JORDAN VALLEY WATER CONSERVANCY DISTRICT

JORDAN VALLEY WATER CONSERVANCY DISTRICT
WEST JORDAN, UTAH

JORDAN VALLEY WATER TREATMENT PLANT FILTER AND CHEMICAL UPGRADES

CLIENT PROJECT NO. 202001

CONTRACT/TECHNICAL SPECIFICATIONS

100% SUBMITTAL

VOLUME 4 OF 6

DIVISIONS 16 *(16262 to 16990K)* AND 17

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JORDAN VALLEY WATER CONSERVANCY DISTRICT

JORDAN VALLEY WATER TREATMENT PLANT FILTER AND CHEMICAL UPGRADES

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SECTION 16262

VARIABLE FREQUENCY DRIVES 0.50 - 50 HORSEPOWER

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Variable frequency drives (VFD) 0.5 to 50 horsepower for control of NEMA Design B squirrel cage induction motors.

1.02 REFERENCES

A. International Organization for Standardization (ISO):
   1. 9001 - Quality Management Systems - Requirements.

B. National Electrical Manufacturers Association (NEMA).

C. Underwriters' Laboratories (UL):
   1. 508A - Standard for Safety for Industrial Control Panels.
   2. 845 - Standard for Motor Control Centers.
   3. 61800-5-1 - Standard for Adjustable Speed Electrical Power Drive Systems.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Point of common coupling: The point of common coupling for all harmonic calculation and field measurements for both voltage and current distortions is defined as the closest directly connected bus supplying power to the VFD.

1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures:
   1. Custom prepared by the VFD manufacturer and specific for the equipment furnished.

B. Product data:
   1. Manufacturer of the VFD.
   2. Manufacturer of all components of the VFD.
   3. Dimensions:
      a. Height.
      b. Width.

c. Depth.
d. Weight.

4. Nameplate schedule.
5. Bill of material.
6. Ratings:
   a. Voltage.
   b. Phase.
   c. Input current.
   d. Output current.
   e. Interrupting rating.
   f. Momentary current rating.
7. List of recommended spare parts.
8. Catalog cutsheets for major components.
9. Design data:
   a. Efficiency and power factor values.
   b. Certification that the drive is sized for the full nameplate motor horsepower and current of the driven load at the installed altitude and ambient temperature.
   c. Certification that based upon VFD design, cable length to motor, and motor dielectric insulation level that the VFD will not damage motor insulation due to carrier frequency, reflected wave, dv/dt, or other VFD produced characteristics.
   d. Certification that electronic circuits and printed circuit boards are conformally coated.
10. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 01850 - Design Criteria:
    a. Manufacturer's statement of seismic qualification with substantiating test data.
    b. Manufacturer's special seismic certification with substantiating test data.

C. Shop Drawings:
   1. Complete plan and elevation drawings showing:
      a. Dimensions.
      b. Panel, sub-panel, and component layout indexed to the bill of material.
      c. Conduit connections.
   2. Block diagram showing the basic control and protection systems specifying the protection, control, trip and alarm functions, the reference signals and commands and the auxiliary devices.
   3. Complete schematic, wiring and interconnection diagrams showing connections to both internal and external devices:
      a. Include terminal number and wire numbers.
   4. Complete single-line and 3-line diagrams, including, but not limited to, circuit breakers, motor circuit protectors, contactors, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete system:
      a. Clearly indicate device electrical ratings on the Drawings.

D. Delegated Design Submittals:
    1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
        a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
        b. For equipment installed outdoors.
        c. For wall mounted equipment weighing 125 pounds or more.

E. Installation instructions:
    1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
    2. Provide manufacturer's installation instructions.

F. Commissioning Submittals:
    1. As specified in Section 01756 - Commissioning, including the following:
        a. Manufacturer's representative qualifications.
        b. Certificates:
            1) Requirements as specified in this Section.
        c. Test Plans:
            1) Test requirements as specified in this Section.
        d. Test Reports.
        e. Manufacturer's representatives field notes and data.
        f. Owner Training.

G. Operation and maintenance manuals:
    1. As specified in Section 01782 - Operation and Maintenance Manuals.
    2. Spare parts list with supplier names and part numbers.
    3. Startup and commissioning instructions and data.
    4. Operating manuals:
        a. Submit operating instructions and a maintenance manual presenting full details for care and maintenance of each model of VFD provided under this Contract.
    5. Operating instructions:
        a. Written descriptions detailing the operational functions of controls on the front panel.
    6. Maintenance manual:
        a. Furnish maintenance manuals with instructions covering details pertaining to care and maintenance of equipment as well as identifying all parts.
        b. Manuals shall include, but are not limited to, the following:
            1) Adjustment and test instructions covering the steps involved in the initial test, adjustment, and start-up procedures.
            2) Detailed control instructions which outline the purpose and operation of every control device used in normal operation.
            3) Schematic wiring and external diagrams:
                a) Furnish Drawings in a reduced 11-inch by 17-inch format that are fully legible at that size.

H. Test forms and reports:
    1. Submit complete factory acceptance test procedures and forms used during the test.

I. Manufacturer's Certificate of Installation and Functionality Compliance.

J. Manufacturer's field reports:
   1. Listing the setting of VFD adjustable parameters and their values after start-up.

K. Record Documents:
   1. Certified Record Documents of equipment with information listed above.

1.06 QUALITY ASSURANCE

A. Qualifications:
   1. Any third-party certification, safety or protection requirements shall be applied to the VFD system as a whole. Certification or protection of system elements or individual components by themselves is not acceptable.
   2. VFDs shall be UL 61800-5-1 listed and labeled:
      a. UL 61800-5-1 for individual units.
      b. UL 508A for VFD systems in control panels.
      c. UL 845 for VFD systems in motor control centers.
   3. VFDs shall be manufactured by the VFD manufacturer at its own facility which shall have a quality assurance program certified in accordance with ISO 9001.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Ship the VFDs and associated equipment to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize on-site off-loading equipment:
   1. VFDs shall be delivered to the site preassembled and wired.

B. Furnish temporary equipment heaters within the VFD to prevent condensation from forming.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.09 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Conduct factory acceptance test and submit certified test results for Engineer's review.
   2. Ship equipment to project site after successful completion of factory acceptance test.
   3. Assemble equipment in the field.
   4. Conduct field acceptance test and submit results for Engineer's review.
   5. Submit Manufacturers Certificate of Installation and Functionality Compliance.
   6. Conduct Owner's training sessions.
   7. Commissioning and process start-up as specified in Section 01756 - Commissioning.

1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

1.11 SYSTEM START-UP

A. VFD manufacturer shall be responsible for start-up of the VFDs in the presence of the equipment suppliers, Contractor, Engineer, and Owner.

1.12 MAINTENANCE

A. Spare parts:
   1. The following shall be furnished:
      a. 1 complete VFD of each size furnished.
      b. Any special dedicated tools for emergency service and troubleshooting.
      c. Hardware and software required for configuration, maintenance, troubleshooting, and inquiry of drive parameters.

PART 2 PRODUCTS

2.01 GENERAL (NOT USED)

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria and as indicated on the Drawings.

B. Non-conditioned spaces:
   1. Provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.

C. Outdoor installations:
   1. Provide conditioning equipment incorporated into the equipment to maintain the enclosures within the equipment manufacturer’s specified operating ranges.

D. Design requirements:
   1. Each VFD system consists of components required to meet the performance, protection, safety, testing, and certification criteria of this Section.
   2. VFD system:
      a. Is a fully integrated package.
      b. Includes material necessary to interconnect VFD system elements, even if shipped separately.
   3. Coordinate bearing protection methods with the supplier of the driven equipment.

E. Any modifications to a standard product necessary to meet this Section shall be made only by the VFD manufacturer:
   1. Each VFD shall be completely factory pre-wired, assembled, and then tested as a complete system by the VFD manufacturer to ensure a properly coordinated, fully integrated drive system.

2. VFD shall be capable of operating standard NEMA Design B motors. It is the responsibility of the VFD manufacturer to ensure that the drive will not damage motor insulation due to high carrier frequency, reflected wave, dv/dt or other drive electrical characteristics based upon the installed conditions:
    a. Provide equipment necessary to mitigate potential damage to motor insulation.
    b. Motors as specified in Section 16222 - Low Voltage Motors up to 500 hp.

F. Performance:
1. Operating envelope:
    a. Speed and torque requirements:
        1) Provide a variable torque or constant torque VFD as required by the driven load.
        2) VFD shall be capable of producing a variable alternating voltage/frequency output to provide continuous operation over the 40 to 200 percent (25 to 120 hertz) speed range.
    b. Current requirements:
        1) Full rated current output on a continuous basis.
        2) Variable torque VFD:
            a) Minimum 110 percent current overload for 1 minute.
        3) Constant torque VFD:
            a) Minimum 150 percent current overload for 1 minute.
2. Minimum VFD system efficiency:
    a. 96 percent when operating at the rated kW output.
    b. VFD system efficiency shall be calculated as follows:

$$\textit{Efficiency (\%)} = \frac{\textit{Power (Load)}}{\textit{Power (Supply)}} \textit{ X 100}$$

        1) Power (Load) is the total power measured at the output terminals of the drive system, including VFD, output filters, or transformers.
        2) Power (Supply) is the total power measured at the input terminals of the VFD including input filters, line reactors, isolation transformers, harmonic distortion attenuation equipment and auxiliary equipment (e.g., controls, fans) for complete system operation.
3. Total power factor:
    a. Minimum of 0.96 lagging across the entire speed range.
    b. At no speed shall the VFD have a leading power factor.
4. Frequency accuracy:
    a. Minimum of within 0.01 percent.
5. Speed regulation:
    a. Minimum of within 0.5 percent across the entire speed range.

2.03 MANUFACTURERS

A. One of the following, or equal:
1. ABB.
2. Allen-Bradley.
3. Danfoss VLT/Vacon.
4. Eaton.
5. Schneider Electric.
6. Siemens-Robicon.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT

A. General:
   1. Sinusoidal pulse width modulated (PWM) type drive.
      a. 6-pulse insulated gate bipolar transistor (IGBT) power section.
      b. Microprocessor based controls.
      c. Line reactor and output device as specified in this Section.

B. Ratings:
   1. Voltage:
      a. Input voltage as indicated on the Drawings.

C. Operational features:
   1. Protective features:
      a. Provide the following minimum protective features:
         1) Motor overload protection.
         2) Instantaneous overcurrent.
         3) Instantaneous overvoltage.
         4) Undervoltage.
         5) Power unit overtemperature.
         6) Phase loss.
         7) VFD output short circuit.
   2. Control mode:
      a. Operation in either a constant volts/hertz or sensorless vector mode:
         1) Control mode selectable using the programming keypad.
   3. Frequency control:
      a. Minimum of 3 selectable skip frequencies with adjustable bandwidths.
      b. Programmable minimum frequency.
      c. Programmable maximum frequency.
   4. Acceleration/deceleration:
      a. Separately adjustable acceleration and deceleration rates:
         1) Each rate adjustable from 0.01 to 1,800 seconds.
   5. Spinning load:
      a. VFD shall be capable of determining the speed and direction of a spinning load, “catch” the load and accelerate or decelerate it without damage to the load.
   6. Programmable loss of signal:
      a. Upon loss of speed reference, the VFD shall be programmable to either:
         1) Stop.
         2) Maintain current speed.
         3) Default to pre-selected speed.
   7. Power interrupt ride-through:
      a. VFD shall be capable of continuous operation in the event of a power loss of 5 cycles or less.

8. Inputs/Outputs:
    a. Manufacturer's standard number the following:
        1) Analog inputs:
            a) Configurable as either 0 to 10 V or 4 to 20 mA.
        2) Analog outputs:
            a) Programmable 4 to 20 mA isolated.
        3) Discrete inputs:
            a) Programmable.
        4) Discrete outputs:
            a) Programmable.
            b) Form C relay contacts.
        5) Potentiometer 3-wire input.
    b. Provide additional inputs/outputs as required to meet the control functions indicated on the Drawings.
9. Automatic control:
    a. PID capability utilizing an internal or external setpoint:
        1) Selectable setpoint source.
10. Diagnostics:
    a. Store a minimum of 4 fault conditions in non-volatile memory on a first in/first out basis.
    b. Operational parameters stored at the time of the fault:
        1) Operating frequency.
        2) Drive status.
        3) Power mode.
    c. Fault memory accessible via RS-232, RS-422, or RS-485.
11. Automatic restart:
    a. User selectable automatic restart feature allowing the VFD to restart following a momentary power failure or other VFD fault:
        1) Programmable for up to 9 restart attempts.
        2) Adjustable time delay between restart attempts.

2.07 COMPONENTS

A. Enclosure:
    1. NEMA Type 12 or motor control center as indicated on the Drawings.
    2. Provide cooling devices required to maintain the VFD within the manufacturer's specified temperature limits for the Project conditions:
        a. Provide cooling device failure alarm.

B. Power disconnect:
    1. Flange-mounted thermal magnetic circuit breaker.
    2. Lockable in the OFF position.

C. Input reactor:
    1. Three percent input line reactor.

D. Output device:
    1. Three percent output load reactor.
    2. dV/dT filter:
        a. Common mode reduction: 30 percent minimum.

b. Motor terminal peak voltage limit: 150 percent of dc bus voltage with a motor lead length up to 1,000 feet.
c. Carrier frequency range: Up to 12 khz.
d. Efficiency: 98 percent minimum.
e. Class H insulation minimum.

E. Keypad:
1. Provide each VFD with a keypad for programming and control.
2. Keypad requirements:
a. Password security to protect drive parameters.
b. Mounted on the door of the VFD enclosure.
c. Back-lit LCD:
1) Minimum of 2 lines with a minimum of 16 characters per line.
d. Programming and display features language: English.
e. Capable of displaying the following parameters:
1) Speed (percent).
2) Output current (amperes).
3) Output frequency (hertz).
4) Input voltage.
5) Output voltage.
6) Total 3-phase kilowatt.
7) Kilowatt-hour meter.
8) Elapsed run time meter.
9) Revolutions per minute.
10) Direct current bus voltage.
3. In addition to keys required for programming, provide the following controls on the keypad:
a. Auto/manual selector.
b. Start pushbutton.
c. Stop pushbutton.
d. Jog pushbutton.
e. Speed increment.
f. Speed decrement.
g. Forward/reverse selector.
h. Run LED indicator.
i. Program LED indicator.
j. Fault LED indicator.
4. Provide the VFD with the hardwired controls as indicated on the Drawings.

F. Control power transformer:
1. Furnish a control power transformer mounted and wired inside the VFD enclosure.
2. With primary and secondary fusing.
3. Sized to power VFD controls and options as well as any external devices indicated on the Drawings including the motor winding heater.

2.08 ACCESSORIES

A. Metal oxide varistors:
1. Provide protection for the VFD against:
a. Line transients: 5,000-volt peak minimum.

b. Line to ground transients: 7,000-volt peak minimum.

B. Conformal coating:
1. Provide conformal coating material applied to electronic circuitry and printed circuit boards to act as a protection against moisture, dust, temperature extremes, and chemicals such as H_2S and chlorine.

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Enclosure finish shall be manufacturer's standard gray.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION

A. Anchoring and bracing to structures:
1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
2. Install anchors of type and material indicated on approved anchoring designs.
3. Install anchors with embedment indicated on approved anchoring designs.

3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
1. Furnish cables, conduit, lugs, bolts, and other accessories needed to complete the installation of the VFD (free-standing or within motor control center).
2. Assemble and install the VFD in the locations and with the layouts indicated on the Drawings.
3. Perform work in accordance with manufacturer's instructions and Shop Drawings.
4. Furnish components and equipment as required to complete the installation.
5. Replace any hardware lost or damaged during the installation or handling to provide a complete installation.
6. Install free-standing enclosures on a raised concrete housekeeping pad:
a. Provide structural leveling channels in accordance with the manufacturer's recommendations to provide proper alignment of the units.
b. Weld and/or bolt the VFD frame to the leveling channels.
7. Provide openings in top or bottom of the VFD (free-standing or within motor control center) enclosure for conduit only, no additional openings will be allowed:
a. Improperly cut holes will require that the entire panel be replaced:
1) No hole closers or patches will be allowed.
8. Bundle circuits together and terminate in each unit:
a. Tie with nylon wire ties.

b. Label wires at each end with wire numbers shown on the approved control drawings.
c. Connections to and from the VFD (free-standing or within motor control center) enclosure must be made via terminal blocks.

3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Source Testing (Factory Acceptance Tests):
1. Not witnessed.
2. General:
a. Incoming inspection of components and raw materials based on strategic supplier base and experience.
b. VFDs furnished under this Section shall be tested and inspected as specified below. Testing of VFDs based on sampling plans is not allowed.
c. Testing procedures specified are the minimum acceptable requirements. Manufacturer may perform additional tests at its discretion.
3. Failure of any component during testing requires repair of the faulted component and complete retest.
4. Perform manufacturer's standard factory acceptance tests.
5. Furnish test reports and Manufacturer’s Certificate of Source Testing.

C. Installation Verification:
1. Furnish Manufacturer’s Certificate of Installation Verification.

D. Functional Testing:
1. As specified in Section 16950 - Field Electrical Acceptance Tests.

E. Owner Training:
1. Not required.

3.05 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Provide the services of a VFD manufacturer representative for startup assistance and training:
1. Inspection and field adjustment:
a. Supervise the following and submit written certification that the equipment and controls have been properly installed, aligned, adjusted, and readied for operation.
2. Startup field testing:
a. Provide technical direction for testing, checkout, and startup of the VFD equipment in the field.
b. Under no circumstances are any portions of the drive system to be energized without authorization from the manufacturer's representative.

3.06 ADJUSTING

A. Make adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

B. Provide the services of a VFD manufacturer factory technician to make drive parameters and protective device settings:
   1. Protective device settings provided by the VFD manufacturer in accordance with the manufacturer of the driven equipment requirements.
   2. Provide documentation of VFD settings, including, but not limited to:
      a. Minimum speed.
      b. Maximum speed.
      c. Skip speeds.
      d. Current limit.
      e. Acceleration time.
      f. Deceleration time.

END OF SECTION

SECTION 16265

REDUCED HARMONIC VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Reduced harmonic 18 pulse or active front end, variable frequency drives (VFD), 60 to 500 hp for control of standard NEMA Design B squirrel cage induction motors.

1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

B. Underwriters' Laboratories, Inc. (UL):
   1. 508A - Standard for Safety for Industrial Control Panels.
   2. 61800-5-1 - Standard for Adjustable Speed Electrical Power Drive Systems.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. AFE: Active Front End.
   2. IGBT: Insulated Gate Bipolar Transistor.
   3. VFD: Variable Frequency Drive.

1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures:
   1. Custom prepared by the VFD manufacturer and specific for the equipment furnished.

B. Product data:
   1. Manufacturer of the VFD.
   2. Manufacturer of all components of the VFD.
   3. Dimensions:
      a. Height.
      b. Width.
      c. Depth.
   4. Weight.

5. Nameplate schedule.
6. Bill of material.
7. Ratings:
    a. Voltage.
    b. Phase.
    c. Input current.
    d. Output current.
    e. Interrupting rating.
    f. Momentary current rating.
8. Catalog cutsheets for major components.
9. Surge protection data.
10. Design data:
    a. Efficiency and power factor values.
    b. Certification that the drive is sized for the full nameplate motor hp and current (at rated RPM) of the driven load at the installed altitude.
    c. Certification that based upon VFD design, cable length to motor, and motor dielectric insulation level that the VFD will not damage motor insulation due to carrier frequency, reflected wave, dv/dt, or other VFD produced characteristics.
    d. Certification that electronic circuits and printed circuit boards are conformably coated.
    e. Certification that the VFD will operate with all power sources (including alternate utilities and on-site generation when applicable).
11. List of recommended spare parts.
12. For equipment installed in structures designated as seismic design category C, D, E, or F, submit the following as specified in Section 01850 - Design Criteria:
    a. Manufacturer's statement of seismic qualification with substantiating test data.
    b. Manufacturer's special seismic certification with substantiating test data.

C. Shop Drawings:
1. Complete plan and elevation drawings showing:
    a. All dimensions.
    b. Panel, sub-panel and component layout indexed to the bill of material.
    c. Conduit connections.
    d. Required clearance around equipment.
2. Block diagram showing the basic control and protection systems identifying the protection, control, trip and alarm functions, the reference signals and commands and the auxiliary devices.
3. Complete schematic, wiring and interconnection diagrams showing connections to both internal and external devices:
    a. Wiring diagrams shall include terminal number and wire numbers.
4. Complete 1-line and 3-line diagrams, including, but not limited to, circuit breakers, motor circuit protectors, contactors, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete system:
    a. Device electrical ratings shall be clearly indicated on the Drawings.

D. Delegated Design Submittals:
    1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
        a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
        b. For equipment installed outdoors.

E. Installation instructions:
    1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
    2. Provide manufacturer's installation instructions.

F. Commissioning Submittals:
    1. As specified in Section 01756 - Commissioning, including the following:
        a. Manufacturer's representative qualifications.
        b. Certificates:
            1) Requirements as specified in this Section.
        c. Test Plans:
            1) Test requirements as specified in this Section.
        d. Test Reports.
        e. Manufacturer's representatives field notes and data.
        f. Owner Training.

