-4405, as provided by digital data communications:

a) LOCAL/REMOTE.

b) Gate Position (0-100%).

c) Gate Open.

d) Gate Closed.

e) Gate in Transition.

f) Gate Fault.

b. Alarms:

1) Level Alarm High, NPDES 44A Overflow Structure.

2) Gate Fault.

c. Operator set points:

1) Storage Tank level control set point (initially set at elevation 20.5 feet).

C. Loop 4410: CSO 8A Storage Tank Drain Pumps:

1. Reference:

a. P&ID: Sheets 171, 172, 173, and 201.

b. Hydraulic Schematic: Sheet 009.

c. Hydraulic Profile: Sheet 010.

2. Key Elements:

a. CSO 8A Storage Tank.

b. CSO 8A Storage Tank Drain Pumps (P-4411, P-4412, P-4413).

c. CSO 8A Lake Line Control Gate (SG-4403).

d. CSO 8A Effluent Control Structure.

e. Level element in the Storage Tank (LT-4410).

f. Level element in the Effluent Control Structure (LT-4403).

g. Level element in MH 074-212 in Basin 45 (LT-4570).

h. Level element in Pump Station 10 Wet Well in Basin 45.

3. System description:

   a. Storage tank drain pumps discharge flow stored in CSO 8A Storage Tank back into the Lake Line when there is available capacity.

4. Process data logging:

   a. The following points are logged to the process data historian:

      1) Start/stop command output signal sent to individual pumps.

      2) Individual pump statuses and alarms.

      3) Individual pump runtimes.

5. Operation:

   a. General description:

      1) Pump On: The drain pumps will be called to operate based on the following control strategy:

         a) The PAC will turn on the Lead Pump when there is stored flow in CSO 8A Storage Tank (above the pump on level) and the level in the CSO 8A Effluent Control Structure drops below a user defined pump-on set point (initially set at 10 inches).

         b) After a time delay (initially set at 5 minutes), turn 1st Lag Pump on if level in the CSO 8A Effluent Control Structure is at or below the pump-on set point.

         c) After a time delay (initially set at 5 minutes), turn 2nd Lag Pump on if level in the CSO 8A Effluent Control Structure is at or below the pump-on set point.

         d) While one or more pumps operate the flow from Basin 44 that is being conveyed through the Lake Line Control Gate and the pumped flow may exceed the flow being discharged to the Lake Line to Basin 45. This will cause the Lake Line to surcharge until the level reaches the CSO 8A Recirculation Weir in the CSO 8A Effluent Control Structure. Excess flow will then be diverted back into the CSO 8A Storage Tank. As long as the pumped flow rate exceeds the flow being recirculated back to the tank the stored volume in CSO 8A Storage Tank will continue to drop.

2) Pump Off: Any and all pumps that have been called to operate will continue to operate until any of the following conditions occur:

a) Turn off all pumps if level in storage tank rises more than a pre-set depth (initially set at 3 inches) from a continuously measured lowest depth in the CSO 8A Storage Tank. A rise in tank depth indicates that flow from Basin 44 exceeds the flow being discharged to the Lake Line to Basin 45 and excess flow is being diverted back to the CSO 8A Storage Tank and the stored volume is increasing.

b) The PAC will override the automatic pump operation and shut off all pumps when LT-4570 reaches a user defined high level (initially set at 24.25 feet NAVD 88). A high level from LT-4570 indicates insufficient capacity in the Lake Line downstream of Pump Station 10. The PAC will return the pumps to automatic operation when the level in the Pump Station 10 Wet Well reduces to low level.

c) Turn off the 1st and 2nd Lag Pumps when the CSO 8A Storage Tank level drops below the multiple pump operation level set point.

d) Turn off the Lead Pump when the CSO 8A Storage Tank level reaches low level (pump shut off level). The tank will be completely drained.

e) Each time the Lead Pump turns off or is not available, alternate the Lead Pump to the next pump in the sequence.

b. System operation with equipment failure:

1) No standby power is provided for the drain pumps. In the event of a utility power failure, stored flow will remain in the CSO 8A Storage Tank until power is restored.

c. Manual control functions:

1) OIU: Manual Start/Stop of Pumps.

2) PAC: None.

d. Automatic control functions:

1) PAC control as described above.

e. Process control interlocks:

1) Pumps configured to operate as described unless:

a) The tank level is below the minimum level to operate pumps.

b) The pump(s) has failed.

c) The pump(s) motor has overheated.

d) The pump(s) have seal leak.

e) Power fail alarm.

6. OIU indication, alarming and operator set points:

a. OIU Display:

1) For each pump:

a) Pump status – running.

b) Pump status – seal leak.

c) Pump status – motor overtemp.

d) Pump motor overload.

e) Pump call to run.

f) Pump status – auto/man.

b. Alarms:

1) For each pump:

a) Pump alarm – seal leak.

b) Pump alarm – motor overtemp.

c) Pump motor overload alarm.

2) For all pumps:

a) Power fail alarm.

c. Operator set points:

1) Lead/lag selector.

2) Start/stop control levels.

D. Loop 4432: CSO 8A Air Gap Tank:

1. Reference:

a. P&ID: Sheet 175.

2. Key Elements:

a. Air gap tank (T-4432).

3. System description:

a. T-4432 provides protection for the potable water supply system and provides a source of water for use by the CSO 8A Storage Tank Flushing System and the CSO 8A Wash Water System. Once water enters the air gap tank it is no longer potable water.

4. Process data logging:

a. The following points are logged to the process data historian:

1) Air gap tank low level (LSL-4432).

2) Air gap tank high level (LSH-4432).

5. Operation:
    a. General description:
        1) T-4432 is filled via two motor actuated fill valves in series located on the utility water pipe immediately upstream of T-4432. The utility water pipe discharges to T-4432 via a physical separation of greater than 2 pipe diameters.
        2) The motor actuated valves are controlled via high (close valves – LSC-4432B) and low (open valves – LSC-4432A) level float switches located in T-4432.
        3) LSL-4432 triggers an alarm if the tank level gets too low.
        4) LSH-4432 triggers an alarm if the tank level gets too high.
        5) An overflow from T-4432 flows to the sump in the Mechanical Room of the Facility Vault.
    b. System operation with equipment failure:
        1) In the event of a utility power failure the motor actuated valves will be provided power from DC UPS located in the MCP.
    c. Manual control functions:
        1) OIU: None.
        2) PAC: None.
    d. Automatic control functions:
        1) Hardwired control of the fill valves using LSC-4432A and LSC-4432B.
    e. Process control interlocks:
        1) Upon low level in tank, Tipping Bucket Fill Pumps (P-4441 and P-4442) operation is disabled.
6. OIU indication, alarming and operator set points:
    a. OIU Display:
        1) Air gap low level alarm.
        2) Air gap high level (overflow) alarm.
    b. Alarms:
        1) Air gap low level alarm.
        2) Air gap high level (overflow) alarm.
    c. Operator set points:
        1) None.

E. Loop 4420: CSO 8A Storage Tank Flushing System:
1. Reference:
    a. P&ID: Sheets 174 and 175.

2. Key Elements:
    a. CSO 8A Storage Tank.
    b. Tipping Buckets (TB-4421, TB-4422, TB-4423, and TB-4424).
    c. Proximity Switches on Tip Buckets (ZS-4421, ZS-4422, ZS-4423, and ZS-4424).
    d. Tipping Bucket Fill Valves (FV-4421, FV-4422, FV-4423, and FV-4424).
    e. Tipping Bucket Fill Pumps (P-4441 and P-4442).
    f. Air Gap Tank (T-4432).
    g. Air Gap Tank Fill Valves (FV-4432A and FV-4432B).
    h. Level Switches in Air Gap Tank (LSH-4432, LSC-4432A, LSC-4432B, and LSL-4432).
3. System description:
    a. After an event in which flow has been stored in CSO 8A Storage Tank, the flushing system will automatically clean the storage tank of solids that settle in the tank during the storage event.
4. Process data logging:
    a. Individual pump statuses and alarms.
    b. Individual pump runtimes.
5. Operation:
    a. General description:
        1) Any time the PAC senses the level in the storage tank has reached a specified level an automatic flushing sequence will be called for. The sequence will begin once the level in CSO 8A Storage Tank has reached the Storage Tank Drain Pump off level.
        2) Four Tipping Buckets are used to sequentially fill with water, tip and flush settled solids to the Storage Tank Drain Pump sump. A flushing cycle includes each of the four Tipping Buckets flushing their corresponding Flushing Channels sequentially. The PAC programed flushing sequence may provide one or more flushing cycles.
        3) Two Tipping Bucket Fill Pumps (1 duty; 1 standby) are used to supply the water to fill the Tipping Buckets. The pumps draw water from the Air Gap Tank.
        4) Control valves are used to direct flushing water flow to one Tipping Bucket at a time.
        5) After the CSO 8A Storage Tank level reaches the pump off level, a flow control valve to the first Tipping Bucket will open after a user defined time (initially set at 12 hours). The duty pump will then be called to operate to send water to the tipping bucket in the first channel. Once the water level in the Tipping Bucket reaches

a certain level, gravity causes the bucket to rotate and discharge a flushing wave. The flushing wave is sent through the flushing channel scouring settled solids and is conveyed to the Drain Pump sump. The Storage Tank Drain Pumps will sense stored water and will operate in accordance with Loop 4410 – CSO 8A Storage Tank Drain Pumps.

6) The proximity switch senses the rotation of the Tipping Bucket and sends a signal to open the fill valve to the second Tipping Bucket and close the fill valve to the first Tipping Bucket.

7) The PAC will proceed through each Tipping Bucket in the cycle. If multiple cycles have been programmed the PAC will continue through all cycles in the sequence.

8) At the conclusion of the Tipping Bucket flushing sequence, the duty Tipping Bucket Fill Pump is turned off and the fill valve to the last Tipping Bucket is closed.

9) The drain down valve opens and the tipping bucket fill lines drain back to the air gap tank.

10) If at any time during the flushing sequence the level in CSO 8A Storage Tank rises to a use defined level (initially set to 4-feet), the flushing sequence will be terminated and a new flushing sequence initiated when the level in the tank reaches the pump off level. Water level above this level indicates that excess combined sewage is again being stored in CSO 8A Storage Tank and there is no purpose in continuing the flushing sequence.

11) The Tipping Bucket Fill Pumps will not operate if the low level alarm is active on the Air Gap Tank.

b. System operation with equipment failure:

1) In the event of a utility power failure the Tipping Bucket Flushing sequence will be suspended and will resume when power is restored.

6. OIU indication, alarming and operator set points:

a. OIU Display:

1) OIU Auto/Manual.

2) Pump P-4441 in auto, HS-4441A.

3) Pump P-4441 in hand, HS-4441B.

4) Pump P-4441 Running, QL-4441.

5) Pump P-4441 Overload, YI-4441.

6) Pump P-4441 Disconnect Open, ZSO-4441.

7) Pump P-4442 in auto, HS-4442A.

8) Pump P-4442 in hand, HS-4442B.

9) Pump P-4442 Running, QL-4442.

10) Pump P-4442 Overload, YI-4442.

11) Pump P-4442 Disconnect Open, ZSO-4442.

12) Fill valves FV-4421, FV-4422, FV-4423 and FV-4424 Closed, ZSC-4421, ZSC-4422, ZSC-4423 and ZSC-4424.

13) Fill valves FV-4421, FV-4422, FV-4423 and FV-4424 Opened, ZSO-4421, ZSO-4422, ZSO-4423 and ZSO-4424.

14) Fill valves FV-4421, FV-4422, FV-4423 and FV-4424 Auto, HS-4421, HS-4422, HS-4423 and HS-4424.

15) Tipping Buckets TB-4421, TB-4422, TB-4423 and TB-4424 Tipped, ZS-4421, ZS-4422, ZS-4423 and ZS-4424.

16) Drain Control Valve FV-4433 Open, ZSO-4433.

17) Drain Control Valve FV-4433 Closed, ZSC-4433.

18) Drain Control Valve FV-4433 Auto, HS-4433.

b. Alarms:

1) Tipping Bucket Fill Pump 1 Overload, UA-4441.

2) Tipping Bucket Fill Pump 2 Overload, UA-4442.

3) Tipping Bucket Fill Pump 1 Disconnect Open, ZA-4441.

4) Tipping Bucket Fill Pump 2 Disconnect Open, ZA-4442.

5) Tipping Bucket Fill Pump Running but no Fill Valve Open for 60 seconds (user adjustable).

6) Fill Valve open and tipping bucket not tipped for 30 minutes (user adjustable).

c. Operator Set Points:

1) Time in seconds that a tipping bucket pump is running, without a fill valve being open.

2) Time in minutes that a tipping bucket pump is running, without a proximity switch changing state.

F. Loop 4434: CSO 8A Wash Water System:

1. Reference:

a. P&ID: Sheet 175.

2. Key Elements:

a. Washdown Booster Pump (P-4434).

b. Diaphragm Tank (T-4434).

c. Air Gap Tank (T-4432).

d. Air Gap Tank Fill Valves (FV-4432A and FV-4432B).

e. Level Switches in Air Gap Tank (LSH-4432, LSC-4432A, LSC-4432B, and LSL-4432).

3. System description:
    a. The Wash Water System provides non-potable water for site and facility maintenance purposes.
4. Process data logging:
    a. None.
5. Operation:
    a. General description:
        1) A Washdown Booster Pump is provided to supply water to hose bibbs in the Mechanical Room and yard hydrants on site. A Diaphragm Tank is connected to the discharge of the Washdown Booster Pump to provide consistent pressure and flow.
    b. Manual control functions:
        1) None.
    c. Automatic control functions:
        1) Pump cycle on and off to maintain pressure within a preset range.
    d. Process control interlocks:
        1) None.
6. OIU indication, alarming and operator set points:
    a. OIU Display:
        1) None.
    b. Alarms:
        1) None.
    c. Operator set points:
        1) None.

G. Loop 4450: CSO 8A Odor Control System:
1. Reference:
    a. P&ID: Sheet 176.
2. Key Elements:
    a. Mist and Grease Eliminator (FLT-4450).
    b. Odor Control Fan (EF-4450).
    c. Odor Control Unit (OCU-4450).
    d. Air Exhaust Plenum.
    e. Dampers (manual).
    f. Filter Differential Pressure Indicators (PDI-4450A, PDI-4450B, and PDI-4450C).
    g. Exhaust Duct Silencer (SLC-4450).

h. LEL and H2S Gas Sensors (AIT-4451A and AIT-4451B) and Sample Pumps (SP-4451A and SP-4451B).

3. System description:

a. Provides odor control for CSO 8 Storage Pipe, CSO 8A Storage Tank and limited odor control for the combined sewer system in the vicinity of these facilities.

4. Process data logging:

a. AIT-4451A LEL Concentration in CSO 8A Storage Tank.

b. AIT-4451B H2S Concentration in Odor Control Ducting.

5. Operation:

a. General description:

1) The odor control system operates continuously.

2) EF-4450 has two operating modes to limit noise at night:

a) Day: fast.

b) Night: slow.

3) Foul air is pulled from the storage tank and the existing CSO 8 Storage pipe and sent through a dual-bed active carbon scrubber to prevent fugitive odors from escaping the storage tank.

4) Treated air is discharged at the Exhaust Air Plenum with the top of the plenum flush at grade.

5) FLT-4450 is installed in the foul air line to protect the carbon.

6) SLC-4450 is installed on the treated air line downstream of the fan to minimize the noise emitted from the system.

b. Manual control functions:

1) The odor control fan may be operated manually from VFD-4450.

2) PAC: None.

c. Automatic control functions:

1) When the odor control fan is in automatic, the fan starts and runs. Fan speed is determined by time of day.

a) Night (operator adjustable time period): slow (operator adjustable speed setpoint).

b) Day (operator adjustable time period): fast (operator adjustable speed setpoint).

d. Process control interlocks:

1) Odor control fan shut down:

a) On high LEL measured by AIT-4451A. The fan shall remain off until the condition clears.

6. OIU indication, alarming and operator set points:

a. OIU Display:

1) Odor Control Fan, EF-4450, in auto, HS-4450.

2) Odor Control Fan, EF-4450, in hand, HS-4450.

3) OIU Auto/Manual.

4) Odor Control Fan, EF-4450, Running, QL-4450.

5) Odor Control Fan, EF-4450, Overload, YI-4450.

6) Odor Control Fan, EF-4450, Disconnect Open, ZSO-4450.

7) No Flow in odor ducting, FSL-4450.

b. Alarms:

1) High Lower Explosive Limit (LEL) from storage tank.

2) High Hydrogen Sulfide (H_2S) in odor control duct.

3) Discrete contacts from AIT-4451A, Storage Tank LEL, will send a signal to the PAC in the event of an instrument fault.

4) Discrete contacts from AIT-4451B, Odor Control Unit Hydrogen Sulfide, will send a signal to the PAC in the event of an instrument fault.

5) Discrete contacts from AIT-4451A, Storage Tank LEL, will send a signal to the PAC in the event of a high concentration.

6) Discrete contacts from AIT-4451B, Odor Control Unit Hydrogen Sulfide, will send a signal to the PAC in the event of a high concentration.

7) Discrete contacts from SP-4451A will send a signal to the PAC in the event of Sample Pump Loss of Flow.

8) Discrete contacts from SP-4451B will send a signal to the PAC in the event of Sample Pump Loss of Flow.

9) Low air flow in odor control duct, (FSL-4450).

c. Operator Set Points:

1) Alarm setpoints set at instruments.

H. Loop 4455: CSO 8A Ventilation System:

1. Reference:

a. P&ID: Sheets 177, 178 and 179.

2. Key Elements:

a. Electrical Room, Mechanical Room and Entryway.

b. Air Intake Plenums.

c. Air Exhaust Plenums.

d. Supply and Exhaust Ducting.

e. Supply Fans (SF-4455 and SF-4456).

f. Supply Fan Filters (FLT-4455 and FLT-4456).

g. Exhaust Fan (EF-4456).

3. System description:

a. Provides ventilation in each of the three rooms within the Facilities Vault.

4. Process data logging:

a. None.

5. Operation:

a. General description:

1) The supply and exhaust fans operate continually to provide the required number of air exchanges in all three rooms.

2) Ventilation is provided for the mechanical room, electrical rooms, and the Entryway.

3) Electrical Room will be maintained at a slight positive pressure by SF-4455. No exhaust fan will be provided in the room. Air will exhaust via a duct to the Exhaust Plenum.

4) Mechanical Room will be maintained at a slight negative pressure by SF-4456 and EF-4456.

5) The Entryway will be ventilated by SF-4456 in the Mechanical Room. No exhaust fan will be provided in the Entryway. Air will release either back to the Mechanical Room or through the Entrance hatch.

6) Visual indication (for each room) is provided to notify personnel of ventilation failure for that room.