G. Certifications:
    1. Certification letter from the VFD manufacturer stating that the VFD(s) are capable of operating with new and existing sources (utility sources and on-site generation in possible operating configurations).
    2. Certification letter from the VFD manufacturer stating that the VFD(s) are capable of operating with new and existing VFDs in the existing and new distribution system.

H. Installation instructions:
    1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
    2. Provide manufacturer's installation instructions.

I. Calculations:
    1. Harmonic study:
        a. Perform a preliminary harmonic analysis:
            1) Measure conductor lengths and obtain other information required for the analysis from Drawings.
            2) A power system short circuit ratio of 20 shall be used.
            3) VFDs shall be assumed to be operating at maximum speed and maximum load.
            4) Short circuit current (ISC) utilized for the harmonic analysis calculations is defined as:
                a) ISC = 20 * (Sum Total Full Load Amps of all VFDs).

b. A separate harmonic analysis shall be performed based on the standby generator system:
    1) Coordinate with the generator manufacturer and the VFD manufacturer so the actual characteristics for the generator supplied, for this Project are used in the harmonic analysis.
    2) Verify the characteristics of the existing generator and coordinate with the VFD manufacturer.

2. Detailed calculations or details of the actual physical testing performed on the VFD to prove the VFD is suitable for the seismic conditions at the Project Site.

J. Test forms and reports:
1. Submit complete factory acceptance test procedures and forms used during the test.
    a. For VFD units less than 250 hp, provide certified test results for the actual VFD being furnished or prototype units. For VFD units 250 hp and larger, provide certified test results for the actual VFD being furnished.
    b. Provide the following certified test reports:
        1) Efficiency at rated power output and output frequency of 60 hertz.
        2) Power factor at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent speed.
        3) Harmonics at the input terminals of the VFD at 100 percent speed and 100 percent load:
            a) Voltage distortion: Measure individual harmonics up to and including the 50th harmonic and total harmonic distortion.
            b) Current distortion: Measure individual harmonics up to and including the 50th harmonic and total demand distortion.
2. Submit complete field acceptance test procedures and forms used during the test:
    a. Testing performed by independent organization as specified in Section 16950 - Field Electrical Acceptance Tests.

K. Record documents:
1. Certified record documents of equipment with information listed above.

L. Manufacturer’s field reports:
1. Certification letter from the VFD manufacturer that the VFD(s) has been inspected and installed in accordance with the manufacturer’s requirements.
2. Report listing the setting of VFD adjustable parameters and their values after start-up.
3. Certification letter from the VFD manufacturer stating that the VFD(s) are programmed to avoid system resonances when connected to the standby generator and will not conflict with generator system voltage regulator.

M. Operation and maintenance manuals:
1. Spare parts list with supplier names and part numbers.
2. Start-up and commissioning instructions and data.
3. Complete bill of material indexed to the Drawings, identifying the catalog or part numbers, manufacturer, and quantities of components of the VFD system.

4. Operating manuals:
    a. Submit operating instructions and a maintenance manual presenting full details for care and maintenance of each model of VFD provided under this Contract.
5. Operating instructions:
    a. Written descriptions shall detail the operational functions of controls on the front panel including keypad functions and parameters.
6. Maintenance manual:
    a. Furnish maintenance manuals with instructions covering details pertaining to care and maintenance of equipment, as well as identifying all parts.
    b. Manuals shall include, but are not limited to, the following:
        1) Adjustment and test instructions covering the steps involved in the initial test, adjustment and start-up procedures.
        2) Detailed control instructions that outline the purpose and operation of every control device used in normal operation.
        3) Schematic wiring and external diagrams:
            a) Furnish Drawings in a fully legible reduced 11-inch by 17-inch format.

1.06 QUALITY ASSURANCE

A. Qualifications:
    1. Any third-party certification, safety or protection requirements shall be applied to the VFD system as a whole. Certification or protection of system elements or individual components by themselves is not acceptable.
    2. VFDs shall be UL 61800-5-1 listed and labeled.
    3. VFD systems (packaged VFD panels) shall be UL 508A listed and labeled.
    4. VFDs shall be manufactured by the VFD manufacturer at its own facility, which shall have a quality assurance program that is certified in accordance with ISO 9001.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Ship VFDs to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize on site off-loading equipment:
    1. VFDs shall be delivered to the site pre-assembled and wired.
    2. Ship each VFD with 2 tamperproof accelerometers that record the maximum shock and vibration experienced by the VFD during shipping and handling.

B. Furnish temporary equipment heaters within the VFD to prevent condensation from forming.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.09 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
    1. Conduct factory acceptance test and submit certified test results for Engineer’s review.

2. Ship equipment to Project Site after successful completion of factory acceptance test.
3. Assemble equipment in the field.
4. Conduct field acceptance tests including harmonic testing and submit results for Engineer's review:
    a. Utility power sources and on-site generation shall be installed and operable for field test.
5. Submit manufacturer's certification that equipment has been properly installed and is fully functional for Engineer's review.
6. Conduct Owner's training sessions.
7. Commissioning and process start-up as specified in Section 01756 - Commissioning.

1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

1.11 SYSTEM START-UP

A. VFD manufacturer shall be responsible for start-up of the VFDs in the presence of the equipment suppliers, Contractor, Engineer, and Owner.

1.12 MAINTENANCE

A. Maintenance service: Manufacturer shall describe the field service system available to support the proposed VFD system. As a minimum describe:
    1. Type of technical support available (e.g., system engineer and technician).
    2. Location of field service personnel.
    3. Field service daily rates in dollars per hour and dollars per day.
    4. Guaranteed response times to service requests.

B. Spare parts:
    1. The following spare parts shall be furnished:
        a. 1 spare fan for each VFD unit.
        b. 2 sets of ventilation filters for each VFD unit (if applicable in VFD cabinet louvers).
        c. Any special dedicated tools for emergency service and troubleshooting.
        d. Hardware and software required for configuration, maintenance, troubleshooting and inquiry of drive parameters.

PART 2 PRODUCTS

2.01 GENERAL (NOT USED)

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria, and as indicated on the Drawings.

B. Non-conditioned spaces:
   1. For equipment located in non-conditioned spaces, provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.

C. Outdoor installations:
   1. Provide conditioning equipment incorporated into the equipment to maintain the enclosures within the equipment manufacturer's specified operating ranges.

D. Design requirements:
   1. Each VFD system shall consist of all components required to meet the performance, protection, safety, testing and certification criteria of this Section.
   2. VFD system:
      a. Is a fully integrated package.
      b. Includes material necessary to interconnect VFD system elements, even if shipped separately.
   3. Any modifications to a standard product necessary to meet this Section shall be made only by the VFD manufacturer.
   4. Each VFD shall be completely factory pre-wired, assembled and then tested as a complete package by the VFD manufacturer to ensure a properly coordinated, fully integrated drive system.
   5. VFD shall be capable of operating standard NEMA Design B motors. It is the responsibility of the VFD manufacturer to ensure that the drive will not damage motor insulation due to high carrier frequency, reflected wave, dv/dt or other drive electrical characteristics:
      a. VFD manufacturer shall furnish equipment necessary to mitigate potential damage to motor insulation.
      b. Coordinate bearing protection methods with the supplier of the driven equipment.
      c. Motors as specified in Section 16222 - Low Voltage Motors up to 500 Horsepower.

E. Performance:
   1. Operating envelope:
      a. Speed and torque requirements:
         1) Provide a variable torque or constant torque VFD as required by the driven load.
         2) VFD shall be capable of producing a variable alternating voltage/frequency output to provide continuous operation over the 40 to 110 percent (25 to 66 hertz) speed range.
      b. Current requirements:
         1) Provide 100 percent of rated output current on a continuous basis.
         2) Variable torque VFD:
            a) Minimum 110 percent current overload for 1 minute.
         3) Constant torque VFD:
            a) Minimum 150 percent current overload for 1 minute.

2. Harmonics:
    a. VFD shall meet the following distortion limits at 2 percent line voltage unbalance measured at the input terminals of the VFD:
        1) Voltage harmonics: Maximum allowable total harmonic distortion, THD, for each VFD shall not exceed 5 percent.
        2) Current harmonics: Maximum allowable total harmonic current distortion limit, TDD, for each VFD shall not exceed 5 percent as measured at the input terminals of the VFD system.
3. Efficiency:
    a. VFD system minimum efficiency shall be 93 percent at rated kilowatt output of the VFD. VFD system efficiency shall be calculated as follows:

$$Efficiency\ (\%) = \frac{Power\ (Load)}{Power\ (Supply)}\ X\ 100$$

    b. Power:
        1) Load power is the total 3-phase power measured at the output terminals of the drive system, including the output filter.
        2) Supply power is the total power measured at the input terminals of the VFD including phase shifting transformer or active front end components and auxiliary equipment (e.g., controls, fans) for complete system operation.
4. Total power factor:
    a. Minimum of 0.96 lagging across the entire speed range.
    b. Under no operating conditions shall the VFD have a leading power factor.
5. Frequency accuracy:
    a. Minimum of within 0.01 percent.
6. Speed regulation:
    a. Minimum of within 0.5 percent across the entire speed range.
7. Capable of working with all available power sources (utility and on-site generation) and with all new and existing VFDs.

2.03 MANUFACTURERS

A. One of the following or equal:
    1. ABB.
    2. Allen-Bradley.
    3. Danfoss VLT/Vacon.
    4. Eaton.
    5. Schneider-Electric.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT

A. General:
    1. Sinusoidal pulse width modulated, (PWM), voltage source type drive shall consist of the following:
        a. Rectifier section.
        b. Direct current link with capacitors.

c. Insulated gate bipolar transistor (IGBT), inverter section.
d. Microprocessor based controls.
e. Output filter.

2. Rectifier section:
   a. Provide VFDs with either an 18-pulse rectifier section or an active front end:
   b. 18-pulse rectifier:
      1) Integral phase shifting autotransformer:
         a) Converts 3-phase utility power to 3 sets of 3 power circuits with each set phase shifted and powering its own 3-phase bridge rectifier.
      2) Minimum 18-pulse diode rectifier section consisting of three 3-phase bridge rectifiers:
         a) Specifically designed as a system to share currents between the bridges to within 1 percent.
   c. Active front end rectifier:
      1) IGBT based converter module:
         a) 6 IGBTs minimum.
      2) Inductor/capacitor/inductor, LCL, harmonic filter:
         a) Low pass filter.
         b) Filter shall be disconnected from the line when the VFD is not running or powered off.
         c) Installed within same enclosure as VFD.
   d. 6-pulse rectifiers with harmonic filters are not allowed.

B. Ratings:
   1. Voltage:
      a. Input voltage: 480 Volts plus or minus 10 percent, 3-phase, 3-wire, 60 hertz.
      b. Solidly grounded.
   2. Short-circuit rating:
      a. 65 kA RMS symmetrical.

C. Operational features:
   1. Protective features:
      a. Annunciated at the keypad and available via network connection.
      b. Include the following protective features:
         1) Motor overload protection.
         2) Instantaneous overcurrent.
         3) Instantaneous overvoltage.
         4) Undervoltage.
         5) Power unit overtemperature.
         6) Phase loss.
         7) VFD output short circuit.
         8) VFD output ground fault.
         9) Blown fuse with blown fuse indication.
         10) IGBT protection.
         11) Cooling fan failure.
         12) Component failure.
   2. Control mode:
      a. VFD shall operate in either a constant volts/hertz or sensorless vector mode. Selectable using the programming keypad.

3. Frequency control:
    a. Minimum of 3 selectable skip frequencies with adjustable bandwidths.
    b. Programmable minimum frequency.
    c. Programmable maximum frequency.
4. Acceleration/Deceleration:
    a. Separately adjustable acceleration and deceleration rates.
    b. Each rate shall be adjustable from 0.01 to 1,800 seconds.
5. Spinning load:
    a. Capable of determining the speed and direction of a spinning load, “catch” the load and accelerate or decelerate it without damage to the load.
6. Programmable loss of signal:
    a. Upon loss of reference speed signal the VFD shall be programmable to either stop, maintain current speed, or default to preselected speed.
7. Power interrupt ride through:
    a. Capable of continuous operation in the event of a power loss of 5 cycles or less.
8. Hardwired inputs and outputs:
    a. Manufacturer’s standard number the following:
        1) Analog inputs:
            a) Configurable as either 0 to 10 volts or 4 to 20 mA.
        2) Analog outputs:
            a) Programmable 4 to 20 mA isolated.
        3) Discrete inputs:
            a) Programmable.
        4) Discrete outputs:
            a) Programmable.
            b) Form C relay contacts.
        5) Potentiometer 3-wire input.
    b. Provide additional inputs and outputs as required to meet the control functions indicated on the Drawings.
9. Real-time clock:
    a. Capable of providing time-stamped events.
    b. Set locally or via a remote controller.
    c. Programmable for day, month, year, local time zones in hours, minutes and seconds.
10. Diagnostics:
    a. Minimum of 4 fault conditions in memory on a first in - first out basis.
    b. Time stamped.
    c. Operating frequency, drive status and power mode shall also be stored at the time of the fault.
    d. Fault memory shall be maintained in the event of a power outage.
    e. Fault memory shall be accessible via RS-232, RS-422, RS-485, or USB.
11. Automatic restart:
    a. User selectable, automatic restart feature allowing the VFD to restart following a momentary power failure or other VFD fault:
        1) Programmable for up to 9 automatic restart attempts with an adjustable time delay between restart attempts.

2.07 COMPONENTS

A. Enclosure:
   1. NEMA Type 12.
   2. Provide cooling devices required to maintain the VFD within the manufacturer's specified temperature limits for the Project conditions:
      a. Provide cooling device alarm.

B. Power disconnect:
   1. Flange mounted thermal magnetic circuit breaker:
      a. Lockable in the OFF position.

C. Phase shifting transformer for 18-pulse VFDs:
   1. Auto-transformer.
   2. Integral part of the VFD assembly and factory mounted and wired within the VFD enclosure.
   3. Embedded thermal protection.
   4. Rated for rectifier duty.
   5. Copper or aluminum windings with 180-degree Celsius insulation.

D. Output filter:
   1. dv/dt filter:
      a. Common mode reduction: 30 percent minimum.
      b. Motor terminal peak voltage limit: 150 percent of dc bus voltage with a motor lead length up to 1,000 feet.
      c. Carrier frequency range: Up to 12 KHz.
      d. Efficiency: 98 percent minimum.
      e. Class H insulation minimum.

E. Keypad:
   1. Furnished with a keypad for programming and control.
   2. Password security to protect drive parameters.
   3. Mounted on the door of the VFD.
   4. Back-lit LCD with a minimum of 2 lines of a minimum of 16 characters each.
   5. Programming and display features language: English.
   6. Capable of displaying the following parameters:
      a. Speed (percent).
      b. Input current (amperes).
      c. Output current (amperes).
      d. Output frequency (hertz).
      e. Input voltage.
      f. Output voltage.
      g. Total 3-phase kilowatt.
      h. Kilowatt hour meter.
      i. Elapsed run time meter.
      j. Revolutions per minute.
      k. Direct current bus voltage.
   7. In addition to keys required for programming, keypad shall have the following:
      a. Automatic/Manual selector.
      b. Start pushbutton.
      c. Stop pushbutton.

d. Jog pushbutton.
e. Speed increment.
f. Speed decrement.
g. Forward/Reverse selector.
h. RUN indicator.
i. PROGRAM indicator.
j. FAULT indicator.
k. DRIVE READY indicator.
l. Diagnostics.

8. Provide the VFD with the hardwired controls indicated on the Drawings.

F. Control power transformer:
1. Mounted and wired inside the drive enclosure:
a. Primary and secondary fusing.
2. Size transformer to supply power to all VFD controls and options as well as any external devices indicated on the Drawings including the motor winding heater.

G. Line side tuning for AFE VFDs:
1. Provide 2 sets of line side tuning parameters: One for the normal utility supply, another for the alternate (generator) supply.
2. Parameters shall be selectable via the communications network or a digital input from a contact closure at the automatic transfer equipment or PCIS.
3. When more than 1 generator source is used, VFD shall be capable of storing multiple generator profiles to use as the alternate supply based on command inputs.

2.08 ACCESSORIES

A. Surge protection:
1. Metal oxide varistors:
a. Provide protection for the VFD against:
1) Line transients: 5,000-volt peak minimum.
2) Line to ground transients: 7,000-volt peak minimum.

B. Conformal coating:
1. Provide conformal coating material applied to electronic circuitry and printed circuit boards to act as protection against moisture, dust, temperature extremes, and chemicals such as H_2S and chlorine.

C. Air filters:
1. Mounted on the outside of the VFD enclosure:
a. Replaceable without requiring that the VFD be turned off or the door opened.
2. Located on the front or top of the VFD enclosure:
a. Side or rear mounted air filters are not acceptable.

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Enclosure finish shall be manufacturer's standard gray.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
   1. Furnish cables, conduit, lugs, bolts, and other accessories needed to complete installation of the VFD (free-standing or within motor control center).
   2. Assemble and install the VFD in the locations and with the layouts indicated on the Drawings.
   3. Perform Work in accordance with the manufacturer's instructions and Shop Drawings.
   4. Furnish components and equipment as required to complete the installation.
   5. Replace any hardware lost or damaged during the installation or handling to provide a complete installation.
   6. Install free-standing enclosures on a raised concrete housekeeping pad:
      a. Provide structural leveling channels in accordance with the manufacturer's recommendations to provide proper alignment of the units.
      b. Weld and/or bolt the VFD frame to the leveling channels.
   7. Provide openings in top or bottom of the VFD (free-standing or within motor control center) enclosure for conduit only, no additional openings will be allowed:
      a. Improperly cut holes will require that the entire panel be replaced:
         1) No hole closers or patches will be allowed.
   8. Bundle circuits together and terminate in each unit:
      a. Tie with nylon wire ties. As specified in Section 16123 - 600-Volt or Less Wires and Cables.
      b. Label wires at each end with wire numbers shown on the approved Control Drawings.
      c. Connections to and from the VFD (free-standing or within motor control center) enclosure must be made via terminal blocks.

3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Source Testing:
   1. Not witnessed.
   2. VFDs furnished under this Section shall be tested and inspected as specified below.
   3. Testing procedures specified are the minimum acceptable requirements. Manufacturer may perform additional tests at its discretion.
   4. Failure of any component during testing requires replacement of the faulted component and a complete retest.
   5. Component tests:
      a. Preliminary inspection:
         1) Verify that components are correct.
         2) Verify that connections are properly torqued.
      b. Printed circuit boards:
         1) Test each printed circuit board in accordance with the manufacturer's standard testing procedure.
      c. Wiring:
         1) Control and power wiring continuity verified point-to-point.
         2) Hi-pot power and control wiring at manufacturer's recommended levels.
         3) Verify ground bond resistance.
      d. Load testing:
         1) No load testing in accordance with the manufacturer's standard factory test procedure.
         2) Full load testing:
            a) Test each VFD and all control logic with a representative motor or dynamometer load to simulate field operation conditions at 25 percent, 50 percent, and 100 percent full load current.
            b) Tests shall be conducted in a manner in which the inverter (IGBT) section supplies all the output power (kw) of the VFD system. Control strategies using a contactor or other means of bypassing the VFD when operating at the line frequency shall not be permitted.
            c) Tests shall be conducted using a minimum output frequency of 60 hertz, and a minimum switching frequency of 2.5 kHz.
   6. Furnish test reports and Manufacturer's Certificate of Source Testing.

C. Installation Verification:
   1. Furnish Manufacturer's Certificate of Installation Verification.

D. Functional Testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

E. Owner Training:
   1. Perform Owner Training as specified in Section 01756 - Commissioning.
   2. Number of sessions:
      a. Operations: 1.
      b. Maintenance: 1.

3.05 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Provide the services of a VFD manufacturer representative for start-up assistance and training:
   1. Inspection and field adjustment:
      a. Supervise the equipment installation and confirm controls have been properly installed, aligned, adjusted, and readied for operation.
      b. Configure AFE drives for new and existing sources (utility sources and on-site generation in possible operating configurations).
   2. Start-up field testing:
      a. Provide technical direction for testing, checkout, and startup of the VFD equipment in the field.
      b. Under no circumstances are any portions of the drive system to be energized without authorization from the manufacturer's representative.
      c. Compliance with the following specified parameters shall be verified by the VFD manufacturer:
         1) Motor terminal voltage:
            a) Make field measurements at the motor connection box.
            b) Make measurements of the full speed range of the VFD.
            c) Make measurements with a recording type oscilloscope.
         2) Harmonics:
            a) Make field measurements at the input terminals of the VFD with and without the VFD in operation.
            b) Harmonic testing shall include utility power as well as generator standby power.
            c) Make measurements with a recording type harmonic analyzer displaying individual and total harmonic currents and voltages:
               (1) Record currents and voltages for a minimum of 10 minutes.
               (2) Analyzers using snapshots are not acceptable.
      d. Utility sources and on-site generation shall be operational for start-up field testing.

3.06 ADJUSTING

A. Make adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

B. Provide the services of a VFD manufacturer factory technician to make drive parameter and protective device settings:
   1. Protective device settings provided by the VFD manufacturer in accordance with the manufacturer of the driven equipment requirements.
   2. Provide documentation of VFD settings, including, but not limited to:
      a. Minimum speed.
      b. Maximum speed.
      c. Skip speeds.
      d. Current limit.
      e. Acceleration time.
      f. Deceleration time.
      g. Carrier frequency.

END OF SECTION

SECTION 16272

DRY-TYPE TRANSFORMERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Enclosed dry-type transformers:
      a. Rated 1 to 1,000 kilovolt-amperes, single and 3-phase.
      b. Primary voltage 600 volts and below.

1.02 REFERENCES

A. Standards:
   1. Institute of Electrical and Electronics Engineers (IEEE):
      a. 389 - IEEE Recommended Practice for Testing Electronics Transformers and Inductors.
      b. C57.96 - IEEE Guide for Loading Dry-Type Distribution and Power Transformers.
   2. Underwriters Laboratory (UL):
      a. 1561 - Standard for Dry-Type General Purpose and Power Transformers.
   3. United States Department of Energy (DOE):
      a. 10 CFR Part 431 - Energy Efficiency Program for Certain Commercial and Industrial Equipment.

1.03 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

1.04 SUBMITTALS

A. Furnish submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Catalog cutsheets.
   2. Nameplate data.
   3. Dimensions:
      a. Height.
      b. Width.
      c. Depth.
   4. Inrush current.
   5. Insulation system and temperature constraints.
   6. Number and rating of taps.
   7. Sound levels.

8. Connection diagrams:
    a. Primary.
    b. Secondary.
9. BIL rating.
10. Required clearances.
11. Percent impedance.
12. Efficiency.
13. Certification of full capacity capability at the Project elevation and ambient conditions.
14. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 01850 - Design Criteria:
    a. Manufacturer's statement of seismic qualification with substantiating test data.
    b. Manufacturer's special seismic certification with substantiating test data.

C. Delegated design submittals:
1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
    a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
    b. For equipment installed outdoors.

D. Installation instructions:
1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
2. Provide manufacturer's installation instructions.

E. Commissioning submittals:
1. As specified in Section 01756 - Commissioning, including the following:
    a. Certificates:
        1) Requirements as specified in this Section.
    b. Test Plans:
        1) Test requirements as specified in this Section.
    c. Test Reports.

1.05 QUALITY ASSURANCE (NOT USED)

1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)

1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL (NOT USED)

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria and as indicated on the Drawings.

B. Provide 3-phase or 1-phase, 60 hertz dry-type with voltage ratings, kilovolt-ampere capacities, and connections as indicated on the Drawings:
   1. Transformers shall provide full capacity at the Project elevation and environmental conditions as specified in Section 01850 - Design Criteria after all derating factors have been applied.
   2. Suitable for continuous operation at full rating with normal life expectancy in accordance with IEEE C57.96.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. ABB.
   2. Eaton.
   3. Jefferson.
   4. Schneider Electric.

2.04 MATERIALS

A. Cores:
   1. Non-aging, grain-oriented silicon steel.
   2. Magnetic flux densities below the saturation point.

B. Windings:
   1. High-grade magnet wire.
   2. Impregnated assembly with non-hydroscopic, thermo-setting varnish:
      a. Cured to reduce hot-spots and seal out moisture.
   3. Material electrical grade:
      a. Copper.

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT

A. General:
   1. 10 kilovolts BIL for 600-volt class windings.
   2. Sound levels, in accordance with IEEE 389 test conditions, not to exceed:

Kilovolt-Amperes Range	Audible Sound Level (dB)
1-9	40
10-50	45

Kilovolt-Amperes Range	Audible Sound Level (dB)
51-150	50
151-300	55
301-500	60
501-700	62
701-1,000	64

3. Taps:
   a. 15 kilovolt-amperes and less:
      1) Two 5 percent full capacity primary taps below rated voltage.
   b. 25 kilovolt-amperes and larger:
      1) Four 2.5 percent full capacity primary taps below rated voltage.
      2) Two 2.5 percent full capacity primary taps above rated voltage.
   c. Operated by a tap changer handle or tap jumpers accessible through a panel.
4. Terminals:
   a. UL listed for either copper or aluminum conductors.
   b. Rated for 75 degrees Celsius.
5. Daily overload capacities, at rated voltage and without reduction in life, in accordance with IEEE C57.96.

B. Transformers less than 15 kilovolt-amperes:
   1. Insulation class: 185 degrees Celsius.
   2. Temperature rise: 115 degrees Celsius.

C. Energy efficient transformers 15 kilovolt-amperes and larger:
   1. Insulation class: 220 degrees Celsius.
   2. Temperature rise: 80 degrees Celsius, except as noted below:
      a. 150-degree Celsius rise for dry-type transformers located in motor control centers.
   3. Efficiency:
      a. In accordance with DOE 10 CFR Part 431.

D. Enclosures:
   1. Heavy gauge steel:
      a. Outdoor: Moisture and water resistant with rodent screens over all openings and in a weather-protected enclosure, NEMA Type 3R.
      b. Indoor: NEMA Type 2.
   2. Louvers to limit coil temperature rise to the value stated above, and case temperature rise to 50 degrees Celsius.
   3. Built-in vibration dampeners to isolate the core and coils from the enclosure:
      a. Neoprene vibration pads and sleeves.

2.07 COMPONENTS (NOT USED)

2.08 ACCESSORIES

A. Nameplates:
   1. Non-corrosive metal or UL listed non-metallic:
      a. Stamped, engraved or printed with the following information:
         1) Phases.
         2) Frequency.
         3) Kilovolt-ampere rating.
         4) Voltage ratings.
         5) Temperature rise.
         6) Impedance.
         7) Insulation class.
         8) BIL rating.
         9) Connection diagram.
         10) Weight.
         11) Manufacturer.
         12) The identification “transformer”.
         13) Classes of cooling.
         14) Tap voltage(s).
         15) Vector diagram.

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Finish to consist of de-greasing, phosphate cleaning, and an electrodeposited manufacturer’s standard gray enamel rust-inhibiting paint.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
   1. Mounted as indicated on the Drawings.
   2. Install where not in direct contact with building structure.

3. Install on single layer vibration pad under the entire mounting surface:
    a. Manufacturers: The following or equal:
        1) Korfund.
4. Make any necessary connections to the enclosure with liquidtight flexible conduit having neoprene gaskets and insulated ground bushings.
5. Ground the enclosure:
    a. To an equipment ground conductor in the conduit.
    b. To the facility grounding electrode system.
6. Floor mounted transformers:
    a. Install transformers on a housekeeping pad.
    b. Install transformers with adequate space from walls or other enclosures for proper ventilation in accordance with the manufacturer's recommendations.

3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Factory Tests:
1. Applied voltage test to each winding and from each winding to the core:
    a. 600-volt class winding 4.5 kilovolt.
2. Induced voltage test at 2 times normal voltage and 400 hertz for 1,080 cycles.
3. Voltage ratio and polarity.
4. Sound level, performed in a test room with ambient sound level not exceeding 24 dB.
5. Perform all tests in accordance with UL 1561.
6. Furnish test reports and Manufacturer's Certificate of Source Testing.

C. Functional Testing:
1. As specified in Section 16950 - Field Electrical Acceptance Tests.

3.05 FIELD QUALITY CONTROL (NOT USED)

3.06 ADJUSTING

A. Set the transformer taps as required to obtain nominal output voltage on the secondary terminals.

END OF SECTION

SECTION 16273

LIQUID FILLED PAD MOUNTED TRANSFORMERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Medium voltage, outdoor, liquid-filled pad mounted transformers.

1.02 REFERENCES

A. American National Standards Institute (ANSI).

B. ASTM International (ASTM).

C. Institute of Electrical and Electronic Engineers (IEEE):
   1. C57.12.00 - IEEE Standard General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers.
   2. C57.12.10 - IEEE Standard Requirements for Liquid-Immersed Power Transformers.
   3. C57.12.26 - IEEE Standard for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers.
   4. C57.12.28 - IEEE Standard for Pad-Mounted Equipment-Enclosure Integrity.
   5. C57.12.90 - IEEE Standard Test Code for Liquid-Immersed Distribution, Power and Regulating Transformers.
   6. C57.91 - IEEE Guide for Loading Mineral-Oil-Immersed Power Transformers up to and including 100 MVA with 65 degrees or 55 degrees Average Winding Rise.
   7. C57.93 - IEEE Guide for Installation of Liquid-immersed Power Transformers.
   8. C57.98 - IEEE Guide for Transformer Impulse Tests.
   9. C57.106 - IEEE Guide for Acceptance and Maintenance of Insulating Mineral Oil in Electrical Equipment.
   10. C57.147 - IEEE Guide for Acceptance and Maintenance of Natural Ester Fluids in Transformers.

D. National Electrical Manufacturers Association (NEMA):
   1. TR-1 - Transformers, Regulators, and Reactors.

E. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).

F. U.S. Department of Energy (DOE):
   1. 10 CFR Part 431 - Energy Efficiency Program for Certain Commercial and Industrial Equipment.

1.03 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Complete installation instructions.
   2. Complete storage and handling instructions.
   3. Kilovolt-ampere rating, including derating calculations.
   4. Primary/secondary connections.
   5. Primary voltage and available taps.
   6. Secondary voltage.
   7. BIL rating.
   8. Temperature rise.
   9. Lightning arrester data.
   10. %Z, %X, %R, X/R.
   11. Efficiency.
   12. Gross weight.
   13. Torque values for bolted connections for secondary cable connections.
   14. Manufacturer's suggested hi-potential test procedures and test levels for field testing:
      a. Initial field test.
      b. Subsequent maintenance tests.
   15. Certification from the manufacturer stating the transformer design complies with IEEE C57.12.00.
   16. Type of oil.
   17. Gallons of oil.
   18. Weight of oil.
   19. Complete MSDS sheets. There is no C57 standard for ANSI or IEEE.
   20. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 01850 - Design Criteria:
      a. Manufacturer's statement of seismic qualification with substantiating test data.
      b. Manufacturer's special seismic certification with substantiating test data.

C. Shop Drawings:
   1. Complete detailed, dimensioned drawings showing the equipment being furnished, with pertinent information, including the following:
      a. Dimensions and locations of conduit entrance windows.
   2. Complete nameplate schedule, except impedance.

D. Delegated Design Submittals:
    1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
        a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
        b. For equipment installed outdoors.

E. Installation instructions:
    1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
    2. Provide manufacturer's installation instructions.

F. Commissioning Submittals:
    1. As specified in Section 01756 - Commissioning, including the following:
        a. Manufacturer's representative qualifications:
        b. Certificates:
            1) Requirements as specified in this Section.
        c. Test Plans:
            1) Test requirements as specified in this Section.
        d. Test Reports.
        e. Manufacturer's representatives field notes and data.

G. Operation and maintenance manuals:
    1. As specified in Section 01782 - Operation and Maintenance Manuals.
    2. Complete as-built dimensioned and scaled drawings for transformer.
    3. Recommended periodic maintenance requirements.
    4. Maintenance instructions including schedules, parts identification, troubleshooting, assembly instructions, parts list, and predicted life of parts subject to wear and deterioration.
    5. Recommended field test levels and procedures before installation and for maintenance purposes after being placed in service.
    6. Periodic maintenance torque values for bolts.
    7. List of recommended maintenance tests, test frequencies, test procedures, acceptable test result ranges and disposal recommendations for natural ester fluids in accordance with IEEE C57.147.
    8. Copies of factory test reports.

H. Record documents.

I. Calculations:
    1. Detailed calculations or details of the actual physical testing performed on the transformer to prove the transformer is suitable for the seismic requirements at the Project Site.

1.05 QUALITY ASSURANCE

A. Manufacturer qualifications:
    1. Manufacturer shall be in the business of regularly manufacturing the specified transformer for a minimum of 10 years with a satisfactory performance record.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Ship transformers to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize onsite off-loading equipment:
   1. Each transformer shall be shipped with a global positioning system (GPS) unit to record the shipping route.
   2. Provide monitoring of the acceleration the transformer experiences during shipment:
      a. GPS unit can record the acceleration.
      b. Utilize a G-force gauge that indicates that the acceleration has exceeded allowed values.
   3. Transformers that experience vertical accelerations greater than 3 G or horizontal accelerations greater than 5 G shall not be accepted.

B. Furnish temporary equipment heaters within the transformer to prevent condensation from forming.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Make necessary field measurements to verify the equipment will fit in the allocated space in full compliance with the minimum clearances required by the NEC and local codes.
   2. Conduct factory acceptance test and submit certified test results for the Engineer’s review.
   3. Ship equipment to Project Site after successful completion of factory acceptance test.
   4. Assemble equipment in the field.
   5. Conduct field acceptance test and submit certified test results for the Engineer’s review.
   6. Verify installation is in accordance with IEEE C57.93.
   7. Submit manufacturer’s certification that equipment has been properly installed and is fully functional for the Engineer’s review.
   8. Set taps.
   9. Commissioning as specified in Section 01756 - Commissioning.

1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Outdoor oil-filled, pad mounted transformers for operation on a 60 hertz system with voltage and kilovolt-ampere ratings as indicated on the Drawings.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria and as indicated on the Drawings.

B. Pad mounted transformers shall be compartmental type, designed for outdoor installation on a concrete pad.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. Asea Brown Boveri (ABB).
   2. Eaton/Cooper Power Systems.
   3. Schneider Electric.

2.04 MATERIALS

A. Windings:
   1. Primary and secondary windings shall be high conductivity copper.

B. Insulating fluid:
   1. Envirotemp FR3.Insulating fluid shall meet or exceed the requirements of the appropriate IEEE and ASTM fluid standards.

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT

A. Transformer and associated terminal compartments designed and constructed to be tamper-resistant:
   1. No externally removable screws, bolts, or other devices.

B. Ratings:
   1. 3-phase, 60 hertz.
   2. Self-cooled.
   3. 65-degree Celsius rise.
   4. Primary voltage as indicated on the Drawings.
   5. Primary connection as indicated on the Drawings.
   6. Secondary voltage as indicated on the Drawings.
   7. Secondary connection as indicated on the Drawings.
   8. Kilovolt-ampere rating as indicated on the Drawings.
   9. Basic impulse insulation level (BIL) in accordance with IEEE C57.98:
      a. 1.2 kV Class: 30 kV.

b. 2.5 kV Class: 45 kV.
c. 5.0 kV Class: 75 kV.
d. 8.7 kV Class: 75 kV.
e. 15 kV Class: 95 kV.

10. Sound levels:
    a. In accordance with NEMA TR1.
    b. Measurement procedure in accordance with IEEE 57.12.90.
11. Efficiency:
    a. Transformers 2,500 kVA and less shall have an efficiency rating in accordance with DOE 10 CFR Part 431.
12. Short-circuit capacity:
    a. Mechanical short-circuit capability in accordance with IEEE C57.12.90.
13. Thermal short-circuit capability in accordance with IEEE C57.12.00.

2.07 COMPONENTS

A. Core and coil:
   1. Manufactured from burr-free, grain-oriented silicon steel laminations and stacked to eliminate gaps in the corner joints.
   2. Insulated with B-stage, epoxy coated, diamond pattern, insulating paper, thermally cured under pressure to ensure proper bonding of conductor and paper.
   3. Clamped and braced to resist distortion caused by short-circuit stresses within ratings or by shipping and handling and to prevent the shifting of core laminations.
   4. Vacuum processed to ensure maximum penetration of insulating fluid into the coil insulation system:
      a. Energize the windings under vacuum to heat the coils and drive out moisture.
      b. While under a vacuum and the coils are heated, fill the tank with preheated, filtered and degassed insulating fluid.

B. Tank:
   1. Conforming to the enclosure integrity requirements in accordance with IEEE C57.12.28.
   2. Equipped with extra-heavy duty, welded-in-place lifting lugs and jacking pads:
      a. Provide adequate cross-bracing of the base to allow skidding or rolling in any direction.
   3. Capable of withstanding a pressure of 7 pounds per square inch gauge without permanent distortion, and 15 pounds per square inch gauge without rupturing.
   4. Provide a pressure relief valve as a means to relieve pressure in excess of pressure resulting from normal operation:
      a. Cracking pressure: 10 pounds per square inch gauge within 2 psig.
      b. Resealing pressure: 6 pounds per square inch gauge minimum.
      c. Zero leakage from reseal pressure to 8 pounds per square inch gauge.
      d. Flow at 15 pounds per square inch gauge: 35 scfm minimum.

C. Terminal compartments:
   1. Conforming to the enclosure integrity requirements in accordance with IEEE C57.12.28.
   2. Full-height, air filled primary and secondary terminal compartments with hinged doors shall be located side-by-side separated by a steel barrier, with the primary compartment on the left, complete with tamper resistant hardware.
   3. Hinges and pins to be passivated Type 304 stainless steel or equivalent corrosion-resistant metal.
   4. Doors and compartment hood shall be removable:
      a. Removable doorsill on compartments shall be provided to permit rolling or skidding of unit into place over conduit stubs in foundations.
   5. Doors in both the high-voltage section and the low-voltage section shall be able to be latched in the open position.
   6. Entire terminal compartment for the transformer shall be bolted to the transformer so that the terminal compartment may be unbolted from the transformer and the transformer removed without disturbing conduits that enter the compartment from the side or top.
   7. Minimum of 30-inches deep.
   8. Secondary compartment:
      a. Enclose the secondary termination bushings and provide for incoming cable from below the compartment.
      b. Compartment shall also house:
         1) Liquid level indicator.
         2) Drain valve with sampling device.
         3) Dial type thermometer.
         4) Pressure relief valve.
         5) Vacuum pressure gauge.
      c. Door to low-voltage section shall have a 3-point latching mechanism with pad-locking provision.
   9. Primary compartment:
      a. Enclose the high voltage bushings and provide for incoming cables from below the compartment:
         1) Coordinate primary bushing size with incoming cables size as indicated on the Drawings.
      b. Compartment shall also house:
         1) Dead front lightning arresters.
         2) No-load tap changer.
         3) Primary ON-OFF switch.
      c. Accessible only after the door for the secondary compartment has been opened. Door shall be held closed by a captive bolt; access to this bolt shall be provided only when the door to the low-voltage section is opened.
   10. Primary terminals and parking stands:
      a. Dead front construction, in accordance with IEEE C57.12.26, utilizing high voltage elbows for connections to primary cable and lightning arresters.
      b. Terminal arrangement with 6-bushing wells:
         1) 3 for terminating primary power cables.
         2) 3 for connecting lightning arresters.
         3) 6 parking stands.

c. Supporting structure within cabinet to support cables and eliminate mechanical stress on insulators.
d. Where indicated on the Drawings, provide oil-immersed fuses in the primary circuit.

11. Secondary terminals:
    a. 4 low voltage spade bushings with 2 holes for each cable, in accordance with IEEE C57.12.26.
    b. Extend low voltage bushings as necessary to accommodate the cable arrangement indicated on the Drawings or indicated on the conduit schedule:
        1) Extension via a fully rated, tin-plated, copper bus system braced to withstand the available fault current.
    c. Neutral brought out through an insulated bushing and externally grounded to the tank with a removable ground strap.
    d. Supporting structure within cabinet to support cables and eliminate mechanical stress on insulators.

D. De-energized tap changer:
1. Furnish with full capacity high-voltage taps:
    a. Two 2-1/2 percent taps above and below rated voltage.
2. Labeled to indicate that the transformer must be de-energized before operating the tap changer as required by IEEE C57.12.10.
3. Externally operated no-load tap changer switch with snap action switch and lever handle.
4. Padlocking provision in each tap position.
5. Position indication.

2.08 ACCESSORIES

A. Lightning arresters:
1. High voltage dead front design for elbow connection.
2. Metal oxide varistor arresters.
3. Distribution class arresters.
4. Rating as indicated on the Drawings and/or consistent with the distribution voltage.

B. Tank ground pads:
1. 2 stainless steel pads, welded to the tank wall, with unpainted surfaces:
    a. One pad in primary compartment.
    b. One pad in secondary compartment:
        1) If additional load ground connections are required, a tin-plated, copper equipment ground bus shall be bolted to the pad.

C. Dial-type thermometer:
1. Direct stem mounted in a closed well so that the thermometer can be removed without breaking the tank seal:
    a. Well shall be threaded into a fitting that is welded to the transformer tank wall.
2. Thermometer shall have a marking hand which is moved by the indicating hand to indicate maximum oil temperature:
    a. Marking hand shall be externally resettable.

D. Sampling device:
   1. Provide for external sampling of the transformer insulating fluid.
   2. Threaded into a fitting that is welded to the transformer tank wall.
   3. Piped such that valve and sample point are external to the termination cabinet:
      a. NEMA Type 4X stainless steel box supported to transformer to house sample device.

E. Liquid level gauge:
   1. Dial-type liquid level gauge.

F. Vacuum pressure gauge:
   1. 10 pounds per square inch gauge vacuum to plus 10 pounds per square inch gauge scale.

G. Pressure relief device:
   1. Located in the air space in the transformer tank to provide a method of relieving internal tank pressure.
   2. Self-relieving.
   3. Indicating.
   4. Operating pressure: 10 within 2 pounds per square inch gauge.