7) A low flow switch is installed in the ducting of the ventilation for each of the facility rooms.

8) An alarm will be displayed on the OIU if flow switches indicate low ventilation flow in the mechanical or electrical rooms.

b. Manual control functions:

1) OIU: None.

2) PAC: None.

3) The fans shall operate continually.

4) The fan shall operate continually.

c. Automatic control functions:

1) None.

d. Process control interlocks:

1) None.

6. OIU indication, alarming and operator set points:

a. OIU Display:

1) Mechanical Room Supply Air Fan, SF-4456, Running, IS-4456A.

2) Mechanical Room Supply Air Fan, SF-4456, Disconnect Open, ZSO-4456A.

3) Mechanical Room Exhaust Air Fan, EF-4456, Running, IS-4456B.

4) Mechanical Room Exhaust Air Fan, EF-4456, Disconnect Open, ZSO-4456B.

5) Mechanical Room Exhaust Air Fan, EF-4456, Low Air Flow, FSL-4456.

6) Electrical Room Supply Air Fan, SF-4455, Running, IS-4455.

7) Electrical Room Supply Air Fan, SF-4455, Disconnect Open, ZSO-4455.

8) Electrical Room Supply Air Fan, SF-4455, Low Air Flow, FSL-4455.

b. Alarms:

1) An alarm shall be displayed on the OIU if flow switches indicate low ventilation flow in the mechanical or electrical rooms.

c. Operator Set Points:

1) None.

I. Loop 4466 and 4465: CSO 8A Sump Pump System:

1. Reference:

a. P&ID: Sheet 180.

2. Key Elements:

a. Electrical room sump pumps (P-4465A and P-4465B).

b. Mechanical room sump pumps (P-4466A and P-4466B).

c. Pump Start Float switches for each sump pump system (LSM-4465 and LSM-4466).

d. Pump Stop Float switches for each sump pump system (LSL-4465 and LSL-4466).

e. “Flood” Float switches for each sump pump system (LSH-4465 and LSH-4466).

f. Control panels for each sump pump system (LCP4465 and LCP-4466).

g. Room Flood Switch (LSHH-4465 and LSHH-4466).

3. System description:

a. Sump pumps are located in the mechanical and electrical rooms.

b. The sump pumps drain the rooms when water has collected in the sump.

4. Alarms:

a. A high level alarm is provided for both rooms to notify personnel of a high sump level. The alarm is integral to the vendor supplied panel and will alarm as “System Trouble”.

b. A dry well float switch is provided for both rooms and will alarm if there is standing water outside of the sump area (Dry Well Flood).

5. Process data logging:

1) None.

6. Operation:

a. General description:

1) Two sump pumps, one lead and one lag, are located in both rooms of the facility.

2) The sump pumps are controlled by floats installed in their respective sump. Each sump has three float switches for: pump stop, pump start, and high level. The high level float switch shall start the lag pump as well as activate an alarm.

b. Manual control functions:

1) OIU: None.

2) PAC: None.

c. Automatic control functions:

1) The sump pumps are controlled by a vendor supplied local control panel.

d. Process control interlocks:

1) None.

7. OIU indication, alarming and operator set points:

a. Alarms:

1) System trouble alarm from vendor-supplied LCP-4466.

2) System trouble alarm from vendor-supplied LCP-4465.

3) High dry well (flood) alarm in mechanical room, LSHH-4466.

4) High dry well (flood) alarm in electrical room, LSHH-4465.

J. Loop 4460: CSO 8A Gas Detection System:

1. Reference:

a. P&ID: Sheets 177, 178, 179.

2. Key Elements:

a. Mechanical Room Gas detection analyzers (AIT-4460A, AIT-4460B, and AIT-4460C).

b. Mechanical Room Go-No/Go panel (LCP-4460).

c. Electrical Room Gas detection analyzers (AIT-4461A, AIT-4461B, and AIT-4461C).

d. Electrical Room Go-No/Go panel (LCP-4461).

3. System description:

a. Air quality is continuously monitored in each room for high levels of explosive gases and hydrogen sulfide, and low levels of oxygen.

b. Each room shall have a local control panel (GO/NOGO) near the entrance with a visual indication of gas alarms for that room. Each panel shall have a “Go” light and a “No/Go” light, with “Go” signifying it is safe to enter and “No/Go” signifying the space is not safe to enter.

c. Any of the three gas detectors for each room above can create a “No/Go” situation for that room.

4. Process data logging:

a. Gas concentrations of explosive gases (AIT-4460A), hydrogen sulfide (AIT-4460B), and oxygen (AIT-4460C) in the mechanical room.

b. Gas concentrations of hydrogen sulfide (AIT-4461A), explosive gases (AIT-4461B), and oxygen concentrations (AIT-4461C) in the electrical room.

c. Gas concentrations of hydrogen sulfide (AIT-4462A), explosive gases (AIT-4462B), and oxygen concentrations (AIT-4462C) in the Entryway.

5. Operation:

a. General description:

1) Gas detectors continually monitor the air quality in all facility rooms and alarm locally and remotely if poor air quality is detected.

2) Each room is continuously monitored for high levels of explosive gases and hydrogen sulfide, and low levels of oxygen.

3) Any gas alarm from any gas monitor will alarm to the corresponding room local alarm panel and also to the PAC for OIU and telemetry notification.

b. Manual control functions:

1) OIU: None.

2) PAC: None.

c. Automatic control functions:

1) When a gas monitor detects an alarm condition, discrete alarm contacts close within the unit which energizes the “No/Go” light. In addition to turning on the “No/Go” light, a horn and strobe will be activated. The horn may be silenced and strobe turned off by depressing the Silence switch. Subsequent alarms from other monitoring devices will re-energize the horn and strobe.

2) When a flow switch detects an alarm condition with one of the ventilation fans, an alarm contact energizes the “LOW FLOW” light.

3) After an alarm condition no longer exists, pressing a reset switch will clear the alarm condition.

d. Process control interlocks:

1) None.

6. OIU indication, alarming and operator set points:

a. OIU Display:

1) The concentration of gases read in all locations shall be displayed on a gas monitoring screen on the OIU.

b. Alarms:

1) An alarm shall be displayed on the OIU if any of the gas detectors indicate any gas alarm condition. The alarm levels shall be controlled by operator-adjustable setpoints through the OIU.

2) A visual indicator is provided to notify personnel of gas alarms or ventilation alarms at the entry for each room.

3) Gas detection alarms and ventilation alarms shall be displayed on OIU and sent to the telemetry system.

4) A horn and strobe will be activated upon an alarm condition being detected by any gas monitor.

5) Discrete contacts from each instrument will send a signal to the PAC in the event of an instrument fault.

c. Operator Set Points:

1) High LEL alarm in each room.

2) High H_2S alarm in each room.

3) Low Oxygen alarm in each room.

K. Loop 4425 – Facility Intrusion:

1. Reference:

a. P&ID: Sheets 172, 173, 174, and 179.

2. Key Elements:

a. Hatch limit switches (ZS-4425A, ZS-4425B, ZS-4435C, ZS-4425 D, ZS-4425E, ZS-4425F, ZS-4425G, and ZS-4425H)

b. Panel intrusion switches (ZS-4400, and ZS-4401).

c. Entryway door intrusion switch (ZS-4457),

3. System description:

a. Monitor for intrusion.

4. Process data logging:

a. None.

5. Operation:

a. General description:

1) Monitor and alarm intrusion.

b. Manual control functions:

1) OIU: None.

2) PAC: None.

c. Automatic control functions:

1) Alarms will be sent to SCADA.

d. Process control interlocks:

1) None.

6. OIU indication, alarming and operator set points:

a. OIU Display:

1) None.

b. Alarms:

1) Intrusion alarm Tipping Buckets, ZS-4425A, ZS-4425B, ZS-4425C, ZS-4425D, ZS-4425E, and ZS-4425F.

2) Intrusion Entryway, ZS-4457.

3) Intrusion: Storage Tank Drain Pumps and Tank Access, ZS-4425G/H.

4) Intrusion: Electrical and Communication Cabinet (ZS-4401).

5) Intrusion: Main Control Panel (ZS-4400).

c. Operator Set Points:

1) None.

L. Loop 4456-Facility Smoke/ Heat Alarms:

1. Reference:

a. P&ID: Sheets 177, 178, 179.

2. Key Elements:

a. Electrical Room smoke detector (SD-4455).

b. Mechanical Room smoke detector (SD-4456).

c. Entryway smoke detector (SD-4457).

3. System description:

a. Monitor Mechanical Room, Electrical Room, and Entryway for smoke and/or heat.

4. Alarms:

a. Smoke/Heat Detected.

5. Process data logging:
   a. None.
6. Operation:
   a. General description:
      1) Monitor Mechanical room for smoke and/or heat detected.
      2) Monitor Electrical room for smoke and/or heat detected.
   b. Manual control functions:
      1) OIU: None.
      2) PAC: None.
   c. Automatic control functions:
      1) Alarm will be sent to MCP-4400.
   d. Process control interlocks:
      1) None.
7. OIU indication, alarming and operator set points:
   a. OIU Display:
      1) None.
   b. Alarms:
      1) Smoke/Heat detected alarm Electrical Room. SD-4455.
      2) Smoke/Heat detected alarm Mechanical Room. SD-4456.
      3) Smoke/Heat detected alarm Entryway. SD-4457.
   c. Operator setpoints:
      1) None.

M. Loops 4455, 4401 and 4402 – Power:
1. Reference:
   a. P&ID: Sheets 171, 173, and 179.
2. Key Elements:
   a. AC UPS Bypass Active switch (YI-4400A).
   b. AC UPS Utility Failure switch (YI-4400B).
   c. AC UPS Battery Low switch (YI-4400C).
   d. AC UPS General Alarm switch (YI-4400D).
   e. MCC Power Fail switch (JE-4455).
   f. MCC Power On switch (JT-4455).
   g. MCC Energy Monitor (JQT-4455).

h. DC UPS Battery Voltage (EE-4401 and EE-4402).

i. DC UPS Replace Battery switch (YI-4401A and YI-4402A).

j. DC UPS Buffering switch (YI-4401B and YI-4402B).

k. DC UPS Ready switch (YI-4401C and YI-4402C).

3. System description:

   a. Monitor AC UPS.

   b. Monitor DC UPS systems.

   c. Monitor power to facility.

4. Process data logging:

   a. DC battery voltage from DCUPS-4401 and DCUPS-4402.

5. Operation:

   a. General description:

      1) Monitor DC and AC power systems.

      2) Monitor Manual transfer switch to Normal.

      3) Monitor Manual transfer switch to Generator.

   b. Manual control functions:

      1) OIU: None.

      2) PAC: None.

   c. Automatic control functions:

      1) None.

   d. Process control interlocks:

      1) None.

6. OIU indication, alarming and operator set points:

   a. OIU Display:

      1) DCUPS-4401, Battery Voltage, EE-4401.

      2) DCUPS-4401, Replace Battery, YI-4401A.

      3) DCUPS-4401, Buffering, YI-4401B.

      4) DCUPS-4401, Ready, YI-4401C.

      5) DCUPS-4402, Battery Voltage, EE-4402.

      6) DCUPS-4402, Replace Battery, YI-4402A.

      7) DCUPS-4402, Buffering, YI-4402B.

      8) DCUPS-4402, Ready, YI-4402C.

      9) Manual Transfer Switch on Normal, ZS-4455A.

      10) Manual Transfer Switch on Generator, ZS-4455B.

11) ACUPS-4400, Bypass Active.

12) ACUPS-4400, Utility Failure.

13) ACUPS-4400, Battery Low.

14) ACUPS-4400, General Alarm.

b. Alarms:

1) DCUPS-4901:

a) Replace Battery, YI-4401A.

2) DCUPS-4902:

a) Replace Battery, YI-4402A.

c. Operator set points:

1) None.

3.03 CSO 29A CONTROL LOOPS

A. Loop 4571: CSO 29A Storage Pipe and Drain Gate:

1. Reference:

a. P&ID: Sheets 201 and 202.

2. Key Elements:

a. CSO 29A Storage Pipe.

b. Pump Station (PS) 10 Wet Well Level.

c. CSO 29A Storage Transfer Weir.

d. CSO 29A Storage Bypass Weir.

e. NPDES 45A Overflow Weir.

f. CSO 29A Storage Drain Float Gate.

g. Flap gate in MH 074-215.

h. Level in CSO 29A Storage Pipe (LT-4571A and LT-4571B).

i. Level elements in MH 074-212 CSO 29A Storage Transfer Structure (LT-4570A and LT-4570B).

j. Level element in CSO 29A Storage Bypass Structure (LT-4572A) Downstream.

3. System description:

a. Provides storage of excess combined sewer flows at Basin 45.

4. Process data logging:

a. Level in MH 074-212 CSO 29A Storage Transfer Structure.

b. Level in CSO 29A Storage Pipe.

c. Level in CSO 29A Storage Bypass Structure - Downstream.

5. Operation:
    a. General description:
        1) CSO 29A Storage Pipe and Drain Gate is an offline facility adjacent to Pump Station 10.
        2) Pump Station 10 lifts flow from Basin 44 and 45 and discharges it to the Lake Line that flows to Basin 46.
        3) Pump Station 10 will deliver flow up to the maximum pumping capacity to MH 074-152.
        4) The CSO 29A Storage Drain Float Gate controls flow between the storage pipe and the Pump Station 10 Wet Well. It is operated by floats that close the gate as the water level in MH 074-215 rises. As the level falls the floats also drop and thereby open the gate.
        5) Flow in excess of Lake Line capacity downstream of Pump Station 10 will spill to CSO 29A Storage Pipe over the CSO 29A Storage Transfer Weir.
        6) If the CSO 29A Storage Drain Float Gate is closed, excess flow will be stored in CSO 29A Storage Pipe.
        7) At High Wet Well level, flow to Pump Station 10 Wet Well can also transfer to the CSO 29A Storage Pipe through a flap gate if there is capacity in the storage pipe.
        8) Overflow to Basin 45 outfall occurs after the level in Pump Station 10 Wet Well has risen to the level of NPDES 45A overflow weir.
    b. Manual control functions:
        1) None.
    c. Automatic control functions:
        1) None.
    d. Process control interlocks:
        1) None.
6. OIU indication, alarming and operator set points:
    a. OIU Display:
        1) Level in MH 074-212 CSO 29A Storage Transfer Structure.
        2) Level in CSO 29A Storage Pipe.
        3) Level in CSO 29A Storage Bypass Structure – Downstream.
    b. Alarms:
        1) MH 074-212 high level alarm.
        2) CSO 29A Storage Pipe high level alarm.
        3) CSO 29A Storage Bypass Structure drain pipe valve stuck open.
        4) CSO 29A Storage Bypass Structure drain pipe blocked.

c. Operator set points:

1) None.

END OF SPECIFICATION SECTION 40 90 05

SPECIFICATION SECTION 40 91 10

PRIMARY ELEMENTS AND TRANSMITTERS

PART 1 - GENERAL

1.01 SUMMARY

A. Specification Section Includes:

1. Level Components and Accessories.
2. Analytical Components.
3. Pressure Components and Accessories.
4. Flow Components.
5. Accessories.
6. Pipe, tubing, and fittings.
7. Instrument valves.

B. Related Specification Sections include but are not necessarily limited to:

1. CSC Parts 1, 2, 3, 4, and 6.
2. Section 40 90 00 - Instrumentation for Process Control: Basic Requirements.
3. Specification Section 40 90 05 - Control Loop Descriptions.
4. Specification Section 40 98 00 - Control Panels and Enclosures.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. American Iron and Steel Institute (AISI).
2. American National Standards Institute (ANSI).
3. American Society of Mechanical Engineers (ASME):
    a. B16.5, Pipe Flanges and Flanged Fittings.
    b. B31.1, Power Piping.
    c. PTC 19.3, Instruments and Apparatus, Part 3 Temperature Measurement.
    d. PTC 19.5, Application of Fluid Meters, Part 2.
    e. Section II, Part A SA-182, Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
    f. Section II, Part A SA-479, Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.
4. ASTM International (ASTM):
    a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

b. A182, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.

c. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

d. A276, Standard Specification for Stainless Steel Bars and Shapes.

e. A479, Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.

5. Federal Communications Commission (FCC):

a. 47 CFR 15, Radio Frequency Devices.

6. National Electrical Manufacturers Association (NEMA):

a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

7. US Department of Interior Bureau of Reclamation (USDIBR):

a. Water Measurement Manual.

1.03 SYSTEM DESCRIPTION

A. The instruments specified in this Specification Section are the primary element components and accessories shown on the Drawings and as required for a complete installation:

1. These instruments are integrated with other control system components specified under Specification Section 40 90 00 - Instrumentation for Process Control: Basic Requirements series to produce the functional control defined in the Contract Documents.

1.04 SUBMITTALS

A. Shop Drawings:

1. See CSC Part 3.1 for requirements for the submittal process.

2. See Specification Section 40 90 00 - Instrumentation for Process Control: Basic Requirements.

B. Operation and Maintenance Manuals:

1. See CSC Part 3.1 for requirements for the submittal process:

a. The mechanics and administration of the submittal process.

2. See CSC Part 3.1 for the content of the Project Operation and Maintenance Manual.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the Articles describing the elements are acceptable.

B. Submit request for substitution in accordance with CSC Part 3.1.

2.02 LEVEL COMPONENTS AND ACCESSORIES

A. Ultrasonic Level Instrument:

1. Acceptable manufacturers:
    a. Pulsar, dBi.
    b. No equal.
2. Materials:
    a. Sensor wetted parts: PVC, polypropylene, KYNAR or polyvinylidene fluoride (PVDF).
3. Design and fabrication:
    a. Instrument with integral sensor and transmitter:
        1) Emits ultrasonic sound.
        2) Detects return echo reflected from surface and converts it to electrical energy proportional to level.
        3) Nominal Beam Angle: 10 degrees or less.
        4) Effective Beam Angle: 3 degrees or less.
        5) Submergence shield.
        6) Rated for hazardous area: Class I, Division 1.
        7) Continuous cable to control panel (no splices), including spare length coiled in the field, no exception.
        8) Mounting accessories as required for the installation.
        9) Integral temperature compensation.
        10) Operating temperature: -40 DegF to 176 DegF.
        11) Humidity: 95 percent non-condensing.
        12) Enclosure rating of NEMA 4X and IP68.
        13) Capable of producing output signal proportional to level of 4-20 mA DC into 500 ohm load.
        14) Power supply: 24VDC; loop-powered.
        15) Inaccuracy: 0.25 percent of range or 0.24-IN, whichever is greater.
        16) Resolution: 0.1 percent of span or 0.08-IN, whichever is greater.
        17) Memory: EEPROM (non-volatile).
        18) HART enabled.
        19) Provide software suite for set-up, echo profile configuration, etc. (Pulsar PC Suite). One license or dongle.
        20) HART Modem (Pulsar HART modem).