H. Nameplates:
   1. Provide nameplate as specified in Section 16075 - Identification for Electrical Systems and the following:
      a. Provide complete nameplates identifying equipment, caution, voltage, etc.
      b. Provide complete nameplates for both inside and outside of the transformer terminal compartments.
      c. Provide diagrammatic nameplate.

I. Bolted 8-inch (minimum) diameter round handhold on cover.

J. Lifting lugs at each corner of tank for lifting complete transformer.

K. Jacking facilities at each corner of base for jacking the complete transformer.

L. Base designed for rolling or skidding in any direction.

M. Bayonet-type fuse:
   1. Oil immersed expulsion type fuse with an interrupting rating of 3,800 A at 8.3 kV; 2,000 A at 15.5 kV.
   2. Hook stick-operable.
   3. Drawout.
   4. Load break design.
   5. 2 types of fuse links:
      a. Overload sensing; or
      b. Fault sensing.

N. Current limiting fuses:
   1. Submersible rated for oil immersion and series rated for use in series with the manufacturer's selected bayonet fuse and to limit transformer primary short circuit current to 5,000 amps.

2.09 FABRICATION

A. Tanks:
   1. Construction: Sealed tank construction with welded cover. Permanently locate an inorganic gasket between the cover and the tank flange during the welding of the transformer cover to prevent the entrance of weld spatter into the tank.
   2. Large handhole with bolted cover and protected with a weather cover.
   3. Four lifting hooks.
   4. Jacking pads.
   5. Fluid sample valve.
   6. Designed for 7 pounds per square inch gauge without permanent distortion; 12 pounds per square inch gauge when silicone oil insulating fluid is specified.

2.10 FINISHES

A. In accordance with IEEE C57.12.28 including the following performance requirements:
   1. Salt spray test.
   2. Crosshatch adhesion test.
   3. Humidity test.
   4. Impact test.
   5. Oil resistance test.
   6. Ultraviolet accelerated weathering test.
   7. Abrasion resistance: Taber® Abraser.

B. Procedure:
   1. Clean with an alkaline cleaning agent to remove grease and oil.
   2. Chemically bond iron phosphate coating to metal surface to ensure coating adhesion and retard corrosion.
   3. Prime metal surface with an electrodeposited powder epoxy to provide a barrier against moisture, salt, and corrosives.
   4. Coat with an electrostatically applied, oven-cured polyester powder coat to enhance abrasion and impact resistance.
   5. Topcoat: Liquid polyurethane coating to seal and add ultraviolet protection:
      a. Color: Munsell Green 7GY.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
   1. Furnish concrete pad and lugs, bolts, and other accessories needed to complete the installation of the transformer.
   2. Assemble and install the transformer in the location and layout indicated on the Drawings.
   3. Perform Work in accordance with manufacturer's instructions and Shop Drawings.
   4. Raise the tank above the pad to protect the bottom finish during installation and to minimize corrosion due to moisture accumulation.
   5. Furnish components and equipment as required to complete the installation.
   6. Replace any hardware lost or damaged during installation or handling.
   7. Position the transformer so required working space and clearance requirements of the NEC and the local building authorities are met.

3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Source Testing:
   1. Perform the following factory tests as required by IEEE C57.12.00 and in accordance with IEEE C57.12.90:
      a. No-load (85 degrees Celsius) losses at rated current. (Maximum allowable no-load losses: 10 percent).
      b. Total (85 degrees Celsius) losses at rated current. (Maximum allowable total losses: 6 percent).
      c. Percent impedance (85 degrees Celsius) at rated current.
      d. Excitation current (100 percent voltage) test.
      e. Winding resistance measurement tests.
      f. Turns ratio tests using tap settings.
      g. Polarity and phase relation tests.
      h. Temperature test.
   2. Furnish test reports and Manufacturer's Certificate of Source Testing.

C. Installation Verification:
   1. Furnish Manufacturer's Certificate of Installation Verification.

D. Functional Testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

3.05 FIELD QUALITY CONTROL

A. Provide the services of a manufacturer's authorized representative:
   1. Inspect installation before start-up.
   2. Witness energization.

B. Energize transformer according to the manufacturer's recommended procedure and in accordance with IEEE C57.91.

3.06 ADJUSTING

A. Set the transformer taps as required to obtain nominal output voltage on the secondary terminals.

END OF SECTION

SECTION 16285

SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. High-energy surge protective devices.

1.02 REFERENCES

A. Institute of Electrical and Electronics Engineers (IEEE):
   1. C62.41.1 - Guide on the Surge Environment in Low-Voltage (1,000 V and less) AC Power Circuits.
   2. C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1,000 V and Less) AC Power Circuits.
   3. C62.45 - Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1,000 V and Less) AC Power Circuits.
   4. C62.62- Standard Test Specifications for Surge Protective Devices (SPDs) for Use on the Load Side of the Service Equipment in Low Voltage (1,000 V and less) AC Power Circuits.

B. International Electrotechnical Commission (IEC).

C. National Electrical Manufacturers Association (NEMA).

D. National Fire Protection Agency (NFPA):
   1. 20 - Standard for the Installation of Stationary Pumps for Fire Protection.
   2. 70 - National Electric Code (NEC).
   3. 75 - Standard for the Fire Protection of Information Technology Equipment.
   4. 780 - Standard for the Installation of Lightning Protection Systems.

E. Underwriters Laboratory (UL):
   1. 96A - Standard for Installation Requirements for Lightning Protection Systems.
   2. 1283 - Standard for Electromagnetic Interference Filters.
   3. 1449 - Standard for Surge Protective Devices.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. I_n: Nominal discharge current.
   2. MCOV: Maximum continuous operating voltage.
   3. MOV: Metal oxide varistor.
   4. SAD: Silicon avalanche diode.
   5. SCCR: Short circuit current rating.
   6. SPD: Surge protective device.

7. VPR: Voltage protection rating.

1.04 DELEGATED DESIGN (NOT USED)

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Furnish complete product data confirming detailed compliance or exception statements to all provisions of this Section.
   2. Manufacturer's catalog cutsheets indicating:
      a. Manufacturer and model numbers.
      b. Ratings of each SPD, including, but not limited to:
         1) Short circuit current rating.
         2) Nominal discharge current.
         3) Maximum continuous operating voltage.
         4) Voltage protection rating.
         5) System voltage.
         6) System frequency.
         7) Surge current capacity.
   3. Submit independent test data from a nationally recognized testing laboratory verifying the following:
      a. Overcurrent protection.
      b. UL 1449.

C. Shop Drawings:
   1. Provide electrical and mechanical drawings by the manufacturer that detail:
      a. Unit dimensions.
      b. Weights.
      c. Components.
      d. Field connection locations.
      e. Mounting provisions.
      f. Connection details.
      g. Wiring diagram.

D. Commissioning Submittals:
   1. As specified in Section 01756 - Commissioning, including the following:
      a. Certificates:
         1) Requirements as specified in this Section.
      b. Test Plans:
         1) Test requirements as specified in this Section.
      c. Test Reports.
      d. Owner Training.

E. Operation and maintenance manuals:
   1. As specified in Section 01782 - Operation and Maintenance Manuals.
   2. Include a list of configurable parameters and the final values for each.
   3. Include a troubleshooting chart covering the complete valve and controls/electrical power systems, showing description of trouble, probable cause, and suggested remedy.

1.06 QUALITY ASSURANCE

A. Provide SPD units that are designed, manufactured, tested and installed in compliance with the following codes and standards:
   1. IEEE C62.41.1, C62.41.2, C62.45, C62.62.
   2. Federal Information Processing Standards Publication 94 (FIBS PUB 94).
   3. NEMA.
   4. NFPA 20, 70, 75 and 780.
   5. UL 1449 current edition and UL 1283.

B. IEC 801.

C. Provide surge protective devices that are suitable for application in IEEE C62.41.1, C62.41.2 Category A, B and C3 environments, as tested to IEEE C62.45.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.09 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Coordinate with and provide SPD equipment to the electrical equipment manufacturer before final assembly and factory testing.

1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

B. Extended warranty:
   1. Furnish a manufacturer’s standard parts and labor warranty from date of shipment against any part failure when installed in compliance with manufacturer’s written instructions, UL listing requirements, and any applicable national, state, or local electrical codes.
   2. Warranty shall include:
      a. Direct, factory trained employees must be available within 48 hours for assessment of the problem.
      b. A 24-hour toll-free 800-number for warranty support.

PART 2 PRODUCTS

2.01 GENERAL (NOT USED)

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide surge protection as indicated on the Drawings.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. ABB.
   2. Eaton.
   3. Southern Tier Technologies.
   4. Schneider Electric.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT

A. Provide Type 1 or Type 2 SPD units as required for the locations indicated on the Drawings.

B. Electrical requirements:
   1. SPD ratings are to be consistent with the nominal system operating voltage, phase, and configuration as indicated on the Drawings.
   2. MCOV:
      a. For the SPD and all components in the suppression path (including all MOVs, SADs, and selenium cells): Greater than 115 percent of the nominal system operating voltage.
   3. Operating frequency:
      a. 47 to 63 hertz.
   4. SCCR:
      a. 65 kAIC minimum, but not less than the equipment it is connected to as indicated on the Drawings.
      b. Marked on the SPD in accordance with UL 1449 and the NEC.
   5. Nominal discharge current I_n:
      a. 20 kA.
   6. Maximum VPR:

Modes	240/120 3W	208Y/120	480Y/277	480 V
L-N, L-G, N-G	700	700	1,200	1,800
L-L	1,200	1,200	2,000	1,800

   7. Peak surge current:
      a. Service entrance locations:
         1) 240 kA per phase minimum.
         2) 120 kA per mode minimum.
      b. Branch locations:
         1) 120 kA per phase, minimum.
         2) 60 kA per mode minimum.

C. Protection modes:
   1. Provide SPD protection modes as follows:
      a. Line to Neutral (L-N) where applicable.
      b. Line to Ground (L-G).
      c. Neutral to Ground (N-G), where applicable.

D. Environmental requirements:
   1. Storage temperature:
      a. -40 to 122 degrees Fahrenheit.
   2. Operating temperature:
      a. 32 to 140 Fahrenheit.
   3. Relative humidity:
      a. 5 to 95 percent.
   4. Audible noise:
      a. Less than 45 dBa at 5 feet (1.5 m).
   5. Operating altitude:
      a. Zero to 12,000 feet above sea level.

2.07 COMPONENTS

A. Enclosure:
   1. Located in electrical equipment as indicated on the Drawings.

B. Internal connections:
   1. Provide low impedance copper plates for intra-unit connections:
      a. Attach surge modules using bolted connections to the plates for low impedance connections.
   2. Size connections, conductors, and terminals for the specified surge current capacity.

C. Surge diversion modules:
   1. MOV:
      a. Where multiple MOVs are used in parallel, utilize computer matched MOVs to within 1 volt variance and tested for manufacturer's defects.

D. Overcurrent protection:
   1. Individually fuse components, including suppression, filtering, and monitoring components:
      a. Rated to allow maximum specified nominal discharge current capacity.
      b. Overcurrent protection that limits specified surge currents is not acceptable.

E. Connections:
   1. Provide terminals to accommodate wire sizes up to #2 AWG.

2.08 ACCESSORIES

A. Unit status indicators:
   1. Provide red and green solid-state indicators, with printed labels, on the front cover to redundantly indicate on-line unit status:
      a. The absence of the green light and the presence of the red light indicate that surge protection is reduced and service is needed to restore full operation.
      b. Indicates the status of protection on each mode or phase.

B. Dry contacts for remote monitoring:
   1. Electrically isolated Form C dry contacts (1 A/125 VAC, or 2 A/24 VDC) for remote monitoring of system integrity, and indication of under voltage, phase and/or power loss.

C. Provide an audible alarm which activates under any fault condition:
   1. Alarm On/Off switch to silence the alarm.
   2. A visible LED will confirm whether alarm is On or Disabled.
   3. Locate both switches and the audible alarm on the unit's front cover.

D. Provide transient counter to count transient voltage surges:
   1. LCD readout located on the unit's front cover.
   2. Counter to utilize batteries with a 10-year nominal life or non-volatile memory to maintain accurate counts in the event of power loss.

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. Permanently affix surge rating to the SPD.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. Follow the manufacturer's recommended installation practices and comply with all applicable codes.

B. Special techniques:
   1. Install SPDs internal to equipment with as short and straight conductors including ground conductor as practically possible:
      a. Twist the input conductors together to reduce input conductor inductance.
   2. Do not subject SPD to insulation resistance testing.

3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Source Testing:
   1. Perform manufacturer's standard factory test:
      a. Perform testing in accordance with UL 1449.
   2. Furnish test reports and Manufacturer's Certificate of Source Testing.

C. Functional Testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

D. Owner Training:
   1. Not required.

END OF SECTION

SECTION 16290

ELECTRICAL POWER MONITORING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Power meters and accessories.

1.02 REFERENCES

A. Definitions:
   1. FS - Full Scale.
   2. RDG - Of Reading.
   3. SSM - Solid State Multifunction Power Meter.
   4. THD - Total Harmonic Distortion.

B. Standards:
   1. American National Standard Institute (ANSI):
      a. C12.20 - Electricity Meters - 0.2 and 0.5 Accuracy Classes.
   2. Institute of Electrical and Electronics Engineers (IEEE):
      a. C57.13.6 - Standard for High Accuracy Instrument Transformers.

1.03 DELEGATED DESIGN (NOT USED)

1.04 SUBMITTALS

A. Furnish submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Power meter data including but not limited to:
      a. Power requirements.
      b. Communications protocols.
      c. Input/outputs.
      d. Dimensions.
      e. Measurement functions.
      f. Front panel controls.
      g. Display characteristics.
   2. Accessory data:
      a. Test switch dimensions and wiring diagrams.

C. Commissioning submittals:
   1. As specified in Section 01756 - Commissioning, including the following:
      a. Owner training.

D. Operation and maintenance manuals:
   1. Descriptive and technical bulletins and sales aids edited to reflect only the equipment to be provided and covering each of the components in the system.
   2. A maintenance section including all instruction leaflets and technical data necessary to setup, change setup and maintain the power meters.
   3. Original licensed copies of all software and software manuals.

E. Configuration files and reports:
   1. Settings including but not limited to:
      a. Device tag name.
      b. IP addresses.
      c. Alarm settings.
      d. Time synchronization settings.
      e. Security settings.
   2. Configuration files are to be provided in the selected manufacturer's native format.
   3. Configuration reports are to be submitted in .PDF format, listing each configured parameter setting and description of each parameter.

1.05 QUALITY ASSURANCE (NOT USED)

1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)

1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL (NOT USED)

2.02 DESIGN AND PERFORMANCE CRITERIA (NOT USED)

2.03 MANUFACTURERS

A. The following, no equal:
   1. Schweitzer Engineering Laboratories, SEL-735.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT (NOT USED)

2.07 COMPONENTS

A. Power meters:
   1. Power meter type 1 (SSM1) device which shall include at a minimum:
      a. Individual phase currents, plus or minus 0.5 percent FS.
      b. Phase-to-phase and phase-to-neutral voltages, plus or minus 0.5 percent FS.
      c. Watts, VARs, VA, plus or minus 1 percent FS.
      d. Watt-hours, VAR-hours, VA-hours, plus or minus 1 percent FS.
      e. PF (apparent and displacement), plus or minus 2 percent FS.
      f. Frequency, plus or minus 1 percent hertz.
      g. Demand:
         1) Ampere, plus or minus 0.5 percent full scale.
         2) Watt, VAR, VA, plus or minus 1 percent full scale.
      h. Minimum and maximum values:
         1) Volts (L-L), volts (L-N), current, watts, VARS, VA.
         2) Power factor:
            a) Apparent.
            b) Displacement.
            c) Frequency.
      i. Synch-input kilowatts utility.
      j. LCD with LED backlight.

2.08 ACCESSORIES

A. Current transformers:
   1. Ring type current transformers:
      a. Suitable for service within low or medium voltage equipment as indicated on the Drawings.
      b. Designed to have a mechanical and thermal rating to withstand short-circuit current, stresses, and heating effects equal to the rating of the equipment of the application.
   2. Current ratio: As indicated on the Drawings.
   3. Rated in accordance with IEEE C57.13.6 with accuracy of the current transformers suitable for relay accuracy class and rated for 200 percent burden for the required connected devices.
   4. Identify polarity with standard marking or symbols.
   5. Capable of carrying rated primary current continuously without damage.
   6. Install secondary wiring from current transformers in a suitable wiring trough, or conduit to proper short-circuiting type terminal blocks for connection to relays, instruments, and other devices.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. Install power meters in accordance with the manufacturer's instructions in the electrical equipment as indicated on the Drawings.

3.04 COMMISSIONING

A. General:
   1. As specified in Section 01756 - Commissioning.

B. Functional Testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

C. Owner Training:
   1. Not required.

END OF SECTION

SECTION 16305

ELECTRICAL SYSTEM STUDIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Short-circuit fault analysis studies.
   2. Protective device coordination study.
   3. Arc-flash hazard study.

1.02 REFERENCES

A. American National Standards Institute (ANSI).

B. Institute of Electrical and Electronics Engineers (IEEE):
   1. 1584 - IEEE Guide for Specification of Scope and Deliverable Requirements for an Arc-Flash Hazard Calculation Study in Accordance with IEEE Std 1584.

C. National Fire Protection Association (NFPA):
   1. 70E - Standard for Electrical Safety in the Workplace.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Modified: Equipment with load additions or with loads being removed that affect fault current, include new overcurrent protective devices that require settings and device coordination, or require additional/removal/replacement of arc flash labels.

1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Signed and Sealed electrical system study reports.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Credentials of the individual(s) performing the study and the individual in responsible charge of the study.

C. General:
   1. Format and quantity:
      a. 6 bound copies of all final reports.

b. 3 complete sets of electronic files on CD or DVD media, including the electrical system model(s), configuration files, custom libraries, and any other files used to perform the studies and produce the reports. Also provide an electronic version of the bound reports in PDF format.

2. One-line diagrams:
   a. The following information shall be included at a minimum:
      1) Motor horsepower.
      2) Transformer data:
         a) kVA.
         b) Configuration.
      3) Cable data:
         a) Insulation.
         b) Size.
         c) Length.
   b. Fully legible at 11-inch by 17-inch size.

D. Initial short-circuit fault analysis:
   1. Based on the Contract Documents and electric utility information.
   2. Include a description of all operating scenarios.
   3. One-line diagrams.
   4. Indicate the estimated available short-circuit current at the line side terminals of each piece of equipment covered by the scope of the study.
      a. Measure conductor lengths from the Drawings. Use of arbitrary short conductor lengths is not allowed.
      b. Provide a list of assumptions used in the initial study.

E. Delegated Design final studies and reports:
   1. Include the following sections at a minimum:
      a. Copies of correspondence and data obtained from the electric utility company.
      b. Letter certifying the inspection and verification of existing equipment and incorporation of applicable RFI's and change orders.
      c. Short-circuit fault analysis:
         1) Modify the initial short-circuit fault analysis as follows:
            a) Utilize the actual equipment provided on the project.
            b) Utilize conductor lengths based on installation.
            c) Update one-line diagrams to show as-built conditions.
         2) Descriptions, purpose, basis, assumptions, recommendations, and scope of the study.
         3) Normal system connections and those that result in maximum fault conditions.
         4) Tabulation of circuit breaker, fuse, and other protective device ratings compared to maximum calculated short-circuit duties.
         5) Fault current calculations for the cases run including a definition of terms and guide for interpretation of computer software printouts.
      d. Protective device coordination study shall include:
         1) Descriptions, purpose, basis, assumptions, recommendations, and scope of the study.
         2) List requirements used in the selection and setting criteria for any protective devices.

3) Manufacturer's time-current curves for circuit breakers, fuses, motor circuit protectors, and other protective devices for new equipment.
4) TCCs graphically indicating the coordination proposed for the system on log-log graphs:
   a) All TCCs shall be in color.
5) Tabulation of relay, fuse, circuit breaker, and other protective devices in graphical form with a one-line diagram to display area coordination.
6) Where coordination could not be achieved, an explanation shall be included in the report to support the statement along with recommendations to improve coordination. Recommended equipment modifications or settings shall be in a tabulated form.
7) Protective device settings in a tabulated format.

e. Include in the arc-flash hazard study:
   1) Descriptions, purpose, basis, assumptions, recommendations, and scope of the study.
   2) Normal system connections and those that result in maximum arc-flash conditions.
   3) Arc-flash raw data, calculations, and assumptions.

f. Form and format of arc-flash labels.
   1) Label data:
      a) Identifying the content of each label.
      b) Identifying the location of each label.

F. Submit course outline for Owner Training.

1.06 QUALITY ASSURANCE

A. Qualifications of the entity responsible for electrical system studies:
   1. A minimum of 5 years of experience in power system analysis is required for the individual in responsible charge of the studies.
   2. Short-circuit fault analysis, protective device coordination, and arc-flash hazard studies shall be performed with the aid of a digital computer program:
      a. Point-to-point calculations are not acceptable.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS (NOT USED)

1.09 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. The individual performing the studies shall visit the site and collect necessary field data in order to perform and complete comprehensive electrical system studies.
   2. Obtain, for all equipment, the required data for preparation of the study, including, but not limited to:
      a. Transformer kilovolt-ampere (kVA), nameplate data, and impedances.
      b. Generator impedances, kilovolt-ampere (kVA), and voltage.
      c. Generator decrement curves.
      d. Bus withstand ratings.
      e. Cable and bus data.

f. Protective device taps, time dials, instantaneous pickups, and time-delay settings.
g. As-built lengths for new wire and cable installations covered by the studies.
h. Grounding schemes (solidly grounded or resistive grounded).

3. Obtain the electric utility information on the minimum and maximum available fault current, minimum and maximum utility impedances, utility protective device settings including manufacturer and model number, interrupting ratings, X/R ratios, and model information one level above the point of connection:
   a. Utility tolerances and voltage variations.
   b. Coordinate with the utility for changes to their protective devices and settings to achieve a coordinated system between the utility and the Owner.
4. Obtain equipment layouts and configurations from the manufacturer's final Submittal requirements and Project layout drawings as required.
5. Bus and conductor data:
   a. Use impedances of the actual installed or specified conductors, unless otherwise indicated.
   b. Use cable and bus impedances calculated at 25 degrees Celsius, unless otherwise indicated.
   c. Use 600-volt cable reactance based on typical dimensions of actual installed or specified conductors, unless otherwise indicated.
   d. Use bus withstand values for all equipment having buses.

B. Use medium-voltage cable reactance based on typical dimensions of shielded cables with 133 percent insulation levels, unless otherwise indicated.

C. Certification:
1. Submit written certification signed by the professional engineer conducting the study, equipment supplier, and electrical subcontractor, stating that the data used in the study is correct and captures all RFIs, as-builts, and change orders affecting the study.

D. Meetings:
1. Electrical system study meetings:
   a. As specified in Section 01312 - Project Meetings.
   b. The individual conducting the electrical system studies leads the meeting.
   c. Meet with the Owner and Engineer 3 times.
   d. First meeting:
      1) Discuss the scope of the studies.
      2) Confirm electrical system operating modes.
      3) Confirm assumptions to be used in the electrical system study with the Owner, including, but not limited to:
         a) Maximum protective device fault clearing time.
      4) Discuss the Owner's operational requirements for both normal operation and maintenance.
   e. Second meeting:
      1) Inform the Owner of the results of the study and impacts on normal operation and maintenance including:
         a) Protective device coordination problems and recommended solutions.
         b) Explanation of the arc-flash hazard study results and its potential impact on operations.

c) Recommendations for reduction of arc-flash category levels including reduction of protective device settings or changes in operational practices.

f. Final meeting:
1) Prior to substantial completion.
2) Discuss changes to the studies based on the previous meeting.
3) Discuss with the Owner how changes to the electrical system may change the arc-flash hazard category.

E. Sequencing:
1. Below is an outline of the typical work sequence. Proposed changes to the work sequence may be reviewed and approved by the Engineer.
a. First system study meeting.
b. Submit the initial short-circuit fault analysis study before submittal of any electrical equipment.
1) Only the initial short-circuit results will be reviewed.
c. Site visit to gather data on the existing facility systems for all studies:
1) Make multiple trips as required to obtain data for the short-circuit fault analysis, protection device coordination, and arc flash hazard studies.
d. Submit the preliminary short-circuit fault analysis, protective device coordination, and arc-flash hazard studies after the approval of all electrical equipment.
e. Second system study meeting for preliminary results.
f. Update the model with changes to the electrical system made during start-up and commissioning.
g. Final system study meeting.
h. Submit the final electrical system studies.
i. Label equipment with approved arc-flash labels.
j. Owner Training.

PART 2 PRODUCTS

2.01 GENERAL (NOT USED)

2.02 DESIGN AND PERFORMANCE CRITERIA

A. General study requirements:
1. Scope:
a. Short-circuit fault analysis, protective device coordination, and arc-flash hazard studies shall include all equipment in the power distribution system, including, but not limited to:
1) Utility equipment (utility transformer and primary protective device).
2) Available utility fault contribution current.
3) All electrical equipment including:
a) Dry-type transformers.
b) 240- and 208-volt panelboards.
4) Generators.
5) Motors.
6) Vendor control panels.

7) HVAC equipment.
b. Study scenarios:
1) Include all possible electrical system configurations, for example:
a) Operation on normal (utility) source.
b) Operation on generator source.
c) Main-breakers closed; tie-breaker open.
d) Either main-breaker open; tie-breaker closed.
2. Motors:
a. Each motor shall be individually modeled:
1) Grouping of motors for fault contribution current is not acceptable.
b. Motors with variable frequency drives (VFDs) may be assumed to have no contribution to fault current, unless VFDs are equipped with bypass contactors.
1) If VFDs are equipped with bypass contactors, perform the fault current and arc flash study assuming 1 of bypass contactors are in the closed position.
3. Use the equipment, bus, and device designations as indicated on the Drawings for all studies.

B. Short-circuit fault analysis study additional requirements:
1. Calculate 3-phase bolted fault, line-to-line fault, line-to-ground fault, double line-to-ground fault, short-circuit 1/2 cycle momentary symmetrical and asymmetrical RMS, 1-1/2 to 4 cycle interrupting symmetrical RMS, and 30-cycle steady-state short-circuit current values at each piece of equipment in the distribution system.
2. Evaluate bus bracing, short-circuit ratings, fuse interrupting capacity and circuit-breaker-adjusted interrupting capacities against the fault currents, and calculate X/R values:
a. Identify and document all devices and equipment as either inadequate or acceptable.
3. Calculate line-to-ground and double line-to-ground momentary short-circuit values at buses having ground-fault devices.
4. Provide calculation methods, assumptions, one-line diagrams, and source impedance data, including utility X/R ratios, typical values, recommendations, and areas of concern.

C. Protective device coordination study additional requirements:
1. Furnish protective device settings for functions indicated on the Drawings, including, but not limited to:
a. Current.
2. Provide log-log form time-current curves (TCCs) graphically indicating the coordination proposed for the system:
a. Include with each TCC a complete title and one-line diagram with legend identifying the specific portion of the system covered by the particular TCC:
1) Typical TCCs for identical portions of the system, such as motor circuits, are acceptable as allowed by the Engineer.
b. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics:
1) These details can be included on the TCC.

c. Include a detailed description of each protective device tap, time dial, pickup, instantaneous, and time delay settings:
1) These details can be included on the TCC.

3. TCCs shall include all equipment in the power distribution system where required to demonstrate coordination. Include utility relay and fuse characteristics, medium-voltage equipment protective relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, transformer characteristics, motor and generator characteristics, and characteristics of other system load protective devices:
   a. Include devices down to the largest branch circuit and largest feeder circuit breaker in each motor control center, main breaker in branch panelboards, and fused disconnect switches.
   b. Provide ground fault TCCs with adjustable settings for ground fault protective devices.
   c. Include manufacturing tolerances and damage bands in plotted fuse and circuit breaker characteristics.
   d. On the TCCs, show transformer full load currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and transformer damage curves.
   e. Cable damage curves.
   f. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed based on the short-circuit fault analysis study.
   g. Coordinate time interval medium-voltage relay characteristics with upstream and downstream devices to avoid nuisance tripping.
4. Site generation: When site generation (including cogeneration, standby, and emergency generators) is part of the electrical system, include phase and ground coordination of the generator protective devices:
   a. Show the generator decrement curve and damage curve along with the operating characteristic of the protective devices.
5. Suggest modifications or additions to equipment rating or settings in a tabulated form.

D. Arc-flash hazard study additional requirements:
1. Include the calculated arc-flash boundary and incident energy (calories/square centimeter) at each piece of equipment in the distribution system:
   a. Perform study with 15 percent arcing fault variation in accordance with IEEE 1584.
   b. Perform arc-flash calculations at minimum and maximum utility and generator fault contributions.
   c. Perform arc-flash calculations for both the line side and load side of the switchgear, switchboard, motor control center, and panelboard main breakers.
   d. Perform arc-flash calculations for short-circuit scenarios with all motors on for 3 to 5 cycles and with all motors off.
2. Provide executive summary of the study results:
   a. Provide summary based upon worst case results.
3. Provide a detailed written discussion and explanation of the tabulated outputs:
   a. Include all scenarios.

4. Provide alternative device settings to allow the Owner to select the desired functionality of the system:
    a. Minimize the arc-flash energy by selective trip and time settings for equipment maintenance purposes.
    b. Identify the arc-flash energy based upon the criteria of maintaining coordination and selectivity of the protective devices.

2.03 MANUFACTURERS

A. Update the Owner's existing SKM Systems Analysis, Powertools electrical system studies.

2.04 EXISTING PRODUCTS (NOT USED)

2.05 MATERIALS (NOT USED)

2.06 MANUFACTURED UNITS (NOT USED)

2.07 EQUIPMENT (NOT USED)

2.08 COMPONENTS

A. Arc-flash hazard labels:
    1. Dimensions:
        a. Minimum 5 inches by 3.5 inches.
    2. Materials:
        a. Polyester with polyvinyl polymer over-laminate.
        b. Self-adhesive.
        c. Resistant to:
            1) UV.
            2) Chemicals and common cleaning solvents.
            3) Scuffing.
            4) Wide temperature changes.
    3. Contents:
        a. Short-circuit bus identification.
        b. Calculated incident energy (calories/square centimeter) range:
            1) Based on worst-case study results.
        c. Arc-flash protection boundary.
        d. Shock hazard boundary:
            1) Contractor may provide separate labels for indication of the shock hazard boundary.
        e. Fed from:
            1) Identify the tag number of the upstream equipment providing power.
    4. Color scheme:
        a. For locations above 40 calories/square centimeter:
            1) White label with red "DANGER" strip across the top.
            2) Black lettering.
        b. For locations below 40 calories/square centimeter:
            1) White label with orange "WARNING" strip across the top.
            2) Black lettering.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. After review and acceptance of the arc-flash hazard study by the Engineer, install arc-flash hazard labels:
   1. At all locations required by NFPA, ANSI, or IEEE standards.
   2. At a minimum, in the following locations:
      a. Front of each main or incoming service compartment.
      b. Front of each low-voltage switchgear section.
      c. Front of each medium-voltage circuit breaker door.
      d. Front of each accessible auxiliary or conductor compartment.
      e. Each accessible rear or side vertical section.
      f. Each motor control center vertical section.
      g. Each panelboard covered by the study.
      h. Each control panel, individual starter or VFD, or other equipment covered by the scope of the study.

3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Owner Training:
   1. Including, but not limited to:
      a. Introduction and basics of NFPA 70E: 2 hours 2 sessions.
      b. Detailed review of the electrical system study: 2 hours 1 session.

3.05 FIELD QUALITY CONTROL

A. Individual performing the arc-flash hazard study shall direct the installation of the arc-flash hazard labels:
   1. Remove and replace any improperly applied labels.
   2. Repair the equipment finish damaged by removal of any label.
   3. Install labels level or plumb across the entire dimension of the label.

3.06 ADJUSTING

A. After review and acceptance of the draft arc-flash hazard study and protective device coordination study by the Engineer, adjust protective device settings in accordance with final study prior to equipment energization.
   1. Devices that require power for configuration may be set during energization, but before any subfed loads are energized.
   2. Ensure that settings for upstream equipment are set prior to energizing downstream devices. Provide documentation that protective devices are set in accordance with the study recommendation.

END OF SECTION

SECTION 16411

DISCONNECT SWITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Knife blade fusible and non-fusible disconnect switches.
   2. Switch-rated plugs and receptacles.

1.02 REFERENCES

A. National Electric Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
   2. KS 1-2001 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

B. Underwriters Laboratories Inc. (UL):
   1. 98 - Enclosed and Dead-Front Switches.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Safety switches and disconnect switches are to be considered synonymous.

1.04 DELEGATED DESIGN (NOT USED)

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Manufacturer.
   2. Manufacturer’s specifications and description.
   3. Ratings:
      a. Voltage.
      b. Current.
      c. Horsepower.
      d. Short circuit rating.
   4. Fused or non-fused.
   5. NEMA enclosure type.
   6. Dimensions:
      a. Height.
      b. Width.
      c. Depth.
   7. Weight.

8. Cross-referenced to the disconnect schedule indicated on the Drawings.

C. Shop Drawings:
   1. Manufacturer's installation instructions:
      a. Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance, Regulatory Requirements below.
      b. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
   2. For each switch, indicate nameplate inscription, including voltage, circuit, fuse size (if applicable), and equipment served.

D. Installation instructions:
   1. Provide manufacturer's installation instructions.

1.06 QUALITY ASSURANCE

A. Regulatory requirements:
   1. NEMA Type KS 1- Enclosed and Miscellaneous Distribution Switches (600 V Maximum).
   2. UL 98 - Enclosed and Dead-Front Switches.

B. Disconnect switches shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.09 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Conduct the initial fault current study as specified in Section 16305 - Electrical System Studies and submit results for Engineer's review.
   2. After successful review of the initial fault current study, submit complete equipment Submittal.

1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL (NOT USED)

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide knife blade disconnect switches and switch-rated plugs and receptacles as indicated on the Drawings and specified in the Contract Documents.

B. Provide equipment with the number of poles, voltage, current, short circuit, and horsepower ratings as required by the load and the power system.

2.03 MANUFACTURERS

A. Knife-blade disconnect switches:
   1. One of the following or equal:
      a. ABB.
      b. Appleton.
      c. Crouse-Hinds.
      d. Eaton.
      e. Schneider Electric.
      f. Siemens.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT

A. Knife-blade style switch disconnects:
   1. Switch mechanism:
      a. Quick-make, quick-break heavy-duty operating mechanisms:
         1) Provisions for padlocking the switch in the Off position.
         2) A minimum of 90-degree handle travel position between Off and On positions:
            a) Provide handle position indicators to identify the handle position.
         3) Full cover interlock to prevent opening of the switch door in the On position and to prevent closing the switch mechanism with the door open:
            a) With an externally operated override.
   2. Switch interior:
      a. Switch blades visible when the switch is Off and the cover is open.
      b. Lugs:
         1) Front accessible.
         2) Removable.
         3) UL listed for 60/75-degree Celsius copper conductors.
      c. Current carrying parts completely plated to resist corrosion.
      d. Removable arc suppressors to facilitate easy access to line side lugs.
      e. Furnish equipment ground kits for every switch.
   3. Fused switches:
      a. Furnish with fuses as indicated on the Drawings:
         1) Provide fuses as specified in Section 16494 - Low Voltage Fuses.
      b. UL approved for field conversion from standard Class H fuse spacing to Class J fuse spacing:
         1) Ratings 100 amps through 600 amps at 240 volts.
         2) Ratings 30 amps through 600 amps at 600 volts.
         3) Provide spring reinforced and plated fuse clips.
   4. Ratings:
      a. UL horsepower rated for AC or DC with the rating not less than the load served.

b. Current:
    1) 30 to 1,200 amps.
c. Voltage:
    1) 250 volts AC, DC.
    2) 600 volts (30 A to 200 A, 600 volts DC).
d. Poles:
    1) 2, 3, 4, and 6 poles.
e. UL listed short circuit ratings:
    1) 10,000 RMS symmetrical amps when used with or protected by Class H or K fuses (30 to 600 amps).
    2) 200,000 RMS symmetrical amps when used with or protected by Class R or J fuses (30 to 600 amps employing appropriate fuse rejection).
    3) 200,000 RMS symmetrical amps when used with or protected by Class L fuses (800 to 1,200 amps).

B. Where not indicated on the Drawings, provide switches with the NEMA ratings specified in Section 16050 - Common Work Results for Electrical for the installed location.

C. Size, fusing and number poles as indicated on the Drawings or as required:
    1. Provide solid neutral where indicated on the Drawings.

2.07 COMPONENTS (NOT USED)

2.08 ACCESSORIES

A. Disconnect switches to have provisions for a field installable “B” type electrical interlock for position indication as indicated on the Drawings.

B. Disconnect switches to have provisions for a field installed insulated groundable neutral kit as indicated on the Drawings.

C. NEMA Type 7 and Type 9 enclosures furnished with drain and breather kit when used in outdoor applications.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION

A. Anchoring and bracing to structures:
    1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
    2. Install anchors of type and material indicated on approved anchoring designs.
    3. Install anchors with embedment indicated on approved anchoring designs.

3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
   1. Use Myers hubs or bolt-on hubs for conduit penetrations on NEMA Type 12, Type 4, and Type 4X enclosures.
   2. Provide mounting brackets, stands, supports and hardware as required:
      a. Match finish and materials for brackets, stands, and hardware with the switch installed.
      b. Provide adequate supporting pillar(s) for disconnect switches in accordance with the approved seismic calculations, and locate aboveground or above decks, where there is no structural wall or surface for box.
   3. When possible, mount switches rigidly to exposed building structure or equipment structural members:
      a. For NEMA Type 4 and Type 4X locations, maintain a minimum of 7/8 inch air space between the enclosure and supporting surface.
      b. When mounting on preformed channel, position channel vertically so that water may freely run behind the enclosure.
   4. Provide a nameplate for each disconnect switch:
      a. As specified in Section 16075 - Identification for Electrical Systems.

3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Functional Testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

3.05 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

END OF SECTION

SECTION 16412

LOW VOLTAGE MOLDED CASE CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Low voltage molded case circuit breakers.

1.02 REFERENCES

A. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).

B. Underwriter's Laboratories (UL):
   1. 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.

1.03 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Catalog cutsheets.
   2. Manufacturer's time-current curves for molded case circuit breakers furnished.

C. Commissioning Submittals:
   1. As specified in Section 01756 - Commissioning, including the following:
      a. Owner Training.

D. Delegated Design Submittals:
   1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria.
      a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
      b. For equipment installed outdoors.
      c. For wall mounted equipment weighing 125 pounds or more.

1.05 QUALITY ASSURANCE

A. Low voltage molded case circuit breakers shall be UL listed and labeled.

1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)

1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Molded case thermal magnetic, solid-state, or motor circuit protector type circuit breakers as indicated on the Drawings and connected to form a completed system.

2.02 DESIGN AND PERFORMANCE CRITERIA (NOT USED)

2.03 MANUFACTURERS

A. One of the following or equal:
   1. ABB.
   2. Eaton.
   3. Schneider Electric.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS

A. General:
   1. In accordance with UL 489.
   2. Operating mechanism:
      a. Quick-make, quick-break, non-welding silver alloy contacts.
      b. Common Trip, Open and Close for multi-pole breakers such that all poles open and close simultaneously.
      c. Mechanically trip free from the handle.
      d. Trip indicating handle - automatically assumes a position midway between the manual ON and OFF positions to clearly indicate the circuit breaker has tripped.
      e. Lockable in the “OFF” position.
   3. Arc extinction:
      a. In arc chutes.
   4. Voltage and current ratings:
      a. Minimum ratings as indicated on the Drawings.
      b. Minimum frame size 100A.
   5. Interrupting ratings:
      a. Minimum ratings as indicated on the Drawings.

b. Modify as required to meet requirements of the short circuit fault analysis as specified in Section 16305 - Electrical System Studies.
c. Not less than the rating of the assembly (panelboard, switchboard, motor control center, etc.).

B. Motor circuit protectors:
1. Instantaneous only circuit breaker as part of a listed combination motor controller.
2. Each pole continuously adjustable in a linear scale with 'LO' and 'HI' settings factory calibrated.

2.06 EQUIPMENT (NOT USED)

2.07 COMPONENTS

A. Terminals:
1. Line and load terminals suitable for the conductor type, size, and number of conductors indicated on the Drawings and in accordance with UL 489.

B. Case:
1. Molded polyester glass reinforced.
2. Ratings clearly marked.

C. Trip units:
1. Provide thermal magnetic or solid-state trip units as indicated on the Drawings.
2. Thermal magnetic:
a. Instantaneous short circuit protection.
b. Inverse time delay overload.
c. Ambient or enclosure compensated by means of a bimetallic element.
3. Solid state:
a. With the following settings as indicated on the Drawings:
1) Adjustable long time current setting.
2) Adjustable long time delay.
3) Adjustable short time pickup.
4) Adjustable short time delay.
5) Adjustable instantaneous pickup.
b. 24 VDC power for trip unit:
1) Unless otherwise noted, manufacturer shall provide bucket or unit mounted disconnect enclosure for control power transformer and 24 VDC UPS power supplies for advanced trip units. Provide Phoenix Contact "Trio-UPS" or equal.
c. Energy reducing maintenance switch on breakers 1,200 amps and above and on additional breakers as indicated on the Drawings.
1) Indication on the breaker.

D. Provide ground fault trip devices as indicated on the Drawings.

E. Molded case circuit breakers for use in panelboards:
1. Bolt-on type:
a. Plug-in type breakers are not acceptable.
2. Ground fault trip devices as indicated on the Drawings.

2.08 ACCESSORIES

A. Key interlocks:
   1. Provide key operated interlocks to ensure safe switching procedures as indicated on the Drawings.