21) Coordinate final scale range with Engineer and Owner following sensor installation.

4. Level Element Mounting:

a. Maintenance Holes and Storage Tank:

1) Minimum of 10-feet of spare cable shall be coiled and secured inside each maintenance hole (or Storage Tank hatch) to facilitate easy removal of instruments for maintenance.

2) Secure the remaining cables to the walls of the maintenance holes (or Storage Tank hatch) approximately at the height of the conduit entry or higher.

3) For LT-4574B, provide Pulsar Fixed Angle Bracket, part number 080A0008. Locate in same location as existing sensor.

5. Schedule:

TAG NUMBER	SERVICE	MAXIMUM DEPTH TO LIQUID SURFACE (FT)	CALIBRATED RANGE (FT)	MOUNT
LT-4403B	Raw Sewage	10	0-6 (Field Verify)	See Above Per Drawings
LT-4404B	Raw Sewage	10	0-6 (Field Verify)	See Above Per Drawings
LT-4410B	Raw Sewage	33	0-30 (Field Verify)	See Above Per Drawings
LT-4570B	Raw Sewage	10	0-8 (Field Verify)	See Above Per Drawings
LT-4571B	Raw Sewage	10	0-10 (Field Verify)	See Above Per Drawings
LT-4574B	Raw Sewage	10	0-10 (Field Verify)	See Above Per Drawings

B. Submersible Pressure Sensor and Transmitter:

1. Acceptable Manufacturers:

a. Pressure Systems, Inc. - KPSI 750 (for Stilling Well mounting).

b. GE, Druck PTX 1830 with STE-110 (for Partial Band mounting).

c. No equal.

2. Materials:

a. Sensor body: Titanium.

b. Sensing diaphragm: elastomeric, Teflon coated.

c. Cable: polyurethane strengthened with kevlar.

3. Design and fabrication:

a. Submersible pressure transmitter with a piezoresistive-micromachined silicon strain gauge type sensor.

b. Flush polytetrafluorethylene-coated elastomeric diaphragm.

c. Pressure port with flush, polytetrafluorethylene-coated elastomeric diaphragm and fluid fill to reduce grease or biosolids buildup.

d. In addition to electrical conductors, the sensor support cable contains a tube which is vented to atmosphere to offset changes in barometric pressure.

e. Provide sensor termination enclosure with micro filter assembly to permit barometric reference, and a replaceable dessicant module to keep vent tube free from moisture.

f. Operating range: sufficient to handle scale shown in schedule below. Four times overpressure protection.

g. Loop-powered (2-wire) device with 4-20 mA DC output and 9-32 VDC excitation.

h. Continuous cable to control cabinet (no splices) including spare length coiled in the field, no exceptions.

i. Accuracy: +/- .25 percent of full scale.

j. Temperature effects: +/- 1.5 percent of full scale.

k. Relative humidity: 0 to 100 percent.

l. Operating temperature range: -5 to 140 DegF.

m. Diameter: 4.1-IN max.

n. UL listed: Intrinsically safe.

4. Mounting:

a. See Schedule below and Drawings.

b. Minimum of 10-feet of spare cable shall be coiled and secured inside each maintenance hole (or Storage Tank hatch) to facilitate easy removal of instruments for maintenance.

5. Schedule:

TAG NUMBER	SERVICE	SCALE (PSI)	ZERO ELEVATION	MOUNT
LT-4403A	Raw Sewage	0-5	Field Verify	Partial Band
LT-4404A	Raw Sewage	0-5	Field Verify	Stilling Well
LT-4410A	Raw Sewage	0-15	Field Verify	Stilling Well
LT-4570A	Raw Sewage	0-5	Field Verify	Partial Band

TAG NUMBER	SERVICE	SCALE (PSI)	ZERO ELEVATION	MOUNT
LT-4571A	Raw Sewage	0-10	Field Verify	Stilling Well
LT-4572A	Raw Sewage	0-10	Field Verify	Stilling Well
LT-4574A	Raw Sewage	0-5	Field Verify	Partial Band

C. Float-Tilt Type Level Switches:

1. Acceptable manufacturers:
   a. Siemens Water Technologies/Consolidated Electric.
   b. MJK North America, Model 7030.
   c. Anchor Scientific Inc.
   d. Or equal.
2. Materials:
   a. Float material: Polypropylene or Teflon coated type 316 stainless steel, or equal.
   b. Cable jacket: PVC, neoprene or equal.
   c. Cable clamp: Polypropylene or 316 stainless steel.
   d. Blind flange: PVC, tapped for cable grommet to secure at set point elevation; fasteners shall be 316 SST (nuts, washers and lock washers) for a complete installation.
3. Design and fabrication:
   a. Sealed mercury-free switch in float.
   b. Break resistant cable.
   c. Provide switch complete with flexible electrical cables.
   d. SPDT contact rated at 4.5 amp at 120 Vac.
   e. Direct acting float switch:
      1) Switch actuates, contact opens on rising level.
      2) Switch deactuates when liquid falls 1-IN below actuation level.
   f. Terminate cables in junction box.
   g. Install floats per Drawing details and as noted in this Specification Section.
   h. Provide SST or non-corrosive mounting hardware as required for installation.
4. Schedule:

TAG NUMBER	SERVICE	CONTACT NO/NC	SET POINT ELEVATION
LSH-4410	Raw Sewage	SPDT	(Rising)

5. Mounting:
    a. Minimum of 10-feet of spare cable shall be coiled and secured inside each maintenance hole (or Storage Tank hatch) to facilitate easy removal of instruments for maintenance.

D. Building Flood Level Switches:

1. Acceptable Manufacturers:
    a. Siemens: Model: 101GX.
    b. Or equal.
2. Design and Fabrication:
    a. Action: A liquid rise of 3/8-inch from rest shall operate the float switch.
    b. Reset: Automatic reset when liquid level drops 1/16-inch.
    c. Designed for sensing flood conditions as an integral and complete system.
    d. Provide junction box and mounting hardware per Material Application Schedule and Area Environmental Designation Schedule.
    e. Operating Range: 1 to 180 DegF with 0 to 100% relative humidity.
    f. Contacts Rating: 0.50A at 24VDC.
3. Mounting:
    a. One inch above finished floor.
4. Schedule:

TAG NUMBER	SERVICE	CONTACT NO/NC	SET POINT ELEVATION
LSHH-4465	Room Flood	SPDT	(Rising)
LSHH-4466	Room Flood	SPDT	(Rising)

E. Displacer Type Level Switches:

1. Acceptable Manufacturers:
    a. Magnetrol: Model: B15.
    b. Or equal.
2. Design and Fabrication:
    a. Displacer material: Porcelain.

b. Flange mount.

c. Designed as an integral and complete system.

d. Provide enclosure per Material Application Schedule and Area Environmental Designation Schedule.

e. Contacts: One DPDT for each setpoint.

f. Contacts Rating: As required.

3. Mounting:

a. Provide mounting hardware and accessories as required for mounting level switch assembly above the tank and off-set from the wall as required.

4. Schedule:

TAG NUMBER	SERVICE	CONTACT NO/NC	SET POINT ELEVATION
LSH-4432	High	DPDT	Field Verify
LSC-4432B	Stop	DPDT	Field Verify
LSC-4432A	Fill	DPDT	Field Verify
LSL-4432	Low	DPDT	Field Verify

2.03 ANALYTICAL COMPONENTS

A. Combustible and Toxic Gas Detectors:

1. Acceptable manufacturers:

a. MSA:

1) Ultima X Series Gas Monitors:

a) Combustible Gas:

(1) Sensor Type: IR Methane.

(2) Range: 0 – 100%.

b) Hydrogen Sulfide (H_2S):

(1) Sensor Type: Electrochemical.

(2) Range: 0 – 50 ppm.

c) Oxygen (O2):

(1) Sensor Type: Electrochemical.

(2) Range: 0-25%

2) No like, equivalent or or-equal item is acceptable.

2. Sensor/Transmitter Requirements:

a. Infrared Combustible (IR) Sensor/Transmitters:

1) Capable of calibration without gas. Capable of performing a full calibration by zero adjustment only.

2) Shall detect for an above 100% LEL condition (over-range). This condition must be indicated on the front panel LCD.

3) The IR sensor/transmitter shall not contain a flashback arrestor.

4) Gas check without alternate calibration or gas check fittings or cap.

b. Electrochemical (Toxic) Sensors/Transmitters:

1) Shall not require the periodic addition of reagents.

2) The interconnect wiring from the electrochemical transmitter to the sensor shall be a 5-wire cable.

c. Operating Requirements:

1) Temperature range: 32 to 158 DegF.

2) Relative humidity range: 0-95 percent non-condensing.

3) Operating Voltage: 7-30 VDC.

4) Sensor/transmitter wiring configurations: 3-wire cable.

5) Set-up and start-up of the sensor/transmitter will be so that the enclosure need not be opened during this process.

6) Sensor/transmitter shall contain no pots, jumpers or switches.

7) Transmitter output signal: 4 to 20mA capable of operating into a 600-ohm load.

8) Sensor/transmitter shall allow for full range scaling of the 4-20mA-output signal.

9) Sensor/transmitter will be capable of storing and displaying average, minimum and maximum gas concentrations over selected periods of time.

10) The sensor/transmitter will give an indication of when sensor is nearing the end of its useful life by means of the front panel LCD. This indication that the sensor is nearing its useful life will be based on the sensor output. It shall not be based on the time the sensor was in service.

11) The sensor/transmitter units can be located remote from a monitor/readout unit by up to 4000 feet via properly gauge wire.

12) Accuracy:

a) Combustible gas detection:

(1) +3 percent LEL to 50 percent full scale.

(2) +5 percent LEL, 50 to 100 percent full scale.

b) Toxic gas detection:

c) +10 percent full scale or 2 PPM, whichever is greater.

d) Oxygen detection:

(1) + 2 percent full scale or 2 PPM, whichever is greater.

13) Minimum detector response time when exposed to 100 percent LEL gas concentration:

a) 10 seconds to 50 percent LEL.

b) 30 seconds to 90 percent LEL.

14) Store calibration data in nonvolatile memory or back up with battery.

d. Sensor/Transmitter Display:

1) Local display to indicate the gas type being monitored and the concentration of gas present. The display will alternate between the gas type (1 second) and gas concentration (5 seconds). The display will be an integral part of the sensor/transmitter enclosure. The display will be visible from a minimum of 5 feet and will be present always, and will not require being turned on or off. This readout will be three, one-half-inch (3-1/2") digit Liquid Crystal Displays (LCD).

2) Sensor/transmitter display shall indicate all diagnostic check/fault conditions with a scrolling message detailing the condition. Error codes shall not be used.

3) Sensor/transmitter will display 3 levels of alarm. Alarm levels will be adjustable by means of a hand held infrared controller.

4) Transmitter Display mounting height to be approximately 5 feet above the finished floor.

e. Smart Sensor Technology:

1) Sensors shall be contained in sensor modules mounted external to the main enclosure. All sensor modules shall have the capability of replacement while the unit is under power (hazardous areas) without the need for tools.

2) Sensor modules shall contain all relevant sensor information within the module. This information shall include sensor manufacturer date, gas type, gas range, calibration data, and default relay parameters.

3) Sensor module shall store all calibration data so that the module may be calibrated off site and installed in the field without the necessity of re-calibration. The sensor module shall not require a battery or power source to store this data.

f. Transmitter LED’s and Relays:

1) Sensor/transmitter shall have optional LED's, viewable from 50 feet, minimum. The LED's shall operate as follows:

   a) Solid green LED – normal operation (measure mode).

   b) Solid red LED – fault condition.

   c) Blinking red LED – alarm condition.

2) Sensor/transmitter shall have four SPDT relays. Relays shall be rated 5 amps at 30 VDC and consist of three for alarm levels and one for fault. All relay contact activation will be monitored. If the relay cannot activate for any reason, the trouble relay will change state. All relays shall be field selectable through a non-intrusive hand-held wireless remote control unit (Controller). Selectable features include:

   a) Alarm level.

   b) Latching / Non-latching.

   c) Upscale / Downscale.

   d) Normally-opened / Normally-closed.

   e) Energized / De-energized.

3) Relay contacts shall be normally energized (normally closed); contacts shall open in the event of a warning, alarm or trouble condition.

g. Non-Intrusive Calibration:

1) All sensor/transmitters can be calibrated without opening any enclosures.

2) By means of a non-intrusive hand held wireless remote control unit, the sensor/transmitter will enter the calibration mode. The display of the sensor/transmitter will instruct the user on when to apply zero and span gas. The sensor/transmitter will automatically adjust its internal settings to the proper calibration values without further intervention by the user. Upon completion of a successful calibration, the sensor transmitter will exit the calibration mode. Date stamp of last successful calibration will be retained in the sensor/transmitter internal memory, with capability to be displayed on LCD. If calibration is unsuccessful for any reason, the display must show an unsuccessful calibration attempt and revert to its previous calibration settings. Use of flashlight type devices, magnets or clamp-on devices to achieve calibration is not acceptable. The acceptable method uses a transmitter, which employs a digitally encoded infrared light beam.

3) A non-intrusive hand held wireless remote control will let the user not only do the functions of the small remote control but activate all functions and features of the sensor/transmitter.

4) The sensor/transmitter will not be affected by low level ambient light either natural or man-made.

3. Sensor Enclosure and Mounting:

    a. Enclosure:

        1) The sensor/transmitter will be in a 316 stainless steel enclosure suitable for location in Class I, Division 1, Groups B, C & D classified areas.

        2) The enclosure shall have a minimum of four entries, allowing for flexible mounting options for sensor, power, signal, and optional relay wiring.

        3) The enclosure shall offer a means to mount without using an entryway.

    b. Mounting:

        1) Sensor/transmitter shall be mounted in a single condulet. The back portion of the enclosure shall be separate from the electronics, allowing for mounting and wiring of the unit without the electronics present.

        2) A mounting strap shall be used which mounts the sensor/transmitter to a wall or similar structure.

        3) The mounting strap shall attach to the sensor/transmitter via two tapped and threaded holes on the rear of the sensor/transmitter. There shall be no brackets or clamps to secure this strap to the sensor/transmitter.

        4) Sensor mounting height shall be based on the sensor type:

            a) Combustible Gas (LEL) Sensor: 54 inches above finished floor.

            b) Hydrogen Sulfide (H_2S) Sensor: 54 inches above finished floor.

            c) Oxygen (O2) Sensor: 54 inches above finished floor.

    c. Remote Sensor Mounting:

        1) The sensor portion of the sensor/transmitter unit will be capable of being able to be remotely mounted from the electronics and display. The separate sensor enclosure will be able to be mounted up to one hundred (100) feet from the main enclosure. The sensor housing for the explosion-proof Gas Monitor will be in an enclosure suitable for location in Class I, Division 1, Groups A, B, C & D classified areas.

        2) A two twisted pair cable will connect the sensor housing and the calibration electronics.

        3) The readout portion of the sensor/transmitter shall have a display of the concentration of gas present.

4. Approvals: UL Class I, Division 1, Groups A, B, C, and D.

5. Accessories and Ancillary Equipment:

a. Calibration Gas Kit:

1) Calibration kits shall be furnished complete with all tubing, regulators, fittings, communication devices, and accessories required to calibrate sensors.

2) Calibration kit shall utilize non-intrusive means of calibrating sensors/transmitters.

3) Provide two (2) full cylinders of each type of calibration check gas:

a) Cylinder size: 17 liters.

4) Provide the same quantity of zero air cylinders as the total required number of calibration check gas cylinders (of all types).

b. Wireless Controller:

1) A non-intrusive hand held wireless remote control will let the user not only do the functions of the small remote control but activate all functions and features of the sensor/transmitter.

2) Provide one wireless controller for the project.

c. Ultima X Sampling Module - Sample Pump (if required):

1) MSA part number: 10043264 DC style sampling pump, 12-24 VDC.

2) Draws a gas sample from a monitored area through a sample line to the Ultima X Gas Monitor sensor.

3) Samples from a remote or inaccessible area such as ducts carrying combustible or toxic gas.

4) When using Ultima XIR Gas Monitor, locate the Ultima XIR sensor on the exhaust side of the sample module to ensure the most accurate readings. (The three-way valve from the XIR flow cap must be installed on the inlet side of the pump).

5) Performance Specifications for the Ultima X Sampling Module – Pump Model:

a) Maximum Power Consumption: 8.5 watts at 9 to 30 VDC.

b) Cable Requirements: Four conductor, shielded, 18 AWG (typical).

c) Sample Transport Time: 30 seconds at 0.5 LPM with 50 feet (15.25 meters) of 180 ID sample tubing.

d) Nominal Sample Flow Rate: 2 CFH (1 LPM)

e) Maximum Sample Tubing Length: 100 feet (30 meters).

f) Maximum Exhaust Tubing Length: 20 feet (6 meters)

g) Inlet Fitting: 1/4” (6.35 mm) OD Tubing Fitting.

h) Exhaust Fitting: 1/4” (6.35 mm) OD Tubing Fitting.

i) Calibration Fitting: 1/4” (6.35 mm) OD Barbed Fitting.

j) Overall Dimensions: 9" x 6" x 5" (228.5 cm x 152.4 cm x 127 cm).

k) Weight: 4.5 lbs. (2 kg).

l) Rating: Explosion-proof enclosure, Class I, Groups A, B, C and D, Division 1, Hazardous Locations.

m) Electrical Entry: 3/4-IN-14 NPT.

n) Flow Fail Relay: SPDT at .06 Amps, 125 Volts AC or 110 Volts DC at 2.0 Amps, 30 Volts DC.

o) Temperature Range: -20° to 55°C (-4 to 122°F).

p) Humidity: 15 to 95% RH, Non-condensing.

d. Flow Caps:

1) Designed to force sample gas past sensor head when sample pump is used:

a) Flow Cap for MSA LEL sensor: 10042600.

b) Flow Cap for MSA H2S sensor: 10041866.

6. Sensing Element Warranty:

a. All sensing elements (sensors) will have a minimum useful life of one year. The supplier will provide replacement sensors at no charge for any sensor that does not meet the minimum requirement.