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. Test breakers in accordance with:
   1. UL 489.
   2. Manufacturer's standard testing procedures.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.03 INSTALLATION

A. Install breakers to correspond to the accepted Shop Drawings.

3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Functional Testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

C. Owner Training:
   1. Not required.

3.05 FIELD QUALITY CONTROL (NOT USED)

3.06 ADJUSTING

A. Adjust trip settings in accordance with Protective Device Coordination Study as accepted by the Engineer and in accordance with manufacturer's recommendations.

B. Adjust motor circuit protectors in accordance with NEC and the manufacturer's recommendation based on the nameplate values of the installed motor.

END OF SECTION

SECTION 16413

LOW VOLTAGE INSULATED CASE CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Low voltage insulated case circuit breakers.

1.02 REFERENCES

A. Underwriters Laboratories (UL):
   1. 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.

1.03 DELEGATED DESIGN (NOT USED)

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Catalog cutsheets.
   2. Manufacturer's time-current curves for all trip devices furnished.

C. Owner Training Submittals:
   1. As specified in Section 01756 - Commissioning.

1.05 QUALITY ASSURANCE

A. Insulated case circuit breakers shall be UL listed and labeled.

1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)

1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Insulated case circuit breakers as indicated on the Drawings and connect to form a completed system:
   1. Used to open and close a circuit, and to open a circuit automatically on a predetermined overload or overcurrent, without damage to itself when properly applied within its ratings.

2.02 DESIGN AND PERFORMANCE CRITERIA (NOT USED)

2.03 MANUFACTURERS

A. One of the following, or equal:
   1. ABB.
   2. Eaton.
   3. Schneider Electric.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS

A. Operating mechanism:
   1. Manual or electric as indicated on the Drawings:
      a. Manual operation:
         1) Circuit breaker closing spring is energized by no more than 6 operations of the constant-force charging handle.
         2) Pushing the “CLOSE (ON)” button will close the breaker’s contacts and pushing the “OPEN (OFF)” button will open the breaker’s contacts.
         3) Opening springs are automatically charged when the breaker is closed.
      b. Quick-make, quick-break, non-welding silver alloy contacts.
      c. Common trip, open and close for multi-pole breakers such that all poles open and close simultaneously.
      d. Mechanically trip free from the handle.
      e. Trip indicating handles - automatically assumes a position midway between the manual ON and OFF positions to clearly indicate the circuit breaker has tripped.
      f. Lockable in the “OFF” position.

B. Arc extinction:
   1. In arc chutes.

C. Voltage and current ratings:
   1. Minimum ratings as indicated on the Drawings.

D. Interrupting ratings:
   1. Minimum ratings as indicated on the Drawings:
      a. Modify as required to meet requirements of the Contractor's Short Circuit Fault Analysis as specified in Section 16305 - Electrical System Studies.
   2. Matching the rating of the assembly.

E. Circuit breaker mounting shall be as indicated on the Drawings and consist of one of the following configurations:
   1. Draw out type capable of being racked to the disconnect position with the door closed:
      a. Interlocks shall be provided to prevent connecting or disconnecting the circuit breaker unless the breaker is in the open position.
      b. Breaker shall be prevented from being closed during any racking operation.
      c. A test position shall be provided to permit operating the breaker while it is disconnected from the power circuit.
      d. Equipped with interlocks to discharge stored energy spring before the circuit breaker is withdrawn from the cell.
   2. Plug-in (stationary) type capable of being removed with the main bus power off.
   3. Individually mounted in a separate enclosure.

2.06 EQUIPMENT (NOT USED)

2.07 COMPONENTS

A. Terminals:
   1. Line and load terminals suitable for the conductor type, size, and number of conductors indicated on the Drawings and in accordance with UL 489.

B. Case:
   1. Molded polyester glass reinforced.
   2. Double level of insulation between primary current-carrying parts and operating personnel.
   3. Ratings clearly marked.
   4. Open contact indication.
   5. Closed contact indication.
   6. Charging spring charged indication.
   7. Charging spring discharged indication.
   8. Open pushbutton.
   9. Close pushbutton.
   10. Retractable charging handle.

C. Trip units:
   1. Microprocessor based with positive action flux-shifting trip device and a solid state type with the following functions:
      a. Adjustable ampere setting:
         1) To determine the value of current that the breaker will carry indefinitely.
      b. Adjustable long time delay:
         1) Varies the time it will take the breakers to trip under sustained overload.

c. Adjustable short time pickup:
    1) Controls the level of high current the breaker will carry for short periods.
d. Adjustable short time delay:
    1) Controls the length of time the breaker will carry a high current without tripping.
e. Adjustable instantaneous pickup:
    1) Controls level at which immediate tripping of breaker occurs.
f. Adjustable ground fault pickup:
    1) Controls the level at which the breaker will trip under a ground fault condition.
g. Adjustable ground fault delay:
    1) Controls the time that a ground fault can exist without tripping the breaker.
h. Long time pickup indicator:
    1) Provides a visual indication that the breaker is experiencing an overload condition.
i. Energy reducing maintenance switch:
    1) Allows for input of alternative trip settings for arc flash hazard reduction during maintenance procedures.
    2) Enabled by the following:
        a) Hardwired input.
        b) Trip unit controls.
        c) Trip unit network.
    3) Status:
        a) Contact for remote indication.
        b) Indication on trip unit.
        c) Status communicated over trip unit network.

D. Fault indicators:
    1. Powered from a lithium battery.
    2. LED indicators for:
        a. Overcurrent fault trip on long-time feature.
        b. Overcurrent fault trip on short-time feature.
        c. Short circuit fault trip on the instantaneous feature.
        d. Ground fault trip.

2.08 ACCESSORIES

A. Provide circuit breakers with the following accessories as indicated on the Drawings and required for proper operation of the system:
    1. Operations counter.

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. Test breakers in accordance with:
    1. UL 489.

2. Manufacturer’s standard testing procedures.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. Install breakers to correspond to the accepted Shop Drawings.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Field electrical acceptance testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

3.05 OWNER TRAINING

A. Not required.

3.06 ADJUSTING

A. Adjust trip settings in accordance with the Protective Device Coordination Study as accepted by the Engineer and in accordance with the manufacturer’s recommendations.

END OF SECTION

SECTION 16422

MOTOR STARTERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Motor starters and contactors.

1.02 REFERENCES

A. Abbreviations:
   1. FVNR: Full voltage non-reversing.

B. Standards:
   1. Institute of Electrical and Electronics Engineers (IEEE).
   2. International Electrotechnical Commission (IEC):
      a. 801-1 - Electromagnetic Compatibility for Industrial-Process Measurement and Control Equipment - Part 1: General Information.
      b. 947-4 - Low-Voltage Switchgear and Control Gear.
   3. National Electrical Manufacturer's Association (NEMA):
      a. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
      b. ICS 2-230 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 V.
   4. Underwriters Laboratories, Inc. (UL):
      a. 508 - Standard for Industrial Control Equipment.
      b. 508A - Standard for Industrial Control Panels.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Overload relay class: A classification of an overload relay time current characteristic by means of a number which designates the maximum time in seconds at which it will operate when carrying a current equal to 600 percent of its current rating.

1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures:
   1. Submit motor starter data with equipment submittal.

B. Product data:
   1. Manufacturer.
   2. Catalog cutsheets.
   3. Technical information.
   4. Complete nameplate schedule.
   5. Complete bill of material.
   6. List of recommended spare parts.
   7. Confirmation that the overload relay class for each starter meets the requirements of the equipment and motor supplier.
   8. Electrical ratings:
      a. Phase.
      b. Wire.
      c. Voltage.
      d. Ampacity.
      e. Horsepower.
   9. Furnish circuit breaker submittals as specified in Section 16412 - Low Voltage Molded Case Circuit Breakers.

C. Shop Drawings:
   1. Elementary and schematic diagrams:
      a. Provide 1 diagram for every starter and contactor.
      b. Indicate wire numbers for control wires on the diagrams:
         1) Wire numbering as specified in Section 16075 - Identification for Electrical Systems.
      c. Indicate interfaces with other equipment on the Drawings.

D. Delegated Design Submittals:
   1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
      a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
      b. For equipment installed outdoors.
      c. For wall mounted equipment weighing 125 pounds or more.

E. Commissioning Submittals:
   1. As specified in Section 01756 - Commissioning, including the following:
      a. Manufacturer’s representative qualifications.
      b. Certificates:
         1) Requirements as specified in this Section.
      c. Test Plans:
         1) Test requirements as specified in this Section.
      d. Test Reports.
      e. Manufacturer’s representatives field notes and data.
      f. Owner Training.

F. Operation and maintenance manuals:
   1. As specified in Section 01782 - Operation and Maintenance Manuals.

2. Submit complete operating and maintenance instructions presenting full details for care and maintenance of equipment furnished or installed under this Section, including, but not limited to:
    a. Electrical ratings:
        1) Phase.
        2) Wire.
        3) Voltage.
        4) Ampacity.
    b. Complete bill of material.
    c. Manufacturer's operating and maintenance instructions starter and/or contactor component parts, including:
        1) Protective devices (fuses, breakers, overload relays, heater elements, etc.).
        2) Pilot devices.
    d. Complete renewal parts list.
    e. As-built drawings:
        1) Furnish as-built drawings for each starter and contactor indicating final:
            a) Wire numbers.
            b) Interfaces with other equipment.
        2) 11-inch by 17-inch format.

G. Certifications:
1. Provide manufacturer's certification that the reduced voltage solid state starter will reliably control the acceleration and deceleration of the driven load at the installed conditions.
    a. Failure of the manufacturer to provide said certification will be interpreted to mean that the manufacturer has agreed that the reduced voltage solid state starter is matched to the driven load at the installed conditions and will function without fault.
    b. If the reduced voltage solid-state starter fails to perform as desired, replace or modify the reduced voltage solid-state starter in order to achieve the desired operational conditions, as directed by the Engineer.

1.06 QUALITY ASSURANCE

A. Regulatory requirements:
1. Starters and components shall be UL listed and labeled:
    a. UL 508 - Industrial Control Equipment.
    b. UL 508A - Industrial Control Panels.
2. NEMA ICS 2 - Industrial Control and System Controllers; Contactors and Overload Relays Rated: 600 Volts.
3. Combination starters shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.09 ADMINISTRATIVE REQUIREMENTS

A. Reduced voltage solid state starters:
   1. Submit certification that the RVSS will reliably accelerate and decelerate the driven load at the installed conditions as part of the equipment submittal.
   2. RVSS start-up and testing by manufacturer after connection to equipment.
   3. RVSS training by manufacturer after start-up and testing, and before plant commissioning.

1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

1.11 MAINTENANCE

A. Spare parts:
   1. Provide the following spare parts, suitably packaged and labeled with the corresponding equipment number:
      a. 1 spare fuse of each size and type per starter.
      b. 1 of each type of circuit board used in the RVSS starters, including, but not limited to:
         1) Control board.
         2) Power board.
         3) Bridge rectifier.
         4) Inverter module.

PART 2 PRODUCTS

2.01 GENERAL

A. Starters for motor control centers, individual enclosed starters, or control panels.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria and as indicated on the Drawings.

B. Non-conditioned spaces:
   1. For equipment located in non-conditioned spaces, provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.

C. Outdoor installations:
   1. Provide conditioning equipment incorporated into the equipment to maintain the enclosures within the equipment manufacturer’s specified operating ranges.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. NEMA starters and contactors:
      a. ABB.
      b. Allen-Bradley.
      c. Eaton.
      d. Schneider Electric.
   2. Reduced voltage solid state starters:
      a. ABB.
      b. Allen-Bradley.
      c. Benshaw.
      d. Eaton.
      e. Schneider Electric.
   3. Manual motor starters:
      a. ABB.
      b. Cutler-Hammer.
      c. Schneider Electric.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS

A. General:
   1. Provide combination type starters with motor circuit protector or thermal-magnetic circuit breaker and control power transformer with ratings as indicated on the Drawings.
   2. NEMA size, design, and rated:
      a. NEMA Size 1 minimum.
   3. Coordinate motor circuit protector, thermal magnetic circuit breaker, or fusible disconnect, and overload trip ratings with nameplate horsepower and current ratings of the installed motor.
      a. If motors provided are different in horsepower rating than those specified or indicated on the Drawings, provide starters coordinated to the actual motors furnished.
   4. Provide starters NEMA Size 2 and larger with arc quenchers on load breaking contacts.
   5. Mount extended overload reset buttons to be accessible for operation without opening starter enclosure door.

B. Full voltage starters (FVNR):
   1. Across-the-line full voltage magnetic starters.
   2. Rated for 600 volts.
   3. Electrical characteristics as indicated on the Drawings.
   4. Provide positive, quick-make, quick-break mechanisms, pad lockable enclosure doors.
   5. Furnish starter with bi-metallic overload relays.
   6. Double-break silver alloy contacts.

C. RVSS:
1. Manufactured and tested in accordance with the applicable requirements of IEEE, UL, and NEMA, including the following:
    a. Dielectric withstand in accordance with UL 508.
    b. Noise and RF immunity in accordance with NEMA ICS-2.
2. Furnish with a motor circuit protector or thermal magnetic circuit breaker as indicated on the Drawings.
3. Provide protection against internal faults and high SCR temperature during operation of the motor including starting, running (except when bypassed), and stopping modes.
4. Capable of continuously delivering full rated current of the motor plus the motor service factor in ambient temperatures from 0 degrees Celsius to 40 degrees Celsius at the installed altitude.
5. Provide a magnetically operated bypass contactor in parallel with the solid state starter:
    a. Bypass contactor to energize when the motor has reached full speed:
        1) Electronic overload protection circuits must be fully functional with the bypass contactor closed.
6. RVSS control module requirements:
    a. Microcomputer based and contains the required circuitry to drive the power semiconductors in the power section of the starter.
    b. Integrally mounted on the power section and requires no additional panel space or wiring.
    c. Mounted for easy wiring, testing, service, and replacement.
    d. Provide 3-phase current sensing.
    e. Quick disconnect plug-in connectors for current transformer inputs, line and load voltage inputs, and SCR gate firing output circuits.
    f. Operates on power supplied from a control power transformer.
    g. Phase insensitive or with phase rotation protection.
    h. Control modes:
        1) Soft start with adjustable linear ramp time and a “kick start” or “boost” feature to provide a short time (typically 0.1 seconds) application of approximately full voltage.
        2) Soft start with adjustable linear ramp time, with a current limit:
            a) Current limit shall be adjustable over the range of 2 to 4 times normal full load current.
        3) Reverse voltage ramp (line voltage to zero voltage):
            a) Adjustable from 2 to 30 seconds to provide smooth stop.
            b) Automatic shutdown at end of voltage ramp.
    i. Protective functions:
        1) Single phase protection.
        2) Under voltage protection.
        3) Short circuit electronic trip overcurrent protection. Time not to exceed 3 cycles.
        4) Inverse time running overcurrent protection.
        5) Auxiliary trip circuitry.
        6) Gate firing circuit lockout protection on trip.
        7) Jam and stall detection.
        8) Fault relay lockout protection.
        9) 100 percent to 130 percent full load running current trip adjustment.
        10) 100 percent to 450 percent of starting current limit adjustment.

11) Dwell time at current limit with ramp continuation after acceleration.
12) Individual light emitting diodes (LEDs) for trip and phase loss.
13) Minimum and maximum initial starting voltage adjustments.
14) Initial torque adjustment.

7. RVSS power section requirements:
   a. 3 sets of back-to-back phase-controlled power semiconductors:
      1) Minimum repetitive peak inverse voltage of 1,500 volts at 480 VAC.
      2) Resistor/capacitor snubber networks to prevent false firing of the SCRs.
      3) Equipped with individual heat sink assemblies.
      4) Provide high-speed fuses for protection of the SCR stacks against short circuit conditions.
   b. Provide metal oxide varistors for surge protection on the line and load side power terminal connections:
      1) Rated for a minimum of 120 joules.
   c. Capable of supplying the following current levels:
      1) 600 percent of full load current for a minimum of 10 seconds.
      2) 450 percent of full load for a minimum of 30 seconds.
   d. Furnish ground lugs, 1 for incoming and 1 for outgoing ground connections.
   e. Furnish pressure type terminals for top or bottom entry power terminations.
8. Remote indicators:
   a. Provide Form C dry contacts for remote indication of:
      1) Internal fault error.
      2) Undervoltage.
      3) Overvoltage.
      4) Phase reversal.
      5) Phase loss.
      6) Overload.
      7) Frequency out of range.
      8) Excessive starts per hour.
      9) Drive electronics over temperature.
      10) Stall.
      11) Jam.
      12) System failure.
      13) Starter failure.
      14) Run status.
      15) Full speed.

D. Manual motor starters:
   1. General:
      a. Provide with number of poles as indicated on the Drawings or as required by the connected load.
      b. Provide handles that clearly indicate the On and Off (with lockout), positions.
      c. Switch shall have positive, quick-make, quick-break mechanisms.
   2. Thermal overload switches:
      a. Provide thermal overloads in manual motor starters where integral overloads are not furnished with the motor.

b. Size heater elements for approximately 115 percent of the nameplate full load current, for motors with a 1.15 service factor.
c. Thermal overload units in all phase legs.
d. Overload conditions interrupts ungrounded conductors.

3. Enclosure:
   a. Provide the NEMA enclosure type specified in Section 16050 - Common Work Results for Electrical for the starter location.

2.06 EQUIPMENT (NOT USED)

2.07 COMPONENTS

A. Molded case circuit breakers:
   1. Circuit breaker type and ratings as indicated on the Drawings.
   2. Provide as specified in Section 16412 - Low Voltage Molded Case Circuit Breakers.

B. Contactors:
   1. NEMA size as indicated on the Drawings.
   2. Electrically held:
      a. For lighting loads designed to withstand the initial inrush currents of ballast and lamp loads.
   3. Factory adjusted and chatter free.
   4. Auxiliary contacts:
      a. Contact ratings in accordance with NEMA A600 rating:
         1) Auxiliary contacts rated 10 amps at 600 volts.
      b. Provide contacts indicated on the Drawings and any additional contacts required for proper operation.
      c. Provide at least 1 normally open and 1 normally closed spare auxiliary contact.
   5. Constructed in accordance with the following standards:
      a. UL 508.
      b. IEC 947-4:
         1) Type 1 coordination when protected by a circuit breaker.
         2) Type 2 coordination when protected by a suitable UL listed fuse.
      c. IEC 801-1 parts 2 through 6.

C. Overloads:
   1. Bi-metallic overload relay:
      a. Class 20 protection.
      b. Ambient compensated.
      c. Interchangeable heater pack:
         1) 1 heater per phase.
         2) Coordinate with installed motor full load amps and service factor.
      d. Visible trip indicator.
      e. Push-to-trip test.
      f. Isolated normally open alarm contact.
      g. Normally closed trip contacts.
      h. Manual reset.

D. Control power transformer:
   1. Furnish integral control power transformer capacity to power:
      a. Motor controls: Motor and starter accessories indicated on the Drawings or specified.
   2. Primary and secondary fusing as indicated on the Drawings:
      a. Fusing sized by the manufacturer for the rating of the transformer furnished.
   3. Control power transformer secondary voltage:
      a. As indicated on the Drawings.

2.08 ACCESSORIES

A. Lugs and terminals:
   1. For external connections of No. 6 AWG and larger.
   2. UL listed for either copper or aluminum conductors.

B. Surge protective devices:
   1. Furnish surge protection devices across the coil of each starter, contactor, and relay.

C. Pilot devices:
   1. Provide pilot lights, switches, elapsed time meters, and other devices as specified or as indicated on the Drawings.
   2. As specified in Section 17710 - Control Systems: Panels, Enclosures, and Panel Components.

D. Nameplates and wire markers:
   1. As specified in Section 16075 - Identification for Electrical Systems.

E. Conformal coating:
   1. Provide conformal coating material applied to electronic circuitry and printed circuit boards to act as protection against moisture, dust, temperature extremes, and chemicals such as H_2S and chlorine.

F. Current switch:
   1. Provide current switches where indicated on the Drawings for monitoring of motor currents.
   2. Solid or split core current transformer.
   3. Self-powered from monitored conductor.
   4. Adjustable setpoint.
   5. LED indicators for setup and status.
   6. Normally open contact.
   7. Select the range based on the amperage of the driven equipment.
   8. Manufacturers: One of the following or equal:
      a. Eaton CurrentWatch.
      b. Veris, Hawkeye X09 Series.

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. RVSS starters:
   1. Manufacturer of the respective RVSS starter shall supply certified test results to confirm that the controller has been tested to substantiate designs according to applicable ANSI and NEMA standards.
   2. Tests shall verify not only the performance of the unit and integrated assembly, but also the suitability of the enclosure venting, rigidity, and bus bracing. In addition, the unit shall be factory tested in accordance with ANSI standards.
   3. RVSS starter manufacturer shall test for noise immunity on both input and output power connections and provide test results to the Engineer. Noise testing shall be performed in accordance with NEMA ICS 2.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. Starters in motor control centers:
   1. Install as specified in Section 16444 - Low Voltage Motor Control Centers.

C. Starters in control panels:
   1. Install as specified in Section 17710 - Control Systems: Panels, Enclosures, and Panel Components.

D. Manual motor starters:
   1. Provide complete mounting brackets and hardware as necessary for complete support of manual motor starter at locations indicated on the Drawings.
   2. Mount manual motor starter rigidly to exposed building or equipment structural members.