7. Schedule:

TAG NO	APPLICATION	GAS	RANGE	SETPOINT ALARM
AE/AIT-4461A	Electrical Room	LEL	0-100%	10% LEL
AE/AIT-4461B	Electrical Room	H_2S	0-50 ppm	15 ppm
AE/AIT-4461C	Electrical Room	O_2	0-25%	19%
AE/AIT-4460A	Mechanical Room	LEL	0-100%	10% LEL
AE/AIT-4460B	Mechanical Room	H_2S	0-50 ppm	15 ppm
AE/AIT-4460C	Mechanical Room	O_2	0-25%	19%
AE/AIT-4462A	Entryway	LEL	0-100%	10% LEL
AE/AIT-4462B	Entryway	H_2S	0-50 ppm	15 ppm
AE/AIT-4462C	Entryway	O_2	0-25%	19%
AE/AIT-4451A	Storage Tank	LEL	0-100%	10% LEL
AE/AIT-4451B	Odor Control Unit	H_2S	0-50 ppm	15 ppm
SP-4451A	For AE/AIT-4451A	--	--	Field Verify
SP-4451B	For AE/AIT-4451B	--	--	Field Verify

B. Photoelectric Smoke Detectors:

1. Acceptable manufacturers:
    a. GE Security ESL 700 Series.
    b. Or equal.
2. Design and fabrication:
    a. Four wire head with terminal base models (packaged together).
    b. Self-diagnostic capability continually monitors operation.
    c. Built-in drift compensation.
    d. Field replaceable optical chamber.
    e. Low-profile design.
    f. Integral heat detectors.
    g. Meets NFPA 72 field sensitivity testing without the need for external meters.
    h. Input power: 24 VDC.
    i. UL listed.
    j. Two auxiliary relays, contacts rated at 2A@30VDC.
3. Accessories:
    a. Provide Smoke in a CAN (aerosol spray) for functional testing.
4. Schedule:

TAG NUMBER	APPLICATION	LOCATION
SD-4455	Smoke and Heat Detector	Electrical Room
SD-4456	Smoke and Heat Detector	Mechanical Room
SD-4457	Smoke and Heat Detector	Entryway

2.04 PRESSURE COMPONENTS

A. Pressure Gage:

1. Acceptable manufacturers:
    a. Ashcroft.
    b. Ametek.
    c. Robert Shaw Acragage.
2. Materials:
    a. Element: 316 stainless steel.
    b. Case: Phenolic or phenol plastic, unless otherwise noted.

c. Diaphragm seal housing: 316 stainless steel.

d. Pressure snubber:

1) Filter disc: 316 stainless steel.

2) Housing: 316 stainless steel.

3. Accessories:

a. Provide valve at point of connection to equipment and at panel if panel mounted.

b. Utilize pressure snubbers with porous metal discs to provide pulsation dampening on gage applications as shown on schedule.

c. Provide 1/2-IN stainless steel antisiphon pigtail inlet connection for hot water and steam applications.

4. Design and fabrication:

a. Element type:

1) Direct reading bellows for ranges below 10 psig or compound gauges.

2) Bourdon tube actuated for ranges 10 psig and above.

b. Movement: stainless steel, rotary geared.

c. Range: as noted. Compound scale when noted.

d. Accuracy: plus or minus 1.6 percent of span.

e. Mounting: Lower stem, unless otherwise noted.

f. Dial: 4.5-IN diameter.

g. Pointer: Micrometer pointer with self-locking adjustment.

h. Dampening: Pulsation dampener for all pump or blower discharge applications, and as shown in the schedule.

i. Process Connection: 1/4-IN NPT, unless otherwise noted.

j. Calibrate gages at jobsite for pressure and temperature in accordance with manufacturer's instructions.

k. Unless otherwise required by codes, provide stem mounted or flush mounted, as required, with 4.5-IN diameter dial.

l. Equip with white faces, black numerals and black pointers.

m. Gage tapping position to be clear of equipment functions and movements, and protected from maintenance and operation of equipment:

1) Gage to be readable from an accessible standing position.

n. Gage accuracy: 1 percent of full range.

o. Select gage range so that:

1) The normal operating value is in the middle third of the dial.

2) Maximum operating pressure does not exceed 75 percent of the full scale range.

p. Certified by the manufacturer for use on natural gas or other potentially explosive gases. (For Odor Control Fan only.)

5. Schedule:

TAG NUMBER	APPLICATION	RANGE (PSI)	DIAPHRAGM SEAL REQ'D	SNUBBER REQ'D
PI-4431A	Upstream PRV	100-150	No	Yes
PI-4431B	Downstream PRV	25-75	No	Yes
--	Odor Control Fan	Field Verify	No	Yes

B. Differential Pressure Indicator:

1. Acceptable manufacturers:
   a. Mid-West Instruments.
   b. Ashcroft.
2. Materials:
   a. Case: die cast aluminum.
   b. Diaphragm: silicone rubber.
   c. Clear plastic face.
3. Design and Fabrication:
   a. Display of differential pressure across an HIGH and LOW process port.
   b. Indicator: 4-IN Dial with red tipped pointer.
   c. Surface mounting.
   d. Process connections: 1/8-IN NPT.
   e. Accuracy: 2 percent of full scale.
   f. Zero adjustment screw.
   g. Certified by the manufacturer for use on natural gas or other potentially explosive gases.
4. Schedule:

TAG NUMBER	APPLICATION	RANGE (PSID)	DIAPHRAGM SEAL REQ'D	SNUBBER REQ'D
PDI-4450A	Odor Control Unit - Compartment 1	Per Supplier	No	No
PDI-4450B	Odor Control Unit - Compartment 2	Per Supplier	No	No
PDI-4450C	Mist and Grease Eliminator	Per Supplier	--	--

TAG NUMBER	APPLICATION	RANGE (PSID)	DIAPHRAGM SEAL REQ'D	SNUBBER REQ'D
PDI-4450D	Odor Control Fan	Per Supplier	No	Yes

2.05 FLOW COMPONENTS

A. Thermal Dispersion Type Flow Switches:

1. Acceptable manufacturers and models:
   a. Fluid Components, Inc.; model FLT93s.
   b. Or equal.
2. Materials:
   a. Wetted surfaces: 316 stainless steel.
   b. Enclosure: Aluminum or 316 stainless steel.
3. Design and fabrication:
   a. Solid state electronics.
   b. Repeatability: +/- 1 percent of full signal.
   c. Response time: adjustable down to 1 second.
   d. Utilize two platinum RTD's in thermowells in flow stream for differential temperature measurement.
   e. Dual switch points.
   f. Two hermetically-sealed SPDT switch contacts.
   g. Power supply: 120Vac +/- 10 percent or 24Vdc +/- 12 percent; field selectable and changeable.
   h. Process temperature: 0-150 DegF.
   i. Process pressure: 0-20 psig.
   j. Suitable for use in Class I, Division 2, Groups A, B, C, and D classified location.
   k. Separate sensor and control circuit housing.
4. Schedule:

TAG NUMBER	APPLICATION	FLUID	PIPE DIAMETER (INCHES)	LOW FLOW SETPOINT (cfm)
FSL-4450	Odor Control Fan Exhaust	Foul Air	16	1000

2.06 ACCESSORIES

A. Furnish all mounting brackets, expansion rings, hardware and appurtenances required for mounting primary elements and transmitters:

1. Materials, unless otherwise specified, shall be as follows:

a. Bolts, nuts, washers, expansion anchors: 316 stainless steel.

b. Mounting brackets and expansion rings:

1) Standard: 316 stainless steel.

2) Highly corrosive areas: Aluminum.

c. Mounting plates, angles:

1) Standard: Stainless steel.

2) Corrosive areas: 316 stainless steel.

B. Provide handheld communicator compatible with all transmitters furnished:

1. Hand held communicator shall provide capability to check calibration, change transmitter range, and provide diagnostics.

2. If these features are not provided with the transmitter, the hand held communicator is not required.

C. Cable lengths between sensors and transmitters shall be continuous (without splices) and as required to accommodate locations as shown on Drawings and by the installation, no exceptions.

2.07 PIPE, TUBING, AND FITTINGS

A. Acceptable Manufacturers:

1. Tube fittings:

a. Parker CPI.

b. Swagelok.

B. Instrument Tubing and Fittings:

1. Material:

a. Tubing: ASTM A269, Grade TP 316 stainless steel.

b. Straight fittings: 316 stainless steel per ASME SA-479 or ASTM A276.

c. Shaped bodies: ASME SA-182 F316 stainless steel.

2. Design and fabrication:

a. Tubing:

1) Seamless.

2) Fully annealed.

3) Maximum hardness: 80 Rb.

4) Free from surface scratches and imperfections.

5) Diameter: 1/2 IN OD unless specified otherwise.

6) Wall thickness:

a) Meet requirements of ASME B31.1, Paragraph 122.3.

b) Minimum 0.049 IN for 1/2 IN OD tubing.

b. Fittings:

1) Flareless.

2) Compression type.

C. Instrument Piping:

1. For applications where the instrument is supported solely by the sensing line, (e.g., pressure gauge directly mounted to process line) utilize piping as specified below.

a. Diameter: 1/2 IN unless specified otherwise.

b. Schedule 80.

c. 316 stainless steel.

2.08 INSTRUMENT VALVES

A. Process instrument multi-valve manifolds, isolation, vent and blow-down valves:

1. Acceptable manufacturers:

a. Whitey Co.

b. Anderson-Greenwood USA, Inc.

2. Materials:

a. Packing:

1) 450 DegF and above: Graphite.

2) Below 450 DegF: Graphite or Teflon.

b. Body: 316 stainless steel per ASTM A479.

c. Stem: 316 stainless steel per ASTM A276.

d. Ball: 316 stainless steel per ASTM A276.

e. Support rings: 316 stainless steel per ASTM A276.

f. Seats:

1) Metal:

a) 316 stainless steel per ASTM A276.

2) Soft:

a) Teflon, Delrin.

b) Only utilized on applications where manufacturer's temperature and pressure ratings exceed process design conditions.

3. Design and fabrication:

a. Either of the following:

1) Ball valve with 1/4 turn activation.

2) Free-swiveling ball stem.

b. Provide body wall thickness sufficient for process design conditions per ASME B31.1.

c. Temperature: Manufacturer's temperature rating for all components shall exceed process design conditions.

d.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install instrument mounting level and plumb.

C. Instrument connections to process lines shall utilize instrument tubing, piping and valves as outlined in this Specification unless otherwise noted in the Contract Documents.

D. Locate instrument so as to be free of vibration and interference with other piping, conduit, or equipment.

E. Keep foreign matter out of the system.

F. Plug all open ends and connections to keep out contaminants.

G. Threaded Connection Seals:

1. Use Tite-Seal or acceptable alternate.

2. Use of lead base pipe dope or Teflon tape is not acceptable.

3. Do not apply Tite-Seal to tubing threads of compression fittings.

H. Instrument Mounting:

1. Mount all instruments where they will be accessible from fixed ladders, platforms, or grade wherever possible.

2. Mount all local indicating instruments with face forward toward the normal operating or access area, within reading distance, and in the line of sight.

3. Mount instruments level, plumb, and support rigidly.

4. Mount to provide:

a. Protection from heat, shock, and vibrations.

b. Accessibility for maintenance.

c. Freedom from interference with piping, conduit and equipment.

I. Cable:

1. Provide 10-feet minimum spare length of neatly coiled cable at both ends (near instrument in the field and in the associated control panel) for each sensor and transmitter.

3.02 TRAINING

A. Provide on-site training in accordance with **Specification Section 40 01 01 - Commissioning / Facility Start-up**.

B. In addition to the training requirements in **Specification Section 40 01 01 - Commissioning / Facility-Start-up**, training for primary elements shall, at the minimum, include the following:

1. Transmitter programming and configuration (Ultrasonic).
2. Calibration.
3. Dessicant maintenance (Submersible Pressure Sensor and Transmitter).
4. Importance of non kinking sensor cable (Submersible Pressure Sensor and Transmitter).

END OF SPECIFICATION SECTION 40 91 10

SPECIFICATION SECTION 40 94 43

PROGRAMMABLE AUTOMATION CONTROLLER (PAC) CONTROL SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Specification Section Includes:

1. Programmable automation controller (PAC) control system(s), excluding software, programming, and training.

B. Related Specification Sections include but are not necessarily limited to:

1. CSC Parts 1, 2, 3, 4, and 6.
2. Specification Section 26 05 16 - Wire and Cable: 600 Volt and Below.
3. Specification Section 40 05 05 - Equipment: Basic Requirements.
4. Specification Section 40 90 00 - Instrumentation for Process Control: Basic Requirements.
5. Specification Section 40 90 05 - Control Loop Descriptions.
6. Specification Section 40 97 00 - Control Auxiliaries.
7. Specification Section 40 98 00 - Control Panels and Enclosures.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
    a. C37.90.2, Trial-Use Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
    b. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
2. National Electrical Manufacturers Association (NEMA):
    a. ICS 1, General Standards for Industrial Control and Systems.

B. Qualifications:

1. Installation supervisor shall have had experience in overseeing installation and startup of at least three (3) similar installations.

1.03 SUBMITTALS

A. Shop Drawings:

1. See CSC Part 3.1 for requirements for the submittal process.
2. See Specification Section 40 90 00 - Instrumentation for Process Control: Basic Requirements.
3. Product technical data including:
    a. Results of factory testing procedures.

b. Drawings containing the following information to be submitted as part of **Specification Section 40 98 00 - Control Panels and Enclosures** submittals:

1) Arrangement drawings for PAC system components.

2) Panel and enclosure plans, sections and details.

3) Access opening locations and required clearances for each panel and enclosure.

4) Enclosure internal wiring and terminal blocks.

c. Catalog cut sheets containing information on PAC components to be submitted as part of this Specification Section submittal(s).

4. Certifications:

a. Qualifications of installation supervisor.

B. Operation and Maintenance Manuals:

1. See CSC Part 3.1 for requirements for the submittal process.

2. See CSC Part 3.1 for the content of the Project Operation and Maintenance Manual.

3. Submit maintenance procedures available to Owner:

a. Include the location and phone numbers of service centers (including 24 HR "hot lines").

b. Provide specific information including operation and maintenance requirements, troubleshooting guide, parts ordering, field service personnel requests, and service contracts.

1.04 SYSTEM DESCRIPTION

A. The contractor is responsible for providing PAC control system hardware (devices, components, accessories, all physical entities, etc.). The Owner will provide software, programming, and training for the PAC control system.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Opto22, SNAP-PAC-R2.

2. No like, equivalent, or or-equal item is acceptable.

2.02 PERFORMANCE AND DESIGN REQUIREMENTS

A. See **Specification Section 40 90 00 - Instrumentation for Process Controls: Basic Requirements**.

B. The PAC system shall accomplish the control requirements of the loop descriptions, Drawings, and Specifications.

C. The PAC system shall operate in ambient conditions of -20 to 60 DegC temperature and 5 to 95 percent relative humidity without the need for purging or air conditioning.

D. All PAC control system components shall be capable of meeting or exceeding electromagnetic interference tests per IEEE C37.90.2.

E. The PAC system shall be capable of the following minimum safety measures:

1. Watchdog function to monitor:
    a. Internal processor clock failure.
    b. Processor memory failure.
    c. Loss of communication between processor and I/O modules.
    d. Processor ceases to execute logic program.
2. Safety function wiring: Emergency shutdown switches shall not be wired into the controller.
3. Safe wiring:
    a. Unless otherwise specified, activation of alarms and stopping of equipment shall result from the de-energization of control circuits, rather than the energization of control circuits.
    b. Low voltage control signal wires:
        1) Place in conduit segregated for that purpose only.
        2) Twisted shielded wire pair.
        3) Not located in the same conduit or bundle with power wiring.
4. Initial safety conditions:
    a. Utilize program module to dictate output states in a known and safe manner prior to running of control program.
    b. Utilize program each time PAC is re-initiated and the control program activated.
5. Monitoring of internal faults and display:
    a. Internal PAC system status and faults shall be monitored and displayed:
        1) Monitored items shall include:
            a) Memory ok/loss of memory.
            b) Processor ok/processor fault.
            c) Scan time overrun.
6. Control of programs: Protect access to PAC program loading with password protection or with locked, key operated selector switches.
7. Design PAC system with high noise immunity to prevent occurrence of false logic signals resulting from switching transients, relay and circuit breaker noise or conducted and radiated radio frequency interference.
8. Operator intervention:

a. Logic system failure shall not preclude proper operator intervention.

b. Safety shutdown of equipment or a system shall require manual operator intervention before the equipment or system operation may be reestablished.

2.03 COMPONENTS

A. PAC System Central Processor Unit (CPU):

1. CPU shall provide communications with other control systems and human-machine interfaces via Modbus communications protocol, no exception.

2. Memory:

a. Battery-backed RAM.

b. EEPROM program back-up:

1) Automatically download to RAM in the event RAM is corrupted.

3. Memory battery backup shall be capable of 60 days memory retention with fresh battery:

a. Provide visual indication of battery status and alarm low battery voltage.

b. Memory battery backup shall be capable of 14 days memory retention after the "Battery Low" indicating LED is on.

4. Plug-in card design to allow quick field replacement of faulty devices:

a. Provide unit designed for field replacement and expansion of memory without requiring rewiring or use of special tools.

5. 20 percent minimum spare useable memory capacity after all required programming is in place and operating.

6. Capable of executing all control functions required by the Specifications and Drawings.

7. Built-in three-mode (proportional-integral-derivative) control capabilities:

a. As directly selectable algorithms requiring no user knowledge of programming languages.

8. On-line reconfigurable.

9. Lighted status indicators for "RUN" and "FAILURE."

10. Capable of manual or automatic control mode transfer from the operating console stations or from within the control strategy:

a. Transfer shall be bumpless and balanceless.

B. Input/output (I/O) Modules:

1. Provide plug-in modular-type I/O with cables to connect to all other required PAC system components.

2. Provide I/O system with:

a. I/O solid state boards with status lights indicating I/O status.

b. Electric isolation between logic and field device.

c. Capability of withstanding low energy common mode transient to 1000 V without failure.

d. Incorporate noise suppression design.

e. Capable of meeting or exceeding electrical noise tests, NEMA ICS 1-109.60-109.66.

f. Capable of being removed and inserted into the I/O rack under power, without affecting any other I/O modules in the rack.

g. Install 20 percent spare I/O modules.

3. Input/output connection requirements:

a. Make connections to I/O subsystem by terminating all field wiring on terminal blocks within the I/O enclosure.

b. Provide each I/O module with a color-coded multi-conductor cable of appropriate length with a pre-terminated connector. Terminate these wires to the terminal blocks.

c. Provide terminal blocks with continuous marking strip.

d. Size terminals to accommodate all active data base points and spares.

e. Provide terminals for individual termination of each signal shield.

f. Field wiring shall not be disturbed when removing or replacing an I/O module.

4. Discrete I/O modules:

a. Interface to ON/OFF devices.

b. I/O status indicator on module front.

c. Voltage rating to match circuit voltage.

d. Output module current rating:

1) Match maximum circuit current draw.

2) Minimum 1.0 continuous A/point for 120 Vac applications.

e. Isolated modules for applications where one (1) module interfaces with devices utilizing different sources of power.

5. Discrete inputs:

a. SNAP-IDC-32:

b. See Schedule for minimum quantities.