3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Source Testing:
   1. Not witnessed.

2. Furnish test reports and Manufacturer's Certificate of Source Testing.

C. Owner Training:
   1. Not required.

3.05 FIELD QUALITY CONTROL

A. RVSS:
   1. Provide the services of the manufacturer's technical representative for start-up, adjustment, and troubleshooting, for each starter at the Owner's facility.

3.06 ADJUSTING

A. Make adjustments as necessary and as recommended by the manufacturer, Engineer, or testing firm.

B. Set overloads and motor circuit protectors based on the nameplate values of the installed motor.

END OF SECTION

SECTION 16442

INDIVIDUALLY MOUNTED CIRCUIT BREAKER SWITCHBOARDS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Free standing, dead-front type metal-enclosed, low voltage switchboards with individually mounted circuit protective devices.

1.02 REFERENCES

A. International Organization for Standardization (ISO):
   1. 9001 - Quality Management Systems - Requirements.

B. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
   2. PB 2 - Deadfront Distribution Switchboards.

C. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code.
   2. 70E® - Standard for Electrical Safety in the Workplace®.

D. Underwriters Laboratories, Inc. (UL):
   1. 891 - Switchboards.

1.03 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Manufacturer of switchboard.
   2. Manufacturer of component parts of switchboard.
   3. Dimensions:
      a. Width.
      b. Length.
      c. Height.
      d. Weight.
   4. Nameplate schedule.
   5. Bill of material.
      a. Automatic transfer system as specified in Section 16491 - Transfer Switches.

6. Ratings:
    a. Voltage.
    b. Phase.
    c. Current.
    d. Interrupting rating (circuit breakers and fuses).
7. List of recommended spare parts.
8. Name of dealer's repair facility and parts stocking agreement with the factory:
    a. Agreement shall outline in detail the manufacturer's parts stocking requirements and the method by which the manufacturer's representative verifies that the stock is at an acceptable level.
    b. Agreement should also outline the method by which the manufacturer's representative determines that the service personnel meet factory standards.
    c. A toll-free or local phone number with 24/7 emergency monitoring/call back is required.
9. Furnish circuit breaker Submittals as specified in:
    a. Section 16412 - Low Voltage Molded Case Circuit Breakers.
    b. Section 16413 - Low Voltage Insulated Case Circuit Breakers.
10. For equipment installed in structures designated as seismic design category C, D, E, or F, submit the following as specified in Section 01850 - Design Criteria:
    a. Manufacturer's statement of seismic qualification with substantiating test data.
    b. Manufacturer's special seismic certification with substantiating test data.

C. Shop Drawings:
1. Complete, detailed, and scaled switchboard layout:
    a. Front panel.
    b. Sub-panels.
    c. Interior panels.
    d. Top and bottom conduit windows.
2. Complete electrical wiring diagrams:
    a. Point-to-point connections.
    b. Internal compartment-to-compartment interconnection wiring diagrams.
    c. Wiring identification and terminal numbers.
3. Complete 3-line diagrams for each switchboard lineup.
    a. These Drawings shall indicate devices comprising the switchboard assembly, including, but not limited to, circuit breakers, control power and instrument transformers, meters, and control devices.
    b. Clearly indicate electrical ratings of devices on Drawings.
4. Complete interface and connection diagrams for metering system.
5. Complete bill of material list and equipment datasheets identifying appropriate information specific to the switchboard being supplied.
6. Nameplate schedule.
7. Interfaces to other equipment.
    a. Detail of interface connections to automatic transfer breakers, engine generators, etc.

D. Calculations:
1. DC power and current requirements needed to operate the switchboard circuit breakers and automatic transfer equipment.

E. Delegated Design Submittals:
   1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
      a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
      b. For equipment installed outdoors.

F. Installation instructions:
   1. Detail the complete installation of the equipment, including rigging, moving, and setting into place.
   2. Provide manufacturer's installation instructions.

G. Quality Control Submittals:
   1. Manufacturer's representative qualifications.
   2. Manufacturer's Certificate of Source Testing as specified in Section 01756 - Commissioning.
   3. Manufacturer's Certificate of Installation Verification as specified in Section 01756 - Commissioning.
   4. Test reports.

H. Owner Training Submittals:
   1. As specified in Section 01756 - Commissioning.

I. Operation and maintenance manuals:
   1. As specified in Section 01782 - Operation and Maintenance Manuals.
   2. Operating instructions:
      a. Printed and framed instruction chart suitable for wall hanging.
      b. Detail the operational functions custom controls which have been placed on the front of the switchboard.
   3. Maintenance manual:
      a. Furnish maintenance manuals with instructions for maintenance of equipment and data identifying all parts.
      b. Include information needed to maintain the switchboard, including, but not limited to, the following:
         1) Instructions for testing, adjustment, and start-up.
         2) Detailed control instructions which outline the purpose and operation of every control device used in normal operation.
         3) Description of the sequence of operation, which outlines the steps the switchboard follows during normal power failure, fault conditions, and return of normal power.
         4) Schematic and wiring diagrams:
            a) Showing internal and external connections.
            b) Furnished in a reduced 11-inch by 17-inch fully legible format.

1.05 QUALITY ASSURANCE

A. Switchboard and components shall be UL listed and labeled.

B. Equipment shall be designed and constructed in accordance with the following standards and requirements:
   1. NEMA PB 2.
   2. UL 891.

C. Manufacturer shall be ISO 9001 certified.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Ship switchboards to the Site in dedicated air ride vans that will allow the Contractor to utilize on-site off-loading equipment.

B. Furnish temporary equipment heaters within the switchboard to prevent condensation from forming.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Conduct the initial fault current study as specified in Section 16305 - Electrical System Studies and submit results for the Engineer's review.
   2. After successful review of the initial fault current study, submit complete equipment Submittal.
   3. Conduct factory acceptance test and submit certified test results for the Engineer's review.
   4. Ship equipment to the Project Site after successful completion of the factory acceptance test.
   5. Assemble equipment in the field.
   6. Conduct final fault current and coordination study.
   7. Conduct field acceptance test and submit results for the Engineer's review.
   8. Submit manufacturer's certification that the equipment has been properly installed and is fully functional for the Engineer's review.
   9. Conduct Owner Training sessions.
   10. Commissioning as specified in Section 01756 - Commissioning.

1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Factory assembled, wired, and tested switchboards, with major components being products of a single manufacturer, including circuit breakers, and other equipment specified in this Section and indicated on the Drawings.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the Site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria and as indicated on the Drawings.

B. Non-conditioned spaces:
   1. Provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.

C. Outdoor installations:
   1. Provide conditioning equipment incorporated into the equipment to maintain the enclosures within the equipment manufacturer's specified operating ranges.

D. Provide complete and functional switchboards with required controls.

E. Furnish and install devices or accessories not described in this Section but necessary for the proper installation and operation of the equipment.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. ABB.
   2. Eaton.
   3. Schneider Electric.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT

A. Voltage ratings:
   1. Voltage level and configuration: As indicated on the Drawings.
   2. Frequency: 60 hertz.
   3. Insulation level:
      a. Twice the rated voltage plus 1,000 volts.

B. Bus:
   1. General:
      a. Tin-plated copper.
      b. Bus cross-section in accordance with UL heat rise requirements.
      c. Current density of 1,000 amps per square inch.
      d. Mounted on supports of high-impact, non-tracking insulators.
      e. Phase A-B-C bus arrangement:
         1) Top-to-bottom, left-to-right, front-to-back throughout the switchboard.
      f. Symmetrical short circuit current bracing of as indicated on the Drawings.
      g. Continuous current rating as indicated on the Drawings.

2. Horizontal bus:
    a. Provisions for future connections to additional switchboard sections.
3. Ground bus:

C. Sized in accordance with UL 891.Space for future devices:
1. Provide spaces as indicated on the Drawings.
2. As specified in Section 16050 - Common Work Requirements for Electrical.

D. Enclosure:
1. General:
    a. Self-supporting structures bolted together to form the required line-up.
    b. All sections rear aligned.
    c. Dead-front.
    d. Conduit entry:
        1) Open bottom.
        2) Removable top cover.
2. Frame:
    a. Die-formed 12-gauge steel.
3. Covers:
    a. Bolt-on.
    b. Code gauge steel.
    c. Removable front covers:
        1) Held in place by captive screws.
4. Rating:
    a. NEMA Type 3R:
        1) Sloped roof.
        2) Filtered vents to provide ventilation to maintain the equipment within its operating temperature range.
        3) Space heaters to prevent condensation.
        4) Control power transformer:
            a) Sized to power space heaters, lights, and receptacles.
            b) Primary and secondary fusing.
        5) Doors:
            a) Front and rear.
            b) Wind stop on each door.
            c) 3-point catch with provision for padlock.
            d) Front to rear full depth lifting beams.
        6) Gasketed.
        7) LED light.
        8) 120-volt, 15-amp GFCI convenience outlet.
        9) Non walk-in construction.

2.07 COMPONENTS

A. Circuit breakers:
1. As specified in Section 16412 - Low Voltage Molded Case Circuit Breakers and Section 16413 - Low Voltage Insulated Case Circuit Breakers.
2. Individually mounted with line and load bus connections.

3. Main circuit breakers shall be 100 percent rated, drawout mounted insulated case breaker with frame and trip ratings as indicated on the Drawings.
    a. Breaker with rating of 1,000 amps or more shall be provided with ground fault shunt trip.
4. Individually fixed mounted feeder devices shall be insulated case circuit breaker with ratings as indicated on the Drawings.
5. Have a minimum interrupting rating equal to the bus rating or as indicated on the Drawings.

B. Wiring:
1. Provide necessary internal wiring, fuse blocks, and terminal blocks as required. Number wires at each end and indicate wire numbers on Shop Drawings.
2. Type SIS switchboard wire with at least 26 strands.
3. Minimum wire size:
    a. No. 14 for control circuits.
    b. No. 12 for voltage and current transformer circuits.
4. Numbered and labeled as specified in Section 16075 - Identification for Electrical Systems.

C. Control power transformers:
1. Provide 480- to 120-volt control power transformers as indicated on the Drawings.
2. Control power transformers to have capacity for 125 percent of the load served.
3. Protect control power transformers with both primary and secondary fuses. Protect primary side with current limiting fuses.

2.08 ACCESSORIES

A. Metering system:
1. Provide power meters as indicated on the Drawings.
2. As specified in Section 16290 - Electrical Power Monitoring.

B. Surge protective devices:
1. As specified in Section 16285 - Surge Protective Devices.

C. Nameplates:
1. As specified in Section 16075 - Identification for Electrical Systems.
2. Furnish an individual nameplate for each breaker and/or switch identifying the load served.
3. Furnish an individual nameplate for each vertical section identifying the vertical section:
    a. Mounted and centered on the top horizontal wireway for each vertical section.
4. Furnish an individual nameplate for each cubicle:
    a. 1 nameplate to identify cubicle designation.
    b. 1 nameplate to identify load served.
5. Manufacturer’s labels:
    a. Each vertical section shall have a label identifying:
        1) Serial number.
        2) Shop order number.

3) Bus rating.
4) Vertical section reference number.
5) Date of manufacture.

D. Warning signs:
1. Voltage:
a. Provide a minimum of 2 warning signs on the front of the switchboard lineup and 2 on the back.
b. Red laminated plastic engraved with white letters approximately 1/2-inch high.
c. Signs shall read:
1) “WARNING-HIGH VOLTAGE-KEEP OUT”.
2. Arc flash:
a. Provide 1 warning sign for each switchboard compartment.
b. Signs shall have read a minimum of:
1) “DANGER ELECTRIC ARC FLASH HAZARD.”
2) Signs shall meet the requirements of NFPA 70E and NEC Article 110.16.

E. Automatic transfer system:
1. As specified in Section 16491 - Transfer Switches.

F. Space heaters:
1. Fused, thermostatically controlled, strip-type, operated at half voltage for long life:
a. 500-volt or 250-volt rated heaters at 240 volt or 120 volt, respectively.
2. Powered from the switchboard control power transformer from 120/240 remote power source.
3. Each powered through its own dedicated circuit breaker.

G. Lugs:
1. For external connections of No. 6 AWG or larger, plated or otherwise suitable for copper or aluminum and UL listed for copper or aluminum.
2. Shall be of the compression type in design requiring a hydraulic press and die for installation as manufactured by:
a. Burndy.
b. T&B.

H. Key interlocks:
1. Provide key interlocks as indicated on the Drawings.

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Chemically clean steel surfaces before painting.

B. Exterior color manufacturer’s standard gray over phosphate-type rust inhibitor.

2.11 SOURCE QUALITY CONTROL

A. Source Testing:
   1. Not witnessed.
   2. Test in accordance with manufacturer's standard testing procedures.
   3. Furnish test reports and Manufacturer's Certificate of Source Testing.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
   1. Furnish cables, conduit, lugs, bolts, and other accessories needed to complete the installation of the switchboard.
   2. Physically assemble and install the switchboard in the location and layout indicated on the Drawings.
   3. Make bus splice connections.
   4. Perform Work in accordance with the manufacturer's instructions and Shop Drawings.
   5. Furnish components and equipment as required to complete the installation.
   6. Replace hardware lost or damaged during the installation or handling to provide a complete installation.
   7. Install the switchboard on a raised concrete housekeeping pad:
      a. Provide structural leveling channels in accordance with the manufacturer's recommendations to provide proper alignment of the units.
      b. Weld and/or bolt the switchgear frame to the leveling channels.
   8. Provide openings in top or bottom of the enclosure for conduit only, no additional openings will be allowed:
      a. Improperly cut holes will require that the entire panel be replaced:
         1) No hole closers or patches will be allowed.

C. Furnish Manufacturer's Certificate of Installation Verification.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Field electrical acceptance testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

C. Provide the services of a qualified manufacturer's representative to:
   1. Inspect, verify, and certify that the mechanical installation meets the manufacturer's requirements.
   2. Make control connections across the shipping splits.
   3. Install and align circuit breakers.
   4. Make bus splice connections.
   5. Make control connections across shipping splits.
   6. Ensure that items furnished are in proper operating condition:
      a. Technician must be completely knowledgeable in the operation, maintenance, and start-up of the electrical system.

3.05 OWNER TRAINING

A. Not required.

3.06 ADJUSTING

A. Make adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

END OF SECTION

SECTION 16444

LOW VOLTAGE MOTOR CONTROL CENTERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Low voltage motor control centers.

1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
   2. ICS 18-2001 - Motor Control Centers.

B. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).

C. Underwriters Laboratories (UL):
   1. 845 - Motor Control Centers.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. SELV: Safety extra-low voltage.

1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Manufacturer of motor control center.
   2. Manufacturer of motor control center parts.
   3. Nameplate schedule.
   4. Bill of material.
   5. Enclosure:
      a. NEMA rating.
      b. Finish color.
   6. Ratings:
      a. Voltage.
      b. Phase.

c. Current:
1) Horizontal bus ampacity.
2) Vertical bus ampacity.
3) Ground bus ampacity.
d. Short circuit withstand rating.
e. Protective device interrupting rating.
7. List of recommended spare parts.
8. Catalog cutsheets:
a. Submit complete manufacturer's catalog information:
1) Clearly indicate the features of the equipment including any options necessary to meet the required functionality.
9. Furnish component Submittals as specified in the appropriate Section.
10. For equipment installed in structures designated as seismic design category C, D, E, or F, submit the following as specified in Section 01850 - Design Criteria:
a. Manufacturer's statement of seismic qualification with substantiating test data.
b. Manufacturer's special seismic certification with substantiating test data.

C. Shop Drawings:
1. Layout drawings:
a. Provide fully dimensioned and to scale layout drawings which include:
1) Dimensions:
a) Overall length.
b) Overall width.
c) Overall height.
d) Overall weight and weight of individual shipping splits.
2. Interfaces to other equipment.
3. Shipping splits.
4. Allowable top and bottom conduit windows.
5. Complete component and unit layout drawings, including control, networking, and metering components.
6. Indicate lug sizes, type, and manufacturer based on the cable size specified in the Contract Documents and as indicated on the Drawings.
7. Elementary schematics:
a. Provide 1 custom schematic diagram for each compartment:
1) Include remote devices.
2) Show wire numbers on the schematics:
a) Provide wire numbering as specified in Section 16075 - Identification for Electrical Systems.
8. External connection diagram showing the wiring to the external controls and devices associated with the motor control center.
9. One-line diagrams:
a. Provide complete one-line diagrams for each motor control center, including, but not limited to: Protective devices, starters, drives, metering, and other equipment.
b. Indicate electrical ratings of the equipment shown on the one-line diagrams.

D. Delegated Design Submittals:
    1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
        a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
        b. For equipment installed outdoors.

E. Installation instructions:
    1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
    2. Provide manufacturer's installation instructions.

F. Commissioning Submittals:
    1. As specified in Section 01756 - Commissioning, including the following:
        a. Manufacturer's representative qualifications.
        b. Certificates:
            1) Requirements as specified in this Section.
        c. Test Plans:
            1) Test requirements as specified in this Section.
        d. Test Reports.
        e. Manufacturer's representatives field notes and data.
        f. Owner Training.

G. Operation and maintenance manuals:
    1. As specified in Section 01782 - Operation and Maintenance Manuals.
    2. Provide complete operating and maintenance instructions presenting full details for care and maintenance of all types of equipment furnished and/or installed under this Section. Include the following:
        a. Electrical ratings:
            1) Phase.
            2) Wire.
            3) Voltage.
            4) Ampacity.
            5) Bus bracing and protective device interrupting ratings.
        b. Manufacturer's operating and maintenance instructions for the motor control center and component parts, including:
            1) Starters.
            2) Overload relays and heater elements.
            3) Variable frequency drives.
            4) Protective devices, including, but not limited to, fuses, circuit breakers and protective relays.
            5) Pilot devices.
        c. Complete renewal parts list.

H. Test forms and reports:
    1. Submit complete factory acceptance test procedures and forms used during the test.

I. Record documents:
   1. Elementary schematics:
      a. Furnish as-built elementary schematics indicating final:
         1) Wire numbers.
         2) Interfaces with other equipment.
      b. Provide 1 custom schematic diagram for each compartment:
         1) Include remote devices.
         2) Show wire numbers on the schematics.
      c. Layout drawings: Provide complete dimensioned component and unit layout drawings.
   2. Record documents shall reflect modifications made during the submittal review process and during construction.

J. Calculations:
   1. Detailed calculations or details of the actual physical testing performed on the motor control center to prove the motor control center is suitable for the seismic requirements at the Project Site.

1.06 QUALITY ASSURANCE

A. All portions of the motor control center, vertical bays, and components shall be UL listed and labeled.
   1. Where indicated as service entrance equipment, the motor control center shall be UL labeled and listed “Suitable for Service Entrance”.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Ship the motor control center and associated equipment to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize onsite off-loading equipment.

B. Furnish temporary equipment heaters within the motor control center to prevent condensation from forming.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.09 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Conduct the initial fault current study as specified in Section 16305 - Electrical System Studies and submit results for Engineer’s review.
   2. After successful review of the initial fault current study, as specified in Section 16305 - Electrical System Studies, submit complete equipment submittal.
   3. Conduct factory acceptance test.
   4. Submit manufacturer’s test results.
   5. Ship equipment to the Project Site after successful completion of factory acceptance test.
   6. Assemble equipment in the field.
   7. Conduct field acceptance test and submit results for Engineer’s review.

8. Submit manufacturer's certification that the equipment has been properly installed and is fully functional for Engineer's review.
9. Conduct Owner's training sessions.
10. Commissioning and process start-up as specified in Section 01756 - Commissioning.

1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Factory assembled, factory wired and factory tested motor control centers:
   1. Motor control centers and major components to be products of a single manufacturer.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria and as indicated on the Drawings.

B. Existing motor control centers:
   1. Provide complete motor control center vertical sections or individual motor control center units to be added to existing motor control centers as specified in this Section and as indicated on the Drawings.
   2. Provide additions that are of the same manufacturer, type, and electrical ratings as the existing motor control centers:
      a. Provide hardware necessary to connect the busses of the new and existing motor control centers.
   3. Provide enclosures to match the NEMA ratings and colors of the existing motor control centers.

2.03 MANUFACTURERS

A. One of the following, or equal:
   1. ABB.
   2. Allen-Bradley.
   3. Eaton.
   4. Schneider Electric.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT

A. General:
   1. Furnish motor control centers as specified in the Contract Documents and indicated on the Drawings.
   2. Arrange the equipped sections to form continuous motor control center lineups as indicated on the Drawings:
      a. Identify any deviations from the Drawings in writing and submit for approval.
   3. Provide wire markers at each end of every wire as specified in Section 16075 - Identification for Electrical Systems.
   4. Provide complete and functional motor control centers.
   5. Provide devices or accessories not specified in this Section but necessary for the proper installation and operation of the equipment.

B. Design and construct motor control center to operate at the voltage level and configuration indicated on the Drawings.