6. Discrete outputs:

a. SNAP-ODC-32.

b. See Schedule for minimum quantities.

c. Provide one (1) fuse per common or per isolated output.

d. Provide blown fuse indication.

e. External fusing shall be provided at the device being controlled.

f. Fuses provided external to output model shall:

1) Be in accordance with module manufacturer's specifications.

7. Analog I/O modules:

a. Analog Input:

1) SNAP-AIMA-8.

2) SNAP-AIV2-i (for battery voltage monitoring).

3) See Schedule for minimum quantities.

b. Analog Output:

1) SNAP-AOA-23.

2) See Schedule for minimum quantities.

c. Input modules to accept signals indicated on Drawings or Specifications.

d. Minimum 12 bit resolution.

e. I/O chassis supplied power for powering connected field devices.

f. Provide isolated analog inputs, either per input or per group of four inputs. May use separate I/I isolators for applications with small PAC's having less than four analog inputs.

g. User configurable for desired fault-response state.

h. Provide output signals as indicated on Drawings and Specifications.

i. Individual D/A converter for each output module.

j. Individual A/D converter for each input module.

8. Modbus Network Communication Modules:

a. SNAP-SCM-232.

b. SNAP-SCM-485-422.

c. See Schedule for minimum quantities.

C. Opto 22 power supply:

1. SNAP-PS5-24VDC.

2. See Schedule for minimum quantities.

D. Terminals for Discrete Inputs:

1. 3-level with LED status indication.

2. Fused per group of 8. Wired to I/O module using plug-in connector with flying leads.

E. PAC System Enclosure:

1. In accordance with Specification Section 40 98 00 - Control Panels and Enclosures.

2. Component placement:

a. Mount all controller components within the enclosure to allow maximum convection cooling.

b. Either install power supplies above all other equipment with at least 10 IN of clearance between the power supply and the enclosure top, or adjacent to other components, but with sufficient spacing for circulation of cooling air.

c. Do not place I/O racks directly above the CPU or power supply.

d. Locate incoming line devices (isolation or constant voltage transformers, local power disconnects, surge suppressors, etc.) so as to keep power wire runs within an enclosure as short as possible.

e. Place circulating fans close to major heat generating devices.

f. Segregate input/output modules into groups of identical type.

3. Wiring and grounding to be in accordance with Specification Section 40 98 00 - Control Panels and Enclosures.

4. Termination requirements:

a. In accordance with Specification Section 40 98 00 - Control Panels and Enclosures.

b. Make connections to I/O subsystem by terminating all field wiring on terminal blocks within the enclosure.

c. Provide each I/O module with a color-coded multi-conductor cable of appropriate length with a pre-terminated connector. Terminate these wires to the terminal blocks.

d. Size terminals to accommodate all active database points and spares.

e. Provide terminals for individual termination of each signal shield.

f. Field wiring shall not be disturbed when removing or replacing an I/O module.

F. PAC System Software and Programming:

1. The Owner will provide programming software and application programming.

2. The Owner will provide all application programming to accomplish all control and monitoring requirements of the Drawings and Specifications.

2.04 SCHEDULE

A. Provide the following PAC Installed Parts and Quantities:

DESCRIPTION	OPTO 22 MODEL NO.	MCP-4400	SPARES
Opto 22 SNAP-PAC-R2			
Backplane (16-slot)	SNAP-PAC-RCK16	1	--
Power Supply Module	SNAP-PS5-24DC	1	1
CPU Module	SNAP-PAC-R2	1	--

DESCRIPTION	OPTO 22 MODEL NO.	MCP-4400	SPARES
32-Pt Discrete Input	SNAP-IDC-32	5	1
32-Pt Discrete Output	SNAP-ODC-32	1	1
8-Pt Analog Input	SNAP-AIMA-8	4	1
2-Pt Analog Output	SNAP-AOA-23	2	1
2-Pt Voltage Input	SNAP-AIV2-i	1	1
Modbus Network Module	SNAP-SCM-232	--	1
Modbus Network Module	SNAP-SCM-485-422	1	--

2.05 ACCESSORIES

A. Provide all accessories required to furnish a complete PAC control system to accomplish the requirements of the Drawings and Specifications Sections.

2.06 SOURCE QUALITY CONTROL

A. Provide a performance test after factory completion and prior to shipment:

1. Conduct a test where the system is operated continuously and checked for correct operation including loop controls, displays, printing, keyboard functions, alarm responses, and on/off sequencing control.
2. Conduct testing with dummy I/Os to verify each control loop operation.
3. Allow for Owner and Engineer representatives to load and test application software program:
    a. Provide minimum of fifteen (15) days notice prior to testing.
4. Do not ship prior to successful completion of this testing program.

2.07 MAINTENANCE MATERIALS

A. Furnish Owner with the following extra materials:

1. Spare I/O cards per above schedule.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install PAC control system in accordance with manufacturer's written instructions.

3.02 FIELD QUALITY CONTROL

A. Employ and pay for services of equipment manufacturer's field service representative(s) to:

1. Inspect equipment covered by these Specifications.
2. Supervise adjustments and installation checks.
3. Maintain and submit an accurate daily or weekly log of all commissioning functions:

a. All commissioning functions may be witnessed by the Engineer.

b. All reports shall be co-signed by the Contractor and the Engineer if witnessed.

4. Conduct startup of equipment and perform operational checks.

5. Provide Owner with a written statement that manufacturer's equipment has been installed properly, started up, and is ready for operation by Owner's personnel.

3.03 DEMONSTRATION

A. Demonstrate system in accordance with **Specification Section 40 01 01 - Commissioning / Facility Start-Up** and **Specification Section 40 98 00 - Control Panels and Enclosures**.

B. On-Site Training:

1. Provide employee of the manufacturer or certified representative to provide four (4) HRS of operating and maintenance training at the Project site after the system has successfully undergone all field testing and acceptance procedures:

a. As a minimum, training shall cover:

1) Hardware overview.

2) Maintenance.

3) Troubleshooting.

END OF SPECIFICATION SECTION 40 94 43

SPECIFICATION SECTION 40 97 00

CONTROL AUXILIARIES

PART 1 - GENERAL

1.01 SUMMARY

A. Specification Section Includes:

1. Signal modules:
    a. Loop isolator.
2. Alarm Devices:
    a. Buzzer.
    b. Strobe.
3. Termination equipment:
    a. Terminal blocks.
    b. Fuse holders.
4. Power supplies:
    a. DC power supplies.
    b. DC Uninterruptible Power Supplies.
    c. DC to DC power supplies.
    d. Isolation transformers.
5. Voltage surge protection devices.
6. Operator Interface (OI).
7. Ethernet Switch: Unmanaged.
8. Batteries.
9. Limit switches.
10. Pilot Devices.
11. Pilot Devices: Hazardous Rated.
12. Relays/Timers.
13. Intrinsic Safety Devices.

B. Related Specification Sections include but are not necessarily limited to:

1. CSC Parts 1, 2, 3, 4, and 6.
2. Specification Section 40 90 00 - Instrumentation for Process Control: Basic Requirements.
3. Specification Section 40 99 00 - Surge Protection Devices (SPD) for Instrumentation and Control Equipment.
4. Seattle Public Utilities:

a. SPU Design Standards and Guidelines:

1) Section 10 – Instrumentation and Control - SCADA.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. The Instrumentation, Systems, and Automation Society (ISA):

a. S18.1, Annunciator Sequences and Specifications.

2. National Electrical Manufacturers Association (NEMA):

a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

b. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.

3. Underwriters Laboratories, Inc. (UL).

B. Miscellaneous:

1. Assure units comply with electrical area classifications and NEMA enclosure type shown on Drawings.

1.03 SUBMITTALS

A. Shop Drawings:

1. See CSC Part 3.1 for requirements for the mechanics and administration of the submittal process.

2. See Specification Section 40 90 00 - Instrumentation for Process Control: Basic Requirements.

B. Operation and Maintenance Manuals:

1. See CSC Part 3.1 for requirements for:

a. The mechanics and administration of the submittal process.

b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers as listed in the articles describing the devices are acceptable.

B. Provide similar components from the same manufacturer for uniformity of appearance, installation, operations, and maintenance.

C. Submit request for substitution in accordance with CSC Part 3.1.

2.02 SIGNAL MODULE

A. Loop Isolators (where required):

1. Acceptable manufacturers:

a. Pepperl & Fuchs.

b. No equal.

2. Design and fabrication:

a. Solid state electronics.

b. Transmit analog output signal directly proportional to measured input signal.

c. Power source: 24 Vdc.

d. Analog input: 4-20 mA DC.

e. Output signal: 4-20 mA DC into 1400 ohms.

f. Impedance:

1) Voltage input: 10 Meg.

2) Current input: 50 ohms.

3) Voltage output: 1 ohm.

4) Current output: 1650 ohms.

g. Accuracy: Better than ± 0.10 percent of span.

h. Isolation: Up to 500 V rms (input, output and case).

i. Temperature effect: ±0.0025 percent of span per DegF.

j. Ambient temperature range: 0-140 DegF.

k. Factory calibrated.

l. UL listed.

2.03 ALARM DEVICES

A. Buzzers:

1. Vibrating horn type, Edwards 87X series or equal.
2. PLC compatible as required.
3. Heavy-duty die cast housing with corrosion resistant finish.
4. Adjustable volume: 78 to 103 dB at 10-FT.
5. Voltage: 24Vdc or as required.
6. Enclosures/mountings:

a. NEMA 4X.

b. Maintain enclosure rating.

B. Strobes:

1. Flashing Strobe: Edwards 105-STR-G1, or equal.
2. Strobe / Light:

a. 360-degree beam.

b. 3 Joule.

3. Approximate flash rate: 60 – 90 flashes per minute.
4. Mounting: base, brackets, fixtures, and hardware as required.
5. Enclosure:
    a. NEMA 4X.
    b. Maintain enclosure rating.
    c. Corrosion resistant.
6. Suitable for use in Class I Division 2 location.
7. Voltage: 24 VDC.

C. UL Listed.

2.04 TERMINATION EQUIPMENT

A. Terminal Blocks:

1. Acceptable manufacturers:
    a. Phoenix Contact.
    b. Allen-Bradley.
    c. Weidmuller.
    d. Or equal.
2. Design and fabrication:
    a. Modular type with screw compression clamp.
    b. Captive screws: Stainless steel.
    c. Current bar: Nickel-plated copper allow.
    d. Thermoplastic insulation rated for -40 to +90 DegC.
    e. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
    f. Install end sections and end stops at each end of terminal strip.
    g. Install machine-printed terminal markers on both sides of block.
    h. Spacing: 6 mm.
    i. Tiers/Levels: as required; 3 maximum.
    j. Wire size: 22-12 AWG.
    k. Rated voltage: 600 V.
    l. DIN rail mounting.
    m. UL listed.
3. Standard-type block:
    a. Rated current: 30 A.
    b. Color: Gray body.

4. Bladed-type block:
    a. Terminal block with knife blade disconnect which connects or isolated the two (2) sides of the block.
    b. Rated current: 10 A.
    c. Color:
        1) Panel control voltage leaves enclosure - normal: Gray body, orange switch.
        2) Foreign voltage entering enclosure: Orange body, orange switch.
5. Grounded-type block:
    a. Electrically grounded to mounting rail.
    b. Use to terminal ground wires and analog cable shields. Use isolated ground bus for analog cable shields.
    c. Color: Green and yellow body.

B. Fuse Holders:
1. Acceptable manufacturers:
    a. Phoenix Contact.
    b. Allen-Bradley.
    c. Weidmuller.
    d. Or equal.
2. Design and fabrication:
    a. Modular-type with screw compression clamp.
    b. Screws: Stainless steel.
    c. Current bar: Nickel-plated copper alloy.
    d. Thermoplastic insulation rated for -40 to +105 DegC.
    e. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
    f. Draw out type of fuse holder.
    g. Blocks can be ganged for multi-pole operation.
    h. Install end sections and end stops at each end of terminal strip.
    i. Install machine-printed terminal markers on both sides of block.
    j. Spacing: 9.1 mm.
    k. Wire size: 30-12 AWG.
    l. Rated voltage: 300 V.
    m. Rated current: 12 A.
    n. Fuse size: 1/4-x 1-1/4.

o. Blown fuse indication: LED.

p. DIN rail mounting.

q. UL listed.

2.05 POWER SUPPLIES

A. DC Power Supplies:

1. Acceptable manufacturers:

a. PULS, Model QS10.241.

b. No equal.

2. Design and fabrication:

a. Converts 120 Vac input to DC power at 24VDC.

b. Output current: 10A continuous.

c. DIN rail mount with enclosure.

d. UL Listed for use in UL 508 industrial control panels.

e. Filtered and electronically regulated output.

f. Switching type.

g. AC input: 120 Vac +/-15 percent, nominal 60 Hz.

h. Efficiency: Minimum 90 percent.

i. Rated mean time between failure (MTBF): 500,000 HRS.

j. Voltage regulation:

1) Static: Less than 1.0 percent Vout.

2) Dynamic: +/-2 percent Vout overall.

k. Output ripple/noise: Less than 100 mV peak to peak (20 MHz).

l. Overload, short circuit and open circuit protection.

m. Temperature rating: -25 to 60 DegC full rated, derated linearly to 75 percent at 70 DegC.

n. Humidity rating: Up to 90 percent, non-condensing.

o. LED status indication for DC power.

p. Relay contacts to monitor the following:

1) DC-OK.

q. Three (3) year warranty.

B. DC Uninterruptible Power Supplies:

1. Acceptable manufacturers:

a. PULS, Model UB10.242.

b. No equal.

2. Design and fabrication:
    a. Power supply with built-in charger for gel or lead acid batteries.
    b. Voltage in: 24VDC; voltage out: 24VDC.
    c. Battery voltage: 12VDC.
    d. Battery Amp-Hour range: 17Ah-130Ah.
    e. Output current: 10A continuous.
    f. DIN rail mount with enclosure.
    g. UL Listed for use in UL 508 industrial control panels.
    h. Filtered and electronically regulated output.
    i. Rated mean time between failure (MTBF): 500,000 HRS.
    j. Temperature rating: -25C to 50C.
    k. Overload, short circuit and open circuit protection.
    l. LED status indication for the following:
        1) Status (i.e. ready, charging or buffering).
        2) Diagnosis (i.e. overload, replace battery, or inhibit active).
        3) Check wiring.
    m. Relay contacts to monitor the following:
        1) Ready (i.e. battery charged).
        2) Buffering (i.e. on battery power).
        3) Replace battery.
    n. Three (3) year warranty.

C. DC to DC Power Supplies:
1. Acceptable manufacturers:
    a. PULS, Model CD5.121.
    b. No equal.
2. Design and fabrication:
    a. Current output: 8A.
    b. Voltage in: 24V; Voltage out: 12V.
    c. Reverse input polarity protection.
    d. DIN rail mounting.
    e. UL Listed for use in UL 508 industrial control panels.
    f. Short-circuit, overload, and over-voltage protection.
    g. Built-in EMI filter with low ripple noise.
    h. Temperature rating: -25C to 60C.

i. 100% full load burn-in test.

j. Three (3) year warranty.

2.06 BATTERIES

A. Acceptable manufacturers:

1. Power Sonic PG-12V103FR.
2. Yukasa.
3. Or equal.

B. Design and fabrication:

1. Voltage: 12 VDC, nominal.
2. Amp-hours: 100.
3. Characteristics:
   a. Rechargeable.
   b. Leak-free.
   c. Maintenance-free.
4. Technology: Valve-Regulated Lead Acid (VRLA).
5. UL-recognized.

C. Terminations and Interconnect Cabling:

1. As required for complete, functional and code-compliant installation.

D. Mounting:

1. Use shelving to keep batteries from resting directly on cabinet floor.
2. Secure batteries to prevent tipping.

2.07 VOLTAGE SURGE PROTECTION DEVICES

A. See **Specification Section 40 99 00 - Surge Protection Devices (SPD) for Instrumentation and Control Equipment**.

2.08 OPERATOR INTERFACE UNIT (OIU):

A. Acceptable manufacturers:

1. Red Lion, G310S210 Color Touchscreen, cables and programming software.
2. No equal, to match Owner’s standards.

B. Design and fabrication:

1. Input power: 12-24 VDC.
2. Display:
   a. 5.6-inch diagonal.
   b. TFT active matrix, 256 color, QVGA 320 x 234 pixel, minimum.
   c. Resistive analog touchscreen.

d. Three (3) front LED indicators.

e. 30,000 hour backlight.

f. NEMA 4/IP 65 rating.

3. Communication ports:

a. Serial:

1) Three (3) total (1-RS-232, 2-RS-232/422/485).

2) Individually programmable up to 115,200 baud.

b. Ethernet:

1) 10 Base-T.

2) Communicates with up to four protocols simultaneously.

4. Memory:

a. Unit configuration: Stored in non-volatile flash memory.

b. SanDisk® or SimpleTech Compact Flash®, 512 MB, industrial grade, two million write cycles, minimum.

5. Cables:

a. USB to RS-232 serial adaptor cable.

b. Y-cable.

6. Software: Crimson® 2.0, or latest available, Owner-approved version.

2.09 ETHERNET SWITCH, UNMANAGED:

A. Acceptable manufacturers:

1. Wiedmuller, IE-SW5-WAVE.

2. Or equal.

B. Design and fabrication:

1. Input power: 4VA for AC input, or 4W for DC input.

2. Input voltage: 12-24 VAC, 10-35 VDC.

3. Input frequency: 47 – 63 Hz.

4. Five (5) each (minimum), RJ45 ports.

5. Dimensions: 4.25” x 0.9” x 5.0” (LxWxH) or less.

6. DIN-mounted.

7. Operating temperature: -0C to 60C.

8. Standard: IEEE 802.3, 3U and 3X.

9. Protection class: IP20.

10. Data rate: 10 Base-T/100 Base-TX (copper); 100 Base-FX (fiber).

11. Functionality: Autonegotiation and Autocrossing (RF45); redundant voltage supply.

12. Status indication: Data rate, Power, Connection/Activity.
13. Approvals: cULus, Class I, Division 2, CD, EN55024, EN 55022, Gost R.
14. Supported protocols: Profinet RT, Modbus TCP, TCP/IP, EthernetIP.

2.10 LIMIT SWITCHES

A. Acceptable manufacturers:
   1. Square D, 9007C52B2.
   2. Or equal.

B. Design and fabrication:
   1. Actuator:
      a. Lever arm.
      b. Roller material: nylon.
      c. Roller adjustment: 360 degree, field adjustable.
   2. Actuation: Rotary, clockwise or counter-clockwise.
   3. Differential travel: 4 degrees, maximum.
   4. UL listed.
   5. Connection: 1/2-inch NPT conduit, minimum.
   6. Contacts:
      a. Snap action.
      b. SPDT.
      c. 10 ampere rated.
      d. Maximum voltage: 600 VAC.

2.11 PILOT DEVICES

A. Selector Switches:
   1. Acceptable manufacturers:
      a. Cutler Hammer.
      b. Allen-Bradley.
   2. Design and fabrication:
      a. Heavy-duty type.
      b. Oiltight and NEMA 4X rated.
      c. Rotary cam units conforming to NEMA ICS 2-216.22.
      d. Mounting hole: 30.5 mm.
      e. Supply switches having number of positions required with contact blocks to fulfill functions shown and specified.
      f. UL listed.

g. Maintained contact type.

h. Knob type operators.

i. Black colored operators.

j. Designed with cam and contact block with approximate area of 2-IN SQ.

k. Legend plate marked per Contract Documents.

l. Contact block requirements:

1) Dry and indoor locations: Standard contact blocks rated for 10 A continuous current.

2) Wet or outside locations: Hermetically sealed contact blocks.

3) Hazardous location: Hermetically sealed contact blocks rated for Class I, Division 2 locations.

B. Pushbuttons:

1. Acceptable manufacturers:

a. Cutler Hammer.

b. Allen-Bradley.

2. Materials:

a. Backing diaphragm: Buna-N.

3. Design and fabrication:

a. Heavy-duty type.

b. Oiltight and NEMA 4X rated.

c. Conforming to NEMA ICS 2-216.22.

d. Mounting hole: 30.5 mm.

e. Diaphragm backed.

f. UL listed.

g. Emergency stop pushbuttons to have mushroom head operator and maintained contact.

h. Non-illuminated type:

1) Momentary contact with necessary contact blocks.

2) Molded, solid color melamine buttons.

3) Standard flush operators with full shroud.

4) Emergency stop pushbuttons shall have mushroom head operators.

5) Red colored buttons for START or ON and black color for STOP or OFF.

6) Appropriate contact blocks to fulfill functions shown or specified.

i. Contact block requirements:

1) Dry and indoor locations: Standard contact blocks rated for 10 A continuous current.

2) Wet or outside locations: Hermetically sealed contact blocks.

3) Hazardous location: Hermetically sealed contact blocks rated for Class I, Division 2 locations.

j. Legend plate marked per Contract Documents.

C. Indicating Lights:

1. Acceptable manufacturers:

a. Cutler Hammer.

b. Allen-Bradley.

2. Design and fabrication:

a. Push-to-test.

b. Heavy duty type.

c. Oiltight and NEMA 4X rated.

d. Type allowing replacement of bulb without removal from control panel.

e. LED type lamp.

f. UL listed.

g. 24 V lamp.

h. Legends marked per Contract Documents.

i. Nominal 2-IN SQ face.

j. Mounting hole: 30.5 mm.

k. Glass lens.

l. Color code lights as follows:

1) Green: OFF or stopped; valve closed.

2) Amber: Fault/Trouble/Malfunction.

3) Red: ON or running; valve open.

m. Legend plate engraved for each light.

2.12 PILOT DEVICES, HAZARDOUS RATED

A. Selector Switches:

1. Acceptable Manufacturers:

a. Furnas.

b. Allen-Bradley.

c. Or approved equal.

2. Design and Fabrication:

a. For installation on NEMA 7 & 9 enclosures.

b. Heavy-duty: Corrosion resistant, copper-free aluminum alloy construction.

c. Mounting: 3/4-14 NPSM threaded hole. Bushing length as required for panel.

d. UL listed for Class I, Groups C & D locations.

e. Rotary cam units conforming to NEMA ICS 2-216.22.

f. Supply switches having number of positioners required with contact blocks to fulfill functions shown and specified.

g. Maintained contact type, unless noted otherwise.

h. Knob type operators.

i. Black colored operators.

j. Designed with cam and contact block to fulfill functions shown or specified.

k. Legend plate marked per Contract Documents.

B. Pushbuttons:

1. Acceptable manufacturers:

a. Furnas.

b. Allen-Bradley.

c. Or approved equal.

2. Design and fabrication:

a. For installation on NEMA 7 & 9 enclosures.

b. Heavy-duty: Corrosion resistant, copper-free aluminum alloy construction.

c. Mounting: 3/4-14 NPSM threaded hole. Bushing length as required for panel.

d. UL listed for Class I, Groups C & D locations.

e. Conforming to NEMA ICS 2-216.22.

f. Diaphragm backed.

g. Momentary contact with necessary contact blocks.

h. Molded, solid color melamine buttons.

i. Standard flush or mushroom operators with full shroud.

j. Appropriate contact blocks to fulfill functions shown or specified.

k. Legend plate marked per Contract Documents.

l. Equipment stop pushbuttons to have mushroom-head operator and maintained contact where indicated (control diagrams).

2.13 RELAYS/TIMERS

A. Control Relays:

1. Acceptable manufacturers:
    a. Idec.
    b. Potter & Brumsfield.
    c. Allen-Bradley.
2. Design and fabrication:
    a. Plug-in general purpose relay.
    b. Blade connector type.
    c. Switching capacity: 10 A.
    d. Contact material: Silver cadmium oxide.
    e. Provide relays with a minimum of 3 SPDT contacts.
    f. Coil voltage: 120 Vac or 24 Vdc.
    g. Relay sockets are DIN rail mounted.
    h. Internal neon or LED indicator is lit when coil is energized.
    i. Clear polycarbonate dust cover with clip fastener.
    j. Check button.
    k. Temperature rise:
        1) Coil: 85 DegF max.
        2) Contact: 65 DegF max.
    l. Insulation resistance: 100 Meg min.
    m. Frequency response: 1800 operations/hour.
    n. Operating temperature: -20 to +150 DegF.
    o. Life expectancy:
        1) Electrical: 500,000 operations or more.
        2) Mechanical: 50,000,000 operations or more.
3. UL listed or recognized.

B. Time Delay Relays:

1. Acceptable manufacturers:
    a. Eagle Signal Controls.
    b. Idec.
    c. Or approved equal.
2. Design and fabrication:
    a. Melt design test and performance requirements of NEMA ICS 2-218.
    b. Heavy-duty.

c. Solid-state construction.

d. External adjusting dial.

e. Auxiliary relays as required to perform functions specified or shown on Drawings.

f. Operates on 120 Vac or 24 Vdc (±10 percent) power source.

g. Contact rating: A150 per NEMA ICS 2-125.

h. Furnish with "On" and "Timing Out" indicators.

2.14 INTRINSIC SAFETY DEVICES

A. Intrinsic Safety Isolators:

1. Acceptable Manufacturers:

a. Pepperl + Fuchs.

b. No equal.

2. Acceptable Models:

a. Analog signals (2-channel):

1) KFD2-STC4-Ex2.

b. Discrete signals (2-channel):

1) KFD2-SR2-Ex2W.

3. Design and Fabrication:

a. Uses a low-power, electrically isolated to safely interface with devices located in hazardous areas.

b. Provided with green and red LED for indication of module and field circuit status.

c. Interface as required by application.

d. External power: 24 Vdc.

e. Pole reversal protection.

f. Captured, self-opening screw terminals.

g. Response time: less than 20ms.

h. Galvanic isolation:

1) Input/Output: 1500V.

2) Input/external supply: 1500V.

3) Output/External supply: 500V.

i. Radio interference suppression: Class A.

j. Housing material: polymide.

k. Operating temperature: -20 to +60 DegC.

l. DIN rail mounting.

m. Grounding method: not required.

n. Testing laboratory approvals: FM and UL.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions and Owner (SPU) standards.

B. Provide as shown on Drawings and as required.

END OF SPECIFICATION SECTION 40 97 00

SPECIFICATION SECTION 40 98 00

CONTROL PANELS AND ENCLOSURES

PART 1 - GENERAL

1.01 SUMMARY

A. Specification Section Includes:

1. Contractual requirements for control panels and enclosures utilized as follows:

a. Unless noted otherwise, all control panels and enclosures housing control components that are specified in:

1) Specification Section 27 21 00 - Telemetry Systems.

2) Specification Section 40 91 10 - Primary Elements and Transmitters.

3) Specification Section 40 94 43 - Programmable Automation Controller (PAC) Control System.

4) Specification Section 40 97 00 - Control Auxiliaries.

5) Specification Section 40 99 00 - Surge Protection Devices (SPD) for Instrumentation and Control Equipment.

B. Related Specification Sections include but are not necessarily limited to:

1. CSC Parts 1, 2, 3, 4, and 6.

2. Division 26 - Electrical.

3. Specification Section 27 21 00 - Telemetry Systems.

4. Specification Section 40 90 00 - Instrumentation for Process Control: Basic Requirements.

5. Specification Section 40 91 10 - Primary Elements and Transmitters.

6. Specification Section 40 94 43 - Programmable Automation Controller (PAC) Control System.

7. Specification Section 40 97 00 - Control Auxiliaries.

8. Specification Section 40 99 00 - Surge Protection Devices (SPD) for Instrumentation and Control Equipment.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. American National Standards Institute (ANSI).

2. ASTM International (ASTM):

a. B75, Standard Specification for Seamless Copper Tube.

3. National Electrical Manufacturers Association (NEMA):

a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

b. ICS 4, Industrial Control and Systems: Terminal Blocks.

4. National Fire Protection Association (NFPA):

a. 70, National Electrical Code (NEC).

5. Underwriters Laboratories, Inc. (UL):

a. 508A, Standard for Safety Industrial Control Panels.

b. 913, Standard for Safety, Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.

c. 698A, Industrial Control Panels Relating to Hazardous (Classified) Locations.

B. Miscellaneous:

1. Approved supplier of Industrial Control Panels under provisions of UL 508A and 698A:

a. Entire assembly shall be affixed with a UL 508A or 698A label "Listed Enclosed Industrial Control Panel" prior to shipment to the jobsite.

b. Control panel(s) without an affixed UL 508A or 698A label will be rejected and sent back to the Contractor's factory for UL labeling by the Contractor, at no additional cost to the Owner.

1.03 DEFINITIONS

A. The term "panel" refers to control panels or enclosures listed in the schedule included in this Specification Section.

B. Foreign Voltages: Voltages that may be present in circuits when the panel main power is disconnected.

C. Intrinsically Safe:

1. A device, instrument or component that will not produce sparks or thermal effects under normal or abnormal conditions that will ignite a specified gas mixture.

2. Designed such that electrical and thermal energy limits inherently are at levels incapable of causing ignition.

D. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.

E. Instrumentation Cable:

1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.

2. Instrumentation cable is typically either TSP (twisted-shielded pair) or TST (twisted-shielded triad), and is used for the transmission of low current or low voltage signals.

F. Ground Fault Circuit Interrupter (GFCI): A type of device (e.g., circuit breaker or receptacle) which detects an abnormal current flow to ground and opens the circuit preventing a hazardous situation.

G. Programmable Automation Controller (PAC): A specialized industrial computer using programmed, custom instructions to provide automated monitoring and control functions by interfacing software control strategies to input/output devices.

H. Remote Terminal Unit (RTU): An industrial data collection device designed for location at a remote site, that communicates data to a host system by using telemetry such as radio, dial-up telephone, or leased lines.

I. Input/Output (I/O): Hardware for the moving of control signals into and/or out of a PAC or RTU.

J. Supervisory Control and Data Acquisition (SCADA): Used in process control applications, where programmable logic controllers (PACs) perform control functions but are monitored and supervised by computer workstations.

K. Digital Signal Cable: Used for the transmission of digital communication signals between computers, PACs, RTUs, etc.

L. Uninterruptible Power Supply (UPS):

1. A backup power unit that provides continuous power when the normal power supply is interrupted.

2. Provided in each cabinet and panel.

3. Sized to provide a minimum of 8 hours of continuous operation of all connected components.

4. Provide monitoring and alarm points shown as shown on the Drawings and specified in **Specification Section 40 90 05 - Control Loop Descriptions**.

M. Loop Calibrator: Portable testing and measurement tool capable of accurately generating and measuring 4-20ma DC analog signals.

1.04 SUBMITTALS

A. Shop Drawings:

1. See CSC Part 3.1 for requirements for the submittal process.

2. See Specification Section 40 90 00 - Instrumentation for Process Control: Basic Requirements.

3. Prepared with computer aided design (CAD) software.

4. Printed on 11-by 17-IN sheets.

5. Provide the specified number of drawing sets, on 11-by 17-IN sheets, and CDROM’s, containing AutoCAD and PDF format drawings, for the submittal reviews per CSC Part 3.1.

6. Drawings shall include a title block containing the following:

a. Location where panel(s) are to be installed.

b. Drawing title.

c. Drawing number.

d. Revision list with revision number and date.

e. Drawing date.

f. Drawing scale.

g. Manufacturer name, address, and telephone number.

7. Cover sheet for each drawing set shall indicate the following:

a. Location.

b. Project name.

c. Submittal description.

d. Revision number.

e. Issue date.

8. Table of contents sheet(s) shall indicate the following for each drawing in the set:

a. Drawing number.

b. Drawing title.

c. Sheet number.

9. Legend and abbreviation sheet shall indicate the following:

a. Description of symbols and abbreviations used.

b. Panel construction notes including enclosure NEMA rating, finish type and color, wire type, wire color strategy, conductor sizes, and wire labeling strategy.

c. Confirmation that the panel(s) are to be affixed with a UL 508A label prior to shipment from the factory.

10. Bill of Material (material, equipment, and component list) for each panel shall include the following component information:

a. Instrument tag number.

b. Quantity.

c. Functional name or description.

d. Manufacturer.

e. Complete model number.

f. Size or rating.

11. Panel exterior layout drawings to scale and shall indicate the following:

a. Panel materials of construction, dimensions, and total assembled weight.

b. Panel access openings.

c. Conduit access locations.

d. Front panel device layout.

e. Nameplate schedule:

1) Nameplate location, layout, and engraving details.

2) Legend which indicates text, letter height and color, and background color.

f. Alarm annunciator window engraving schedule.

g. Layouts of graphic panels or mosaic displays.

12. Panel interior layout drawings shall be drawn to scale and shall indicate the following:

a. Sub-panel or mounting pan dimensions.

b. Interior device layouts.

c. PAC/RTU general arrangement layouts.

d. Wire-way locations, purpose, and dimensions.

e. Terminal strip designations.

f. Location of external wiring and/or piping connections.

g. Location of lighting fixtures, switches and receptacles.

13. Wiring diagrams shall consist of the following:

a. Panel power distribution diagrams.

b. Control and instrumentation wiring diagrams.

c. PAC/RTU I/O information:

1) Model number of I/O module.

2) Description of I/O module type and function.

3) Rack and slot number.

4) Terminal number on module.

5) Point or channel number.

6) Programmed point addresses.

7) Signal function and type.

d. Wiring diagrams shall identify each wire as it is to be labeled.

14. PAC I/O List:

a. Table indicating PAC I/O assignments for each PAC control panel.

b. PAC I/O Information:

1) PAC I/O point type.

2) PAC Rack number.

3) PAC Slot number.

4) Channel or point number.

5) Equipment tag number.

6) Description/Function.

7) Calibration:

a) Signal Scale Range.

b) N.O. or N.C. contact.

8) Power:

a) Signal type: 2-wire, 3-wire, or 4-wire.

b) Control Voltage level.

c) Foreign Voltage.

9) Project P&ID Number.

10) Panel Control Wiring Diagram Number.

B. Manufacturer catalog cut sheets for enclosure, finish, panel devices, control auxiliaries, and accessories.

C. Electrical load calculations for each panel:

1. Total connected load.

2. Peak electrical demand for each panel.

D. Climate control calculations for each panel:

1. Demonstrate that sufficient ventilation, dissipation and/or generation of heat is provided to maintain interior panel temperatures within the rated operating temperatures of panel components.

E. Miscellaneous:

1. Record Drawings:

a. Updated panel drawings delivered with the panel(s) from the Contractor's factory.

b. Drawings shall be enclosed in transparent plastic and firmly secured within each panel.

F. Operation and Maintenance Manuals:

1. See CSC Part 3.1 for requirements for the submittal process.

2. See CSC Part 3.1 for the content of the Project Operation and Maintenance Manual.

3. See Specification Section 40 90 00 - Instrumentation for Process Control: Basic Requirements.

1.05 SYSTEM DESCRIPTION

A. The contractor shall provide custom enclosures (referred to as "Control Cabinet", "Control Panel", "Local Control Panel", or "Main Control Panel" in the contract documents), the intent of which is given in the contract drawings.

B. Room entrance Go/No Go alarm panels:

1. Provide visual and audible indication at room entrances.

2. Provide pilot devices and instruments as shown on the P&IDs and other Drawings.

3. Meeting requirements of NFPA 820.

4. Go/No Go functions and interlocks provided in MCP-4400 as follows:

a. Go condition:

1) Adequate ventilation provided to the respective room (no low air flow alarm condition exists).

2) No gas monitoring system alarm condition exists (for the respective room).

3) Go beacon energized.

4) No Go buzzer de-energized.

b. No Go condition:

1) Inadequate ventilation provided to the respective room (low air flow alarm condition exists).

2) Any gas monitoring system alarm condition exists (for the respective room).

3) Go beacon energized.

4) No Go buzzer energized.

c. Provide ability to silence buzzer.

C. Provide modifications to CSO 29A Local Control Panel (LCP-4500) as indicated on the Drawings and to meet the approval and requirements of this and other Specifications.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Enclosures:
   a. Hoffman Enclosures, Inc.
   b. Skyline.
   c. Vulcan.
   d. Rittal.
   e. Hammond Manufacturing.
   f. Milbank Mfg. Co.
2. Panel heaters:
   a. Hoffman Enclosures, Inc.
   b. Rittal.
   c. Hammond Manufacturing.
3. Heat exchangers, fans, and air conditioners:
   a. IceQube.

b. Hoffman Enclosures, Inc.

c. Rittal.

d. Hammond Manufacturing.

4. Internal corrosion inhibitors:

a. Hoffman Enclosures, Inc.: Model A-HCI.

b. Northern Technologies International Corporation (NTIC): Model Zerust VC.

c. Cortec Corporation: Model VpCl Emitting Systems.

5. Thermostat:

a. Pfannenberg or equal.

6. Intrusion (Door) Switch:

a. Hoffman Enclosures, Inc. or equal.

B. Submit request for substitution in accordance with CSC Part 3.1.

2.02 ACCESSORIES

A. Panel Nameplates and Identification:

1. All fasteners listed as “screws” shall be corrosion-resistant machine screws with self-locking nuts, and meet all UL requirements.

2. Nameplates of embossed tape shall not be permitted for any application, not even for temporary use. No exceptions will be granted.

2.03 FABRICATION

A. General:

1. Fabricate panels with instrument arrangements and dimensions identified in the Contract Documents.

2. Provide panel(s) with the required enclosure rating per NEMA 250 to meet classifications identified in the Contract Documents. Only NEMA Type 4X will be accepted for installation.

3. Devices installed in panel openings shall have a NEMA enclosure rating at least equal to the panel enclosure rating.

4. Short circuit current rating of panel:

a. 10,000A, minimum.

5. Panels and pedestals to be located outdoors shall be fabricated from 316 stainless steel and shall utilize appropriate hinge and locking components. Panel(s) shall be completely assembled at the Contractor’s factory:

a. No fabrication other than correction of minor defects or minor transit damage shall be performed on panels at the jobsite.

6. Painting:

a. Panels fabricated from steel shall have their internal and external surfaces prepared, cleaned, primed, and painted:

1) Mechanically abrade all surfaces to remove rust, scale, and surface imperfections.

2) Provide final surface treatment with 120 grit abrasives or finer, followed by spot putty to fill all voids.

3) Utilize solvent or chemical methods to clean panel surfaces.

4) Apply surface conversion of zinc phosphate prior to painting to improve paint adhesion and to increase corrosion resistance.

5) Electrostatically apply polyester urethane powder coating to all inside and outside surfaces.

6) Bake powder coating at high temperatures to bond coating to enclosure surface:

a) Panel interior shall be white with semi-gloss finish.

b) Panel exterior shall be ANSI #61 gray with flat finish.

7) Application of alkyd liquid enamel coating shall be allowed in lieu of polyester urethane powder for wall mounted NEMA 12 rated panels.

b. Panels fabricated from stainless steel, aluminum, or fiberglass shall not be painted.

7. Finish opening edges of panel cutouts to smooth and true surface conditions:

a. Panels fabricated from steel shall have the opening edges finished with the panel exterior paint.

8. Panel shall meet all requirements of UL 508A:

a. If more than one (1) disconnect switch is required to disconnect all power within a panel or enclosure, unless otherwise required by UL 508A, provide a cautionary marking with the words "CAUTION" and the following or equivalent, "Risk of Electric Shock-More than one (1) disconnect switch required to de-energize the equipment before servicing."

9. Provide control panel in accordance with NEC Article 409 - Industrial Control Panels:

a. In the event of any conflict between NEC Article 409 and UL 508A, the more stringent requirement shall apply.

B. Free-Standing or Pedestal-Mounted Panels:

1. Welded construction.

2. Completely enclosed, self-supporting and gasketed dust-tight.

3. Rolled lip around all sides of enclosure door opening.

4. Seams and corners welded and ground smooth to touch and smooth in visual appearance.

5. Full height, fully gasketed flush pan doors.

6. Full length piano hinges rated for 1.5 times door plus instrument weight.

7. Doors with L-shaped, quarter-turn padlockable handles.

8. Appropriate conduit, wiring, and instrument openings shall be provided.

9. Lifting eyebolts:

a. To allow simple, safe rigging and lifting of panel during installation.

b. Removed, holes plugged, and eyebolts stored inside respective enclosure.

10. Enclosures shall be constructed of a minimum of 12 gauge stainless steel.

11. Where double doors are provided, provide removable center post.

C. Internal Panel Wiring:

1. Panel wire duct shall be installed between each row of components, and adjacent to each terminal strip:

a. Route wiring within the panel in wire-duct as possible.

b. Follow wire-duct manufacturer's recommended fill limits. In addition, raceways must meet fill requirements per UL 508A and NEC.

c. Wire-duct shall have removable snap-on covers and perforated walls for easy wire entrance.

d. Wire-duct shall be Panduit Type E or NE, constructed of nonmetallic materials, and rated in excess of the maximum voltage carried therein.

e. Wire-duct shall be supported by appropriately sized plastic rivets or screws which have been tapped into the subpanel.

2. Wire bundles shall be secured using plastic tie wraps except within wiring ducts. The bundles shall be securely fastened to the steel structure at intervals not exceeding 12-IN using appropriately sized stainless steel machine screws.

3. Wires shall be supported by means other that the connectors or terminal strips. Wires shall be contiguous from connector to connector without wire splices between them.

4. Wiring shall be installed such that if wires are removed from one (1) device, source of power will not be disrupted to other devices.

5. Splicing and tapping of wires permitted only at terminal blocks.

6. Wire bunches to doors shall be secured at each end so that bending or twisting will be around longitudinal axis of wire:

a. Protect bend area with sleeve.

7. Arrange wiring neatly, cut to proper length, with surplus wire removed:

a. Arrange wiring with sufficient clearance.

b. Provide abrasion protection for wire bundles that pass through openings or across edges of sheet metal.

8. AC circuits:

a. Routed separate from analog signal cables and digital signal cables.

b. Separate by at least 6-IN, except at unavoidable crossover points and at device terminations.

9. Analog signal cables carrying low level signals of 100 millivolts or less shall not be run in the same bundle, duct, or wire duct as digital input or control output wiring.

10. Provide at least 6-IN of separation between intrinsically safe devices and circuits and non-intrinsically safe devices and circuits.

11. Wiring to pilot devices or rotary switches shall be individually bundled and installed with a "flexible loop" of sufficient length to permit the component to be removed from panel for maintenance without removing terminations.

12. Conductors for AC and DC circuits shall be type MTW stranded copper listed for operation with 600 V at 90 DegC:

a. Conductor size shall be as required for load and 16 AWG minimum. Conductors for power wiring shall be sized for load and 14 AWG minimum.

b. Internal panel wiring color code:

1) 120 VAC circuits:

a) Power wiring: Black.

b) Control interconnections: Yellow.

c) Neutral: White.

d) Ground: Green.

e) Control circuits: Red.

2) Low voltage DC/AC circuits (typically 24 V):

a) DC Power supply wiring: Blue.

b) AC Power supply wiring: Red.

c) DC Ground: Blue/White.

d) AC Ground: White/Grey.

e) Control interconnections: Violet.

3) Foreign voltage circuits: Pink.

4) Intrinsically safe circuits: Orange.

5) Unless otherwise required by UL.

13. Provide each I/O module with a pre-terminated connector with a color-coded multi-conductor cable of appropriate length prewired to the terminal blocks.

14. Equipment requiring AC power shall be provided with an NFPA Number 70 Type SJ cord with a molded-on grounding type plug for the AC power connection.

15. Analog signal cables shall be of 600 V, 90 degC rated insulation, with stranded copper wire in twisted-shielded pairs:

a. The cable’s outer diameter shall be 0.25 IN maximum with 100 percent coverage aluminum foil mylar-lined shield and 22 AWG minimum stranded tinned copper drain. The cable shall be UL listed.

b. Conductor size: 18 AWG minimum.

c. Terminate shield drain conductors to ground only at one (1) end of the cable. The drain wire shall not be used as a control signal conductor. It shall be terminated at a terminal strip or trimmed back to the jacket of the shielded cable, as required by its application.

d. Shields that are connected to ground shall either be tinned by solder or have heat shrink insulation installed over the wires to prevent stray strands from reaching ground or shorting to other terminals.

16. High precision 250 ohm resistors with 0.25 percent accuracy shall be used where 4-20 mA DC analog signals are converted to 1-5 Vdc signals:

a. Resistors located at terminal strips.

b. Resistors terminated using individual terminal blocks and with no other conductors.

c. Resistor leads shall be un-insulated and of sufficient length to allow test or calibration equipment (e.g., HART communicator, loop calibrator) to be properly attached to the circuit with clamped test leads.

17. Provide surge protection for analog inputs from field (remote) devices.

18. Analog signals for devices in separate enclosures shall not be wired in series:

a. Loop isolators shall be used where analog signals are transmitted between control enclosures.

19. Wire and cable identification:

a. Wire and cables numbered and tagged at each termination.

b. Wire tags:

1) Slip-on, shrink fitted plastic wire sleeves with legible, machine-printed markings.

2) Adhesive, snap-on, or adhesive type labels are not acceptable.

3) Provide at both ends, except for pre-terminated cables with connectors.

4) Markings as identified in the shop drawings.

c. Tag 120 Vac power and control wires with a circuit type identification code followed by a hyphen and the wire number (i.e.L-01). Assign wire numbers using sequential numbers. Match wire numbers with interconnection wire numbers when they are electrically identical:

1) The identification letter shall be as follows:

a) For power wires, use code: L.

b) For 120 Vac control wires, use code: C.

c) For neutral wires, use code: N.

d) For ground wires, use code: PG.

d. Tag 24 Vdc and control signal wires with a three part wire number for identification, with each part separated by a hyphen (i.e. PS24-VDC-2):

1) The first part of the wire number shall be the instrument loop number. If an instrument loop number is not available, use the lowest mechanical equipment number of all final drives associated with the circuit.

2) For the second part, use one of the following codes to indicate the wire type:

a) For 24Vdc power supply circuit, use code: 24Vdc.

b) For analog signal wiring, use code: S.

c) For signal common wires, use code: COM.

d) For equipment ground, use code: PG.

e) For discrete events and low voltage control circuits, use code: C.

3) The third part of the wire number shall identify wires in a circuit that are electrically identical. Assign wire numbers using sequential numbers.

4) For example, wire number PS24-VDC-2, indicates:

a) PS24 = equipment number.

b) VDC = VDC power supply with blue wire.

c) 2 = electrical identity wire number (sequential numbers).

D. Grounding Requirements:

1. Each panel shall be provided with two copper ground bars:

a. One bar (central ground bus) shall be bonded to the panel frame or sheet metal and to the station ground system.

b. The second (signal) ground (bus) bar shall be mounted on insulated stand-offs and shall be bonded to the frame ground bar at one point only.

2. Equipment grounding conductors shall be separated from incoming power conductors at the point of entry.

3. Minimize grounding conductor length within the enclosure by locating the ground reference point as close as practical to the incoming power point of entry.

4. Bond the PAC I/O module chassis and machine elements to a central ground bus:

a. Nonconductive materials, such as paint, shall be removed from the area where the equipment contacts the enclosure.

5. Bond the enclosure to the ground bus:

a. It is imperative that good electrical connections are made at the point of contact between the ground bus and enclosure.

6. Panel-mounted devices shall be bonded to the panel enclosure or the panel grounding system by means of locknuts or pressure mounting methods.

7. Sub-panels and doors shall be bonded to ground.

8. Provide a signal ground bar (bus), 1-IN wide by 0.25 IN thick, isolated from the central ground bus, to be run across the bottom of the sub-panel. The bus shall be insulated from the panel and have tapped holes to accommodate ground connections from instruments and low level signal devices in the chassis plus 100 percent spare tapped holes. Size the signal ground bus to allow proper termination of all shield drain wires and instrument grounds.

9. Connect the signal ground bus to the system ground bus in only one point, using a stranded, insulated copper wire of #8 AWG or larger.

10. Ground each I/O module, or panel in a chassis, to the signal ground bus. Use ring tongue connectors that bolt to the bus. Each different type of signal (i.e. low level sensor, high level output, or noisy switching circuits) shall have a separate line to the bus. Only circuits of the same voltage level shall share the same ground line.

11. Small PAC systems may use a grounding system consisting of a terminal strip with a common connection bar substituted for the copper bus bar. The common connection bar must be tinned and provide ample material for the compression style terminal strip to make low resistance connections.

12. Surge protectors and separately derived AC power supplies shall be bonded to the system ground plate.

E. Termination Requirements:

1. Wiring to circuits external to the panel connected to interposing terminal blocks.

2. Terminal blocks rigidly mounted on DIN rail mounting channels.

3. Terminal strips located to provide adequate space for entrance and termination of the field conductors.

4. Locating the terminal blocks where line-of-site is impaired or making insertion or removal of wires difficult shall not be accepted.

5. Terminal blocks shall be compression type with captive screws.

6. One (1) side of each strip of terminal blocks reserved exclusively for the termination of field conductors.

7. Terminal block markings:

a. Mark one end of each terminal strip with a unique (for the panel) identifying alphanumeric code at one end.

b. Provide a plastic marking strip running the entire length of the strip with a unique (for the terminal strip) number for each terminal.

c. Legible, machine-printed markings with 1/8-IN high numbers.

d. Markings as identified in the shop drawings.

8. Terminal block mechanical and electrical characteristics shall be in accordance with NEMA ICS 4.

9. Terminal blocks carrying power circuits shall include a transparent, hinged cover for personnel protection and access:

a. Each terminal block shall be identified with machine printed labels.

10. Terminals shall facilitate wire sizes as follows:

a. 120 Vac applications: Conductor size 12 AWG minimum.

b. Other: Conductor size 14 AWG minimum.

11. Analog signal cable shield drain conductors shall be individually terminated.

12. Install minimum of 20 percent spare terminals.

13. Bladed, knife switch, isolating type terminal blocks where control voltages enter or leave the panel.

14. Fused terminal blocks shall be used in the following circuits:

a. Control voltage is used to energize a solenoid valve.

b. Control voltage is used to wet a contact.

c. DC power is connected to 2-wire, loop-powered instruments. Use fast acting glass tube type fuses rated 1/8 or 1/10 amp.

d. AC or DC power is used to supply an instrument. For 120 Vac circuits, use ceramic tube type fuses with 25,000 amp interrupting capacity at 125 volts. For supplying 24 Vdc instruments, use fast acting glass tube type fuses rated 3 amps.

15. Fused terminal blocks shall be provided with LED blown fuse indicator lamps.

16. Circuit breakers shall be used in circuits supplying individual instruments or equipment with loads of 10 amps or greater at 120 Vac.

17. When control circuits require more than one (1) field conductor connected to a single wiring point, a sufficient number of terminal points shall be connected internally to allow termination of only one (1) field conductor per terminal block.

18. DIN rail mounting channels shall be installed along full length of the terminal strip areas to facilitate future expansion.

19. Connections to devices with screw type terminals shall be made using ring type (not spade or fork), insulated, compression terminators.

20. All wire connections shall be complete using terminal strips. Wire splices are not allowed.

F. Component Mounting and Placement:

1. Components shall be installed per manufacturer instructions. Double-faced tape will not be permitted.

2. Control relays and other control auxiliaries shall be mounted on DIN rail mounting channels where practical.

3. Terminal blocks shall be mounted vertically in the enclosure with ample clearance to allow visual guidance for installing wires.

4. Front panel devices shall be mounted within a range of 40 to 70 IN above the finished floor or grade, unless otherwise shown in the Contract Documents.

5. PAC/RTU and I/O rack installation:

a. Located such that the LED indicators and switches are readily visible with the panel door open.

b. Located such that calibration, repair and/or replacement of component can be accomplished without the need to remove wire terminations or other installed components.

6. Locate power supplies with sufficient spacing for circulation of air.

7. Where components such as relays, and other electromagnetic devices are installed within the same enclosure as the PAC/RTU system components, provide a barrier of at least 6-IN of separation between the “power area containing the electromagnetic devices” and the “control area”.

8. Components mounted in the panel interior shall be fastened to an interior sub-panel using machine screws:

a. Fastening devices shall not project through the outer surface of the panel enclosure.

b. Follow UL recommendations.

9. Excess mounting space of at least 20 percent for component types listed below to facilitate future expansion:

a. Fuse holders.

b. Circuit breakers.

c. Control relays.

d. Time delay relays.

e. Intrinsically safe barriers and relays.

10. Components installed on sub-panels shall be provided with a minimum spacing between component and wire duct of 1-IN:

a. Minimum of 2-IN separation between terminal strips and wire ducts.

G. Power Distribution:

1. Main incoming power circuits shall be protected with a thermal magnetic circuit breaker:

a. Limit load to maximum of 80 percent of circuit breaker rating.

2. Component types listed below shall be individually fused so that they may be individually de-energized for maintenance:

a. PAC/RTU power supply modules.

3. Each control cabinet and panel with PAC/RTU components shall be furnished with power protection in the form of a double conversion UPS.

4. Equip each panel with necessary power supplies with ratings required for installed equipment and with minimum 25 percent spare capacity.

5. Constant voltage transformers, balancing potentiometers, and rectifiers as necessary for specific instrument requirements.

H. Internal Panel Lighting and Service Receptacles:

1. One (1) electrical GFCI duplex receptacle for each 3-FT of panel face.

2. One (1) 12-IN 12 VDC or 24 VDC LED strip light fixture with door-activated switch(es) per FT of panel face. Model: Ledtronics STP312C-TPW-012V with mounting accessories and connectors; or equal.

I. Environmental Controls:

1. Panels:

a. Outdoor temperature range of 0 DegF through 110 DegF.

b. Thermostat controlled heaters to maintain temperature approximately 10 DegF above ambient for condensation prevention inside the panels. Humidity inside the panel shall be maintained between 10 and 95 percent.

c. Panel internal temperature range of 20 DegF through 90 DegF shall be maintained.

d. Thermostat controlled closed-loop heat exchangers or closed-loop air conditioners if required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the panel and within the required panel internal temperature range per Item c. above.

e. Internal corrosion inhibitors.

2. Environmental control components:

a. Panel heaters:

1) Thermostat controlled.

2) Fan driven.

3) Components mounted in an anodized aluminum housing.

4) Designed for sub-panel mounting.

5) Powered from 120 Vac and protected with a dedicated circuit breaker.

6) Appropriately sized Hoffman type D-AH heater, or approved equal, for panels 36-IN high or larger.

b. Heat exchangers and air conditioners:

1) Dual-loop design to isolate panel interior air from exterior air.

2) Designed and listed to maintain NEMA 4X enclosure rating.

3) Thermostat controlled.

4) Designed for use in areas of contamination and capable of running for 12 month periods without cleaning.

5) Operate from 120 Vac and protected with a dedicated circuit breaker.

6) IceQube: Model IQ3000T-126. Or equal.

7) Top-mounted.

c. Internal corrosion inhibitors:

1) Contains chemical which vaporizes and condenses on surfaces in the enclosure.

2) Inhibitor shall be applied in accordance with manufacturer instructions for the enclosure volume.

3) Inhibitor shall be applied in the panel(s) prior to shipment from the Contractor's factory.

J. Thermostat:

1. Pfannenberg: Model FLZ 541.

2. Or equal.

K. Intrusion (Door) Switch:

1. Provide one switch for each door. If there are multiple doors, wire together to provide single intrusion input. Wired Normally Closed with door closed.

2. Door-activated switch.

3. Hoffman Enclosures Inc., Model ALFSWD or PLFSWD (as required by the application); or equal.

2.04 MAINTENANCE MATERIALS

A. Extra Materials:

1. Quantity of 25 percent replacement lamps for each type installed (minimum of twelve (12) of each type).

2. Minimum five (5) replacement fuses of each type and size installed.

3. Minimum twelve (12) replacement filters for each type installed.

4. One (1) quart of exterior finish touch-up paint.

5. One (1) complete set of replacement corrosion inhibitors in sealed packages for each panel.

PART 3 - EXECUTION

3.01 TEST PLANS AND REPORTS

A. Testing requirements shall be part of every PAC installation. The Contractor shall demonstrate the system was fully tested during development and installation. The control system must be demonstrated to be a functioning, integrated, and reliable control system before final payments are released. The basic testing requirements shall require a comprehensive series of Contractor conducted tests which will be witnessed by Owner (SPU) and certified by the Contractor. The Owner will provide the PAC application programs for the project. Coordinate all testing of software directly with Owner personnel as required.

B. The basic requirements shall include testing of all equipment and software. If specific tests were not defined in the contract documents for a piece of equipment or software, then the Contractor shall be required to develop the testing procedures. All software and all equipment related to the PAC system shall be tested.

C. The Contractor shall be required to prepare and submit for review and approval the following:

1. Factory Acceptance Test Plan and procedures.

2. Site Acceptance Test Plan and procedures.

3. Test Schedules.

4. Test Reports.

5. Instrument and (applicable) component calibration sheets.

D. Test Plans:

1. The Contractor shall be required to prepare and document a separate test plan for each Factory Acceptance Test and Site Acceptance Test. The actual test procedures shall be a formal submittal for review and approval sixty (60) days before the start of the tests.

2. The test procedures shall be structured in a step-by-step, building block, and efficient manner with checkpoints at critical functions. The procedures shall facilitate the reporting of test results and the re-creation of error conditions.

3. Test data sheets shall be used to record applicable drawing numbers, test equipment, discrepancies, corrective action(s) required, and test data. Data entries shall be referenced to the applicable procedures and allowable limits for each entry shall be indicated on the data sheets.

E. Test Reports:

1. The Contractor shall be required to develop, maintain, and update Test Reports of all test results and conditions that were recorded during the course of the testing. The test results shall include:

a. Identification of test being conducted.

b. Date and time of test.

c. Prerequisite tests and demonstrations.

d. Brief statement of test objective(s) and scope.

e. Brief test description.

f. List of calibrated (within the past calendar year) test and monitoring equipment required to perform test.

g. Test results.

h. List of test deficiencies and their resolutions.

i. Retesting requirements (if required).

j. Failure events.

k. Contractor’s certification (as applicable).

3.02 FACTORY TESTING

A. A Factory Acceptance Test (FAT) and verification for all deliverable equipment, programs, and associated documentation shall be performed prior to shipment of the

system. The tests shall verify that the equipment is manufactured and assembled correctly, is operating as designed, and is in compliance with the contractual requirements. The tests shall verify that the software and hardware meet the functional and performance requirements of the project. The FAT shall be performed at the Contractor's factory and shall be witnessed by Owner personnel.

B. The FAT shall include the following major test and verification activities:

1. Verification of the system's configuration. Prior to the beginning of the FAT, the system will be subjected to system deliverable configuration verification. A copy of the configuration and record of quantities of part numbers are to be included with the FAT report. No equipment replacement or substitutions shall be permitted without rigorous quality control accounting and re-testing of affected equipment.

2. Since the Owner is providing the application software, coordination between the Contractor and Owner is required. The Contractor is responsible for proper functioning of the hardware, while the Owner is responsible for proper functioning of the software. The FAT shall primarily test the control cabinet hardware, and the Contractor is responsible for developing and administering the testing procedure which was approved in the submittal process. Prior to the FAT and prior to Owner access to the control panel, use PAC Project Basic (available from Opto 22) to test all I/O from the field terminals to the PAC. In addition to the hardware test, the Contractor shall allow the Owner up to five (5) days of access (either before or after the hardware test) to the control cabinet at the Contractor's fabrication facility in which the Owner will load the software onto the PAC and confirm proper configuration and hardware-software interface. During this time, the Owner may perform functional testing of the software to verify proper operation; provide up to sixteen (16) hours of support during this five (5) day period.

3. Equipment testing and verification shall be performed:

a. During the FAT, a visual inspection will be performed to verify the equipment was assembled in accordance with the approved drawings. As a minimum, the structural integrity of the enclosure will be verified, as well as the subpanel structure, paint work and finish, and the cabinet dimensions.

b. A visual inspection of the wiring and connections will be performed, including the termination of wires, labeling, wiring installation and wire stripping.

c. The fuses and circuit breaker ratings and locations in the panel will be confirmed.

d. The grounding strips, including layout, cables, connection security and correct size will be confirmed.

e. Additionally, the inspection will include the verification of card wiring support, I/O rack clearances, I/O and equipment labeling, I/O card type verification, I/O card layout, power supply mounting, power cable routing, and data cable routing.

C. The FAT shall include a functional test of the system after a burn-in test has been performed. The panel shall be fully energized for a minimum period of 48 hours prior to the functional test. The test shall then exercise every specified system function and shall include, but not be limited to, the following:

1. Exercise all inputs and outputs, both individually and collectively, by measuring or connecting circuits at the field terminal blocks.

2. Demonstrate analog input and analog output accuracy.

3. Test all indicators.

4. Verify all control operations to ensure they result in the correct sequence of operation at the PAC (Owner responsibility).

5. Simulate PAC communication error conditions and demonstrate error detection and handling.

6. Demonstrate PAC power supply failure and recovery.

7. Demonstrate the ability to remove and insert each I/O module.

8. Demonstrate the correct operation of all digital communication devices.

9. Allow time required by Owner to test operation of all Owner-provided application programs and control strategies using whatever simulations are necessary. Provide the Owner with all materials and components required for the duration of their testing (at no additional cost to the Owner).

10. Provide certified test results for the deliverable equipment.

11. Test shall be fully documented and signed by the Contractor's factory supervisor.

12. Make the following documentation available to the Engineer at test site during the tests:

a. Contract Documents.

b. Factory Demonstration Testing procedures.

c. List of equipment to be testing including make, model, and serial number.

d. Shop Drawing submittal data for equipment being tested.

13. Deficiencies shall be corrected prior to shipment from the Contractor's factory. The system shall be packaged and shipped to the Contractor at the site for installation.

D. Test location: Within 50 miles of downtown Seattle.

3.03 INSTALLATION

A. Install control panels only in non-hazardous areas. Install free-standing panels on 4-IN high concrete housekeeping pads.

B. Anchor panels in a manner to prevent the enclosure from racking, which may cause the access doors to become misaligned.

C. Obtain approved panel layouts prior to installation of conduits.

D. Install products in accordance with manufacturer's instructions.

E. Provide sunshields where required per the contract documents.

3.04 SITE ACCEPTANCE TESTING

A. A System Installation Test and a System Operational Test shall be performed at the site. The final documentation will then be reviewed for completeness. Site Acceptance Testing shall be witnessed by Owner personnel.

B. The System Installation Test shall include the requirements as follows whether installing a PAC at an existing or new location. Since the Owner is providing the PAC application

programs, coordinate and schedule directly with Owner personnel a minimum of two months prior to the start of any testing. Provide all labor as required to support the Owner's testing, at no additional cost to Owner:

1. After the installation of the panel and all associated wiring, but prior to making final terminations to the field components, send dummy discrete and analog signals that duplicate the signals at the site to the Operations Control Center (OCC) and verify the communication path and the software are working.

2. Verify all indication devices.

3. Verify communications to the SCADA system is operational. Verify analog and discrete points are functional and transmission control from the OCC is operating where applicable.

4. The installation test shall verify that the equipment and all cables have been properly installed, have not been damaged, and have not failed in shipment or storage.

5. The installation test shall demonstrate stable operation of all PAC I/O modules, wiring, and data transmission to the OCC under actual operating conditions. The test shall also demonstrate proper operation of all digital or sequential control. All start/stop, open/close, raise/lower and similar commands and all discrete status inputs shall be tested for proper operation. In addition, all alarms, both analog and discrete, shall be tested.

6. After one week of operation without notable events or failures, finalize the wiring between the new PAC and the I/O. Organize unused wiring to provide a neat and clean appearance.

C. The System Operational Test shall require the testing of system functions, software, and performance after completion of all site installation tests. These tests shall verify complete operation of the system or site, including additional tests required to verify field-installed equipment, which was not available at the factory. The Contractor shall be required to perform the following:

1. Verify the facility installation.

2. Verify the Site Installation Test.

3. Verify operation of any local operator interface device.

D. Final Documentation Acceptance shall follow the completion of all system testing previously described. Final acceptance of any work shall be linked to the proper operation and documentation of the controls installed by the Contractor. The following actions shall be defined in the contract documents and shall be a prerequisite for final acceptance of the control system:

1. Successful completion of the Site Acceptance Test.

2. Delivery of all "as-built" documentation and drawings.

3. Resolution of all outstanding system deficiencies.

3.05 SCHEDULE

A. Schedule:

TAG NUMBER	LOCATION	TYPE	MATERIAL	LATCH
Go/No Go Panel LCP-4462A	Entry Way entrance, as shown on Drawings	NEMA 4X	316 SS or Fiberglass	As described above, as shown on Drawings
Go/No-Go Control Station LCP-4462B	Inside hatch; as shown on Drawings	NEMA 4X	316 SS or Fiberglass	As described above, as shown on Drawings
Go/No Go Panel LCP-4460	Mechanical Room entrance, as shown on Drawings	NEMA 4X	316 SS or Fiberglass	As described above, as shown on Drawings
Go/No Go Panel LCP-4461	Electrical Room entrance, as shown on Drawings	NEMA 4X	316 SS or Fiberglass	As described above, as shown on Drawings
Control Cabinet ECAB-4400	Outdoors, as shown on Drawings	NEMA 4X	316 SS	As described above, as shown on Drawings
Main Control Panel MCP-4400	Electrical Room, as shown on Drawings	NEMA 4X	316 SS or Fiberglass	As described above, as shown on Drawings

END OF SPECIFICATION SECTION 40 98 00

SPECIFICATION SECTION 40 99 00

SURGE PROTECTION DEVICES (SPD) FOR INSTRUMENTATION AND CONTROL EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Specification Section Includes:

1. Type IC1 SPD - Dedicated 120 Vac circuit, series connection, control panel mounted.
2. Type IC8 SPD - Data line, control panel mounted.

B. Related Specification Sections include but are not necessarily limited to:

1. CSC Parts 1, 2, 3, 4, and 6.
2. Specification Section 40 90 00 - Instrumentation for Process Control: Basic Requirements.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
2. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. LS 1, Low Voltage Surge Protection Devices.
3. Underwriters Laboratories, Inc. (UL):
   a. 497B, Standard for Safety Protectors for Data Communications and Fire-Alarm Circuits.
   b. 1283, Standard for Safety Electromagnetic Interference Filters.
   c. 1363, Standard for Safety Relocatable Power Taps.
   d. 1449, Standard for Safety Transient Voltage Surge Suppressors.

B. Qualifications:

1. Provide devices from a manufacturer who has been regularly engaged in the development, design, testing, listing and manufacturing of SPDs of the types and ratings required for a period of ten (10) years or more and whose products have been in satisfactory use in similar service.
2. Upon request, suppliers or manufacturers shall provide a list of not less than three (3) customer references showing satisfactory operation.

1.03 DEFINITIONS

A. Clamping Voltage: The voltage measured at the end of the 6-IN output leads of the SPD and from the zero voltage reference to the peak of the surge when the applied surge is induced at the 90 degree phase angle of the applied system frequency voltage.

B. Let-Through Voltage: The voltage measured at the end of the 6-IN output leads of the SPD and from the system peak voltage to the peak of the surge when the applied surge is induced at the 90 degree phase angle of the applied system frequency voltage.

C. Maximum Continuous Operating Voltage (MCOV): The maximum steady state voltage at which the SPD device can operate and meet it specification within its rated temperature.

D. Maximum Surge Current:

1. The maximum 8 x 20 microsecond surge current pulse the SPD device is capable of surviving on a single-impulse basis without suffering either performance degradation or more than 10 percent deviation of clamping voltage at a specified surge current.

2. Listed by mode, since number and type of components in any SPD may vary by mode.

E. Protection Modes: This parameter identifies the modes for which the SPD has directly connected protection elements, i.e., line-to-neutral (L-N), line-to-line (L-L), line-to-ground (L-G), neutral-to-ground (N-G).

F. Surge Current per Phase:

1. The per phase rating is the total surge current capacity connected to a given phase conductor.

2. For example, a wye system surge current per phase would equal L-N plus L-G; a delta system surge current per phase would equal L-L plus L-G:

a. The N-G mode is not included in the per phase calculation.

G. System Peak Voltage: The electrical equipment supply voltage sine wave peak (i.e., for a 120 V system the L-N peak voltage is 170 V).

1.04 SUBMITTALS

A. Shop Drawings:

1. See CSC Part 3.1 for requirements for the submittal process.

2. For named products, submit only a catalog cut sheet:

a. For all other products, submit the data required as specified in **Sub-paragraph 1.04.A.4** of this Specification Section.

3. See Specification Section 40 90 00 - Instrumentation for Process Control: Basic Requirements.

4. Product technical data for non-specified models:

a. Manufacturer’s experience.

b. Standard catalog cut sheet.

c. Electrical and mechanical drawing showing unit dimensions, weights, mounting provisions, connection details and layout diagram of the unit.

d. Create a Product Data Sheet for each different model number of SPD provided:

1) Data in the Product Data Sheet heading:

a) SPD Type per **PART 2** of this Specification Section.

b) Manufacturer's Name.

c) Product model number.

2) Data in the Product Data Sheet body:

a) Column one: Specified value/feature of every paragraph of **PART 2** of this Specification Section.

b) Column two: Manufacturer's certified value confirming the product meets the specified value/feature.

3) Data in the Product Data Sheet closing:

a) Signature of the manufacturer's official (printed and signed).

b) Title of the official.

c) Date of signature.

B. Operation and Maintenance Manual:

1. See CSC Part 3.1 for requirements for the submittal process.

1.05 WARRANTY

A. The manufacturer shall provide a minimum of a five (5) year Limited Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers model numbers listed in the individual product paragraphs below are acceptable.

2.02 TYPE IC1 SPD

A. Approved Products:

1. Cutler Hammer: AGSHW CH-120N-15-XS.

2. Phoenix Contact: SFP 1-20/120AC (2856702).

3. EDCO: HSP121BT-1RU.

4. MTL: MA15/D/1/SI.

B. Standards: UL 1449.

C. Design:

1. General:

a. Mounted internally to control panels for point-of-use loads.

b. MOV based or multi-stage hybrid solid state high performance suppression system.

c. Designed for series connection.

d. Enclosure: Metallic or plastic, flange or DIN rail mounting.

e. Field connection: Provide unit with external terminal screws for each phase, neutral and ground that will accept #14 through #12 conductors.

f. Device monitoring: Long-life, solid state, externally visible indicators that monitors the on-line status of the units suppression filter system or power loss in any of the phases.

2. Operating voltage: 120 Vac.

3. Operating current: 15 A minimum.

4. Operating frequency: 45 to 65 Hz.

5. Modes of protection: All modes, L-N, L-G and N-G.

6. Maximum continuous operating voltage: Less than 130 percent of system peak voltage.

7. Maximum surge current: 20,000A per phase, 10,000A per mode minimum.

8. Minimum repetitive surge current capacity: 1000 impulses with no degradation of more than 10 percent deviation of the clamping voltage.

9. Fusing: Optional integral unit level and/or component level short circuit and/or thermal overload protection:

   a. External protection as recommended by manufacturer.

10. Maximum clamping voltages, dynamic test with voltages measured from the zero voltage reference and 90 degree phase angle:

SYSTEM VOLTAGE	TEST MODE	IEEE C62.41		UL 1449
		B COMB. WAVE	A RING WAVE	
L-N = 120 V	L-N	400 V	300 V	330 V
	L-G	500 V	400 V	400 V
	N-G	500 V	400 V	400 V

2.03 TYPE IC8 SPD

A. Approved Products:

1. Cutler Hammer: DHW2P Series.

2. EDCO: PC642 Series.

3. MTL: SD Series.

4. Phoenix Contact: PT Series.

B. Standards: UL 497B.

C. Design:

1. General:
    a. Mounted internally to control panels for protection of equipment connected to data lines (RS485, RS232, telephone line, etc.).
    b. Multi-stage hybrid solid state high performance suppression system.
    c. Designed for series connection.
    d. Enclosure: Metallic or plastic, flange or DIN rail mounting.
    e. Field connection: Provide unit with external terminal screws for line and ground conductors.
2. Operating voltage: Nominal unit operating voltage and configuration as specified or as indicated on the Drawings.
3. Modes of protection: All modes.
4. Maximum continuous operating voltage: Less than 130 percent of system peak voltage.
5. Maximum surge current: 10,000 A.
6. Minimum repetitive surge current capacity:
    a. The SPD shall meet one (1) of the following:
        1) 1000 occurrences of a 200A, 10 x 1000 microsecond waveform.
        2) 400 occurrences of a 500A, 10 x 1000 microsecond waveform.
        3) 100 occurrences of a 400A, 10 x 700 microsecond waveform.
        4) 100 occurrences of a 2000A, 8 x 20 microsecond waveform.
        5) 10 occurrences of a 10,000A, 8 x 20 microsecond waveform.
7. Maximum clamping voltages, L-L (Pos-Neg):
    a. The SPD shall meet one (1) of the following:
        1) 400A, 10x700 microsecond waveform: 400 percent of system voltage.
        2) 10,000A, 8x20 microsecond waveform: 400 percent of system voltage.
        3) IEEE B3 combination wave: 250 percent of system voltage.
8. Maximum clamping voltages, L-G:
    a. The SPD shall meet one (1) of the following:
        1) 400A, 10x700 microsecond waveform: 200 percent of system voltage.
        2) 10,000A, 8x20 microsecond waveform: 200 percent of system voltage.
        3) IEEE B3 combination wave: 300 percent of system voltage.

2.04 SOURCE QUALITY CONTROL

A. Performance tests to be performed or independently verified by a certified testing laboratory.

B. The SPD are to be tested as a complete SPD system including: Integral unit level and/or component level fusing.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Type IC1 SPD:

1. Provide on the following applications:
    a. Incoming 120 V power to all control panels.
    b. Line side of 120 V power terminals to equipment (e.g., PLCs, transmitters).
2. Connected in series with the panel's or equipment’s branch circuit.
3. Provide fuse protection as recommended by manufacturer.
4. Flange mount or DIN rail mount in control panel.
5. Connect all SPDs in the panel to the same grounding point.

C. Type IC8 SPD:

1. Provide on the following applications:
    a. On both ends of data lines that interconnect devices that are locked outdoors or in remote buildings or structures where the conductors are routed above grade or underground:
        1) Frame relay system.
2. Connect in series with the equipment.
3. Flange mount or DIN rail mount in control panel.
4. Connect all SPDs in the control panel to the same grounding point.
5. Verify SPDs series resistance and capacitance does not interfere with the data line signal.

END OF SPECIFICATION SECTION 40 99 00