C. Bus system:
   1. Material:
      a. Tin-plated copper.
      b. Short-circuit rating:
         1) As indicated on the Drawings.
      c. Bus bar supports:
         1) High impact strength, non-tracking glass-polyester material that is impervious to moisture and gases.
   2. Horizontal power bus:
      a. Current-carrying capacity as indicated on the Drawings.
      b. Mounting:
         1) Mount horizontal bus bars edgewise, one above the other, and fully isolated from wireways and units.
      c. Temperature rise:
         1) In accordance with UL 845.
         2) De-rate the temperature rating of the bus for the specified conditions of ambient temperature and altitude as specified in Section 01850 - Design Criteria.
   3. Vertical power bus:
      a. Current-carrying capacity of not less than 600 amps.
      b. Mounting:
         1) Enclose the vertical bus in a polyester-glass cover with small openings to permit unit stabs to mate with the bus:
            a) Provide a shutter mechanism to cover the stab openings when plug-in units are removed.
         2) Provide top and bottom bus covers for insulation and isolation of the ends of the bus.
      c. Isolated from the unit compartments by a full height barrier.
   4. Ground bus:
      a. Horizontal ground bus:
         1) Current-carrying capacity:
            a) 300 amps when the horizontal bus is 2,000 amps or less.
            b) 600 amps when the horizontal bus is greater than 2,000 amps.

2) Mounting:
a) Full width, firmly secured to each vertical section structure:
(1) Located in the top or bottom wireway.
b) Pre-drilled and furnished with lugs for connection to equipment ground wires:
(1) Furnish a minimum of 10 lugs per vertical section of MCC.

b. Vertical ground bus:
1) Mounting:
a) Furnish in each vertical section.
b) Bolted to the horizontal ground bus.
c) Install parallel to the vertical power bus.
d) Mount vertical ground bus such that plug-in units engage the ground bus before any connection to the power bus is made. Upon removal of plug-in units, ground stabs are disconnected from the ground bus after the power stabs have been disconnected.

5. Bus splice bars:
a. Provided to join the bus at the splits.
b. Connected to each horizontal bus bar with a minimum of 2 bolts.
c. Employ conical or spring washers at connections, designed to maintain constant pressure against the splice joint.
d. Same ampacity rating as the horizontal bus.
6. Provide bus system configured for back-to-back MCCs, where required.

D. Enclosures:
1. Each motor control center shall consist of 1 or more vertical sections bolted together:
a. Freestanding.
b. Totally enclosed.
c. Dead-front assembly.
d. Designed for modification and/or addition of future vertical sections.
e. Form each vertical section of heavy gauge steel.
f. Designed for back-to-back arrangement installation, where required and/or as indicated on the Drawings.
2. Enclosure rating:
a. Indoor:
1) NEMA Type 1 gasketed.
3. Standard section dimensions:
a. Nominal height: 90 inches.
b. Nominal depth: 20 inches.
c. Vertical section width as indicated on the Drawings.
4. Wireways:
a. Provide each vertical section with a horizontal wireway at the top and bottom of the section:
1) Arranged to provide a full-width metal enclosed wiring trough across the entire motor control center assembly.
b. Provide each vertical section with a full-height vertical wireway.
c. Completely isolated from the vertical and horizontal bus bars.
d. Provide a removable, hinged door.
5. Shipping splits:
a. No more than 3 vertical sections and not more than 60 inches in width.

b. Solid bussing between vertical sections in a shipping split is not acceptable.

6. Lifting angles:
   a. Furnish each vertical section and/or shipping split with a removable lifting angle mounted to the top of the enclosure:
      1) Extending the entire width of the shipping split.
7. Mounting channels:
   a. Mount each vertical section and/or shipping split on an external 1.5-inch by 3-inch mounting channel.

E. Units:
1. A plug-in unit consists of:
   a. Assembly.
   b. Support pan.
   c. Door assembly.
2. Completely enclosed and isolated from adjacent units, buses, and wireways, except for conductor entries into the unit, by a metal enclosure.
3. Supported and guided by a removable unit support pan:
   a. Re-arrangement of units and the removal of a unit so that a new and possibly larger unit can be added without the removal of an in-service unit to gain access to the unit support pan.
4. Held in place by screws or other positive locking means after insertion.
5. Provide a test position with the unit supported in the structure but disengaged from the bus.
6. Integral plug-in ground stab.
7. Stabs:
   a. Free floating.
   b. Self-aligning.
   c. Backed by spring steel clips to ensure high pressure contacts.
   d. Electrolytically tin-plated copper.
8. Handle:
   a. Provide a flange mounted handle mechanism to operate each disconnect switch or circuit breaker.
   b. Door mounted operators or operator handles are not acceptable.
   c. Engaged with the disconnect device at all times as an integral part of the unit independent of the door position.
   d. Lockable in the “OFF” position with up to 3 padlocks.
   e. Mechanically interlocked so that the door cannot be opened with the handle in the “ON” position:
      1) Provide a means for qualified personnel to defeat this interlock.
   f. Interlocked so the unit cannot be inserted or withdrawn with the handle in the “ON” position.
   g. Lockable in the “ON” position:
      1) This shall not prevent the circuit breaker from operating and opening the contacts in the event of a fault condition.
   h. Color-coded to indicate position.
   i. Located so the center of the grip when it is in its highest position is not more than 6 feet 7 inches above the finished floor, including the height of the housekeeping pad and mounting channels.
9. Space for future devices:
   a. Provide spaces as indicated on the Drawings.

b. As specified in Section 16050 - Common Work Requirements for Electrical.

2.07 COMPONENTS

A. Provide components contained within the motor control center as specified in:
1. Section 16075 - Identification for Electrical Systems.
2. Section 16123 - 600-Volt or Less Wires and Cables.
3. Section 16150 - Low Voltage Wire Connections.
4. Section 16290 - Electrical Power Monitoring.
5. Section 16262 - Variable Frequency Drives 0.50 - 50 Horsepower.
6. Section 16285 - Surge Protective Devices.
7. Section 16412 - Low Voltage Molded Case Circuit Breakers.
8. Section 16422 - Motor Starters.
9. Section 17710 - Control Systems: Panels, Enclosures, and Panel Components.

2.08 ACCESSORIES

A. Wiring:
1. Wire the motor control center in accordance with the following NEMA Class and Type as defined by NEMA ICS 18-2001:
a. NEMA Class II-S:
1) Furnish wiring diagrams for individual units consisting of drawings that identify electrical devices, electrical connections, and indicate terminal numbering designations.
2) Furnish individual unit diagrams with each unit and include inter-wiring between units, i.e., electrical interlocking, etc., as specifically specified in the Contract Documents.
3) Provide custom drawings with unique terminal numbering designations in lieu of standard manufacturer drawings.
b. NEMA Type B wiring:
1) Control wiring:
a) Type B-T pull-apart terminal blocks.
2) Power wiring:
a) Type B-T for Size 1 starters.
b) Type B-T or B-D for Size 2 and 3 starters.
c) Type B for Size 4 and larger starters and feeder units.

B. Lugs and terminals:
1. For external connections of No. 6 AWG wire or larger:
a. UL listed for copper or aluminum conductors.
2. Compression type, requiring a hydraulic press and die for installation.
3. Provide additional terminal blocks as needed for control conductors passing through the MCC.
4. Provide 30 percent spare control block terminals.

C. Nameplates:
   1. Provide nameplates as specified in Section 16075 - Identification for Electrical Systems:
      a. Identifying the motor control center designation as indicated on the Drawings.
   2. Furnish individual nameplates for each unit indicated on the Drawings:
      a. 1 nameplate to identify the unit designation.
      b. 1 nameplate to identify the load served.
      c. Furnish space units with blank nameplates.
   3. Manufacturer's labels:
      a. Furnish each vertical section with a label identifying:
         1) Serial number.
         2) Bus rating.
         3) Vertical section reference number.
         4) Date of manufacture.
         5) Catalog number of section.

2.09 FINISHES

A. Finish metal surfaces and structural parts with phosphatizing, or equal, treatment before painting.

B. Finish interior surfaces including bus support angles, control unit back plates, and top and bottom barrier plates with baked white enamel.

C. Finish exterior of enclosure with manufacturer's standard gray.
   1. Finish NEMA Type 3R exterior cabinets with ultraviolet resistant enamel paint that is UL recognized for outdoor use.

2.10 SOURCE QUALITY CONTROL

A. Perform manufacturer's standard factory test on motor control centers prior to shipment.

PART 3 EXECUTION

3.01 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.02 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
   1. Furnish cables, conduit, lugs, bolts, and other accessories necessary to completely install the motor control center for the line, load, and control connections.
   2. Assemble and install the motor control center in the locations and with the layouts as indicated on the Drawings.
   3. Make bus splice connections.
   4. Perform work in accordance with manufacturer's instruction and Shop Drawings.
   5. Furnish components and equipment necessary to complete the installation.
   6. Replace hardware, lost or damaged during installation or handling, in order to provide a complete installation.
   7. Install the MCC on a raised concrete housekeeping pad:
      a. Provide structural leveling channels in accordance with the manufacturer's recommendations to provide proper alignment of the units:
         1) Remove the manufacturer's supplied mounting channels as required by the manufacturer's installation instructions.
      b. Weld and/or bolt the motor control center frame to leveling channels.

C. Provide openings in the top or bottom of the motor control center for conduit only:
   1. No additional openings will be accepted:
      a. Miscut holes will require that the entire vertical section or removable panel be replaced.
      b. No hole closers or patches will be accepted.

D. Bundle circuits together and terminate in each unit:
   1. Tie with nylon wire ties as specified in Section 16123 - 600-Volt or Less Wires and Cables.
   2. Label wires at each end with wire markers as specified in Section 16075 - Identification for Electrical Systems as shown on the approved elementary schematics.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Source Testing (Factory Acceptance Tests):
   1. Not witnessed.
   2. Test the complete motor control center at the manufacturer's establishment. Completely assemble, wire and test the motor control center:
      a. Detailed inspections before and after assembly to ensure correctness of design and workmanship.
   3. Provide groups of wires leaving the shipping-assembled equipment with terminal blocks with suitable numbering strips.
   4. Furnish test reports and Manufacturer's Certificate of Source Testing.

C. Installation Verification:
   1. Furnish Manufacturer's Certificate of Installation Verification.

D. Functional Testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

E. Owner Training:
   1. Not required.

3.04 FIELD QUALITY CONTROL

A. Provide the services of a manufacturer's representative to:
   1. Inspect, verify, and certify that the motor control center installation meets the manufacturer's requirements.

3.05 ADJUSTING

A. Make adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

END OF SECTION

SECTION 16445

PANELBOARDS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Panelboards serving feeder circuits and branch circuits.

1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

B. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).

C. Underwriters Laboratories, Inc. (UL):
   1. 67 - Standard for Panelboards.

1.03 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Manufacturer of panelboard.
   2. Bill of material.
   3. Assembly ratings including:
      a. Voltage.
      b. Phase.
      c. Continuous current.
      d. Short circuit interrupting rating.
   4. NEMA enclosure type.
   5. Cable terminal sizes based upon actual feeder and sub-feeder conductors used.
   6. Furnish circuit breaker Submittals as specified in Section 16412 - Low Voltage Molded Case Circuit Breakers.
   7. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 01850 - Design Criteria:
      a. Manufacturer’s statement of seismic qualification with substantiating test data.
      b. Manufacturer’s special seismic certification with substantiating test data.

C. Shop Drawings:
    1. Overall panelboard dimensions, interior panel dimensions, and wiring gutter dimensions:
        a. Height.
        b. Length.
        c. Width.
    2. Weight.
    3. Anchoring locations.
    4. Breaker layout drawing with dimensions:
        a. Location of the main, branches, solid neutral, and ground.
    5. Conduit entry/exit locations:
        a. Identify conduit entry/exit locations and restrictions.
    6. Individual panel schedules identifying breaker locations, ratings, and nameplate designations within the panelboard, for every panelboard.

D. Delegated Design Submittals:
    1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
        a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
        b. For equipment installed outdoors.
        c. For wall mounted equipment weighing 125 pounds or more.

E. Installation instructions:
    1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
    2. Provide manufacturer’s installation instructions.

F. Commissioning Submittals:
    1. As specified in Section 01756 - Commissioning, including the following:
        a. Certificates:
            1) Requirements as specified in this Section.
        b. Test Plans:
            1) Test requirements as specified in this Section.
        c. Test Reports.

G. Operations and maintenance manual:

    1. As specified in Section 01782 - Operation and Maintenance Manuals.
    2. Provide a complete manual for the operation and maintenance of the panelboard, circuit breakers, devices, and accessories:
        a. Including, but not limited to:
            1) Instruction narratives and bulletins.
            2) Renewal parts lists.
            3) Time-current curves for all devices.

H. Calculations:
    1. Detailed calculations or details of the actual physical testing performed on the panelboard to prove the panelboard is suitable for the seismic requirements at the Project Site.

1.05 QUALITY ASSURANCE

A. Where indicated as service entrance equipment, panelboards shall be UL listed and labeled “Suitable for Service Entrance.”

1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)

1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Circuit breaker panelboards as indicated in the panelboard schedules, one-lines, and where indicated on the Drawings:
   1. Service voltage and configuration as indicated on the panel schedules.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria and as indicated on the Drawings.

B. Non-conditioned spaces:
   1. Provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. ABB.
   2. Eaton.
   3. Schneider Electric.

B. Circuit breakers:
   1. Same manufacturer as the panelboard.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT

A. Provide panelboards with:
   1. Molded-case circuit breakers with trip ratings as shown on the panel schedules.
   2. Spares and spaces for future circuit breakers in panels as shown on the panel schedules.
      a. Space for future devices as specified in Section 16050 - Common Work Requirements for Electrical.

B. Short circuit rating:
   1. Provide as indicated on the Drawings.
   2. Testing method in accordance with UL 67.
   3. Mark each panelboard with its maximum short circuit rating at the supply voltage.
   4. Panelboards shall be fully rated.

2.07 COMPONENTS

A. Enclosure:
   1. NEMA enclosure type as indicated on the Drawings:
      a. Where not indicated on the Drawings, as specified in Section 16050 - Common Work Results for Electrical for the installed location.
   2. Minimum width: 20 inches.
   3. Gutter space in accordance with the NEC:
      a. Minimum of 4 inches.
   4. Dead-front, no live parts when the panelboard is in service.
   5. Enclose entire panelboard bus assembly in a corrosion resistant galvanized steel cabinet.
   6. 4-piece front to provide ease of wiring access.
   7. Lockable, hinged door over the protective devices with a flush, cylinder tumbler-type lock with catch and door pull:
      a. Minimum 2 keys per panelboard.
      b. Key all panelboard locks alike:
         1) Match locks on existing panelboards to the extent possible.
   8. Circuit directory frame and card on the inside of the door.
   9. Door-in-door construction consists of a one-piece front with 2 doors:
      a. Smaller door provides access to device handles and rating labels and shall be lockable.
      b. Larger door provides access to conductors and wiring terminals.
   10. Interior design such that replacement of circuit breakers does not require disturbing adjacent units or removal of the main bus connectors.
   11. Outdoor locations: Provide NEMA Type 4X enclosures with a NEMA Type 4X stainless steel outer enclosure (with a hinged door) and a NEMA Type 1 interior panelboard, unless otherwise indicated.

B. Bus:
   1. General:
      a. Tin-plated copper.
   2. Phase bus:
      a. Full size and height without reduction.
      b. Dimensions and temperature rise in accordance with UL 67:
         1) Limit current density to less than 1,000 amps per square inch.
      c. Insulate current carrying parts from ground and phase-to-phase with a high dielectric strength insulator.
   3. Ground bus:
      a. Copper, solidly bonded.
   4. Neutral bus:
      a. Provide where indicated on the Drawings.
      b. 100 percent rated.
      c. Provide lugs for each outgoing feeder requiring a neutral connection.
   5. Provide insulation barriers over the vertical bus behind the dead front shield to provide increased safety during field service.

C. Lugs:
   1. UL listed for copper and aluminum wire:
      a. Rated for 75-degree Celsius terminations.
      b. Provide bolted or compression main lug terminations as required for the incoming cable size.

D. Circuit breakers: As specified in Section 16412 - Low Voltage Molded Case Circuit Breakers and as indicated on the Drawings:
   1. Provide with bolt-on connections:
      a. Plug-in circuit breakers are not allowed.

2.08 ACCESSORIES

A. Surge protective devices:
   1. Furnish panelboards with surge protective devices as indicated on the Drawings.
   2. As specified in Section 16285 - Surge Protective Devices.

B. Nameplates:
   1. As specified in Section 16075 - Identification for Electrical Systems.
   2. Install on outside of door.
   3. Indicating:
      a. Panel designation.
      b. Voltage.
      c. Number of phases and configuration.

C. Circuit identification labels:
   1. Provide index cards behind heavy clear plastic in cardholders on the inside of the doors.
   2. Type all information on the cards using designations in the panel schedules.
   3. Laminated on both sides.

D. Pad locking mechanism:
   1. Provide a pad locking attachment to allow circuit breakers to be locked in the off position.
   2. At a minimum, provide 1 mechanism per panelboard:
      a. Provide multiple mechanisms if required to accommodate all circuit breaker frame sizes in the panelboard.

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Finish stand-alone panelboards with a primer, rust-resistant phosphate undercoat, and 2 coats of oven-baked enamel with manufacturer's standard gray.

B. Finish panelboards mounted in motor control centers to match the motor control center finish and color.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
   1. Mounted as indicated on the Drawings.
   2. Mount rigidly to structural members with exposed surfaces plumb and level to within 1/32 inch.
   3. Perform Work in accordance with the manufacturer's instructions and Shop Drawings.
   4. Provide brackets, hangers, supports, and hardware for mounting as required.
   5. In NEMA Type 4 and NEMA Type 4X locations, mount panelboards on 7/8-inch deep stainless steel preformed channel, with channel running vertically from top to bottom of panelboard:
      a. Use only stainless steel mounting hardware.
   6. Mount panelboard so that top operating handle is not more than 6 feet and 7 inches above the operating floor.

C. Provide typewritten schedule in each panelboard.

3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Source Testing:
   1. Perform standard factory tests on the panelboards.
   2. Test in accordance with NEMA and UL standards.
   3. Furnish test reports and Manufacturer's Certificate of Source Testing.

C. Functional Testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

3.05 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

END OF SECTION

SECTION 16472

PACKAGED POWER SUPPLY CENTER

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Packaged power supply centers, a single integrated unit composed of:
      a. Primary main breaker.
      b. Dry-type transformer.
      c. Branch circuit panelboard with main breaker.

1.02 REFERENCES

A. American National Standards Institute (ANSI).

B. National Electrical Manufacturers Association (NEMA).

C. Underwriters Laboratories, Inc. (UL):
   1. 50 - Standard for Enclosures for Electrical Equipment.
   2. 67 - Standards for Panelboards.

1.03 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Manufacturer.
   2. Bill of material.
   3. Assembly ratings including:
      a. Voltage.
      b. Phase/wire.
      c. Continuous current.
      d. Short circuit interrupting rating.
      e. Transformer kVA rating.
   4. NEMA enclosure type.
   5. Catalog sheets for circuit breakers contained within the panelboard.
   6. Cable terminal sizes based upon actual feeder and branch circuit conductors used.
   7. Furnish circuit breaker Submittals as specified in Section 16412 - Low Voltage Molded Case Circuit Breakers.

8. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 01850 - Design Criteria:
    a. Manufacturer's statement of seismic qualification with substantiating test data.
    b. Manufacturer's special seismic certification with substantiating test data.

C. Shop Drawings:
    1. Including, but not limited to:
        a. Overall dimensions, interior panel dimensions, and wiring gutter dimensions:
            1) Height.
            2) Length.
            3) Width.
        b. Weight.
        c. Anchoring locations.
        d. Breaker layout drawing with dimensions:
            1) Location of the main, branches, solid neutral, and ground.
        e. Conduit entry/exit locations.
        f. Individual panel schedules identifying breaker locations, ratings, and nameplate designations within the panelboard, for each and every panelboard.

D. Calculations:
    1. Detailed calculations or details of the actual physical testing performed on the packaged power supply center to prove suitability for the seismic requirements at the Project Site as specified in Section 01850 - Design Criteria.

E. Delegated Design Submittals:
    1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
        a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
        b. For equipment installed outdoors.
        c. For wall mounted equipment weighing 125 pounds or more.

F. Installation instructions:
    1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
    2. Provide manufacturer's installation instructions.

G. Quality Control Submittals:
    1. Manufacturer's representative qualifications.
    2. Manufacturer's Certificate of Source Testing as specified in Section 01756 - Commissioning.
    3. Test reports.

H. Operations and maintenance manual:
    1. As specified in Section 01782 - Operation and Maintenance Manuals.

2. Provide a complete manual for the operation and maintenance of the panelboard, circuit breakers, devices, and accessories, including, but not limited to:
    a. Instruction narratives and bulletins.
    b. Renewal parts lists.

1.05 QUALITY ASSURANCE

A. Where indicated as service entrance equipment:
    1. UL labeled and listed “Suitable for Service Entrance.”

1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)

1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Packaged power supplies centers are an integral unit that provides a means for:
    1. Transforming the distribution voltage level to the utilization voltage level.
    2. Primary and secondary protection for the transformer.
    3. Distribution of secondary power.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria and as indicated on the Drawings.

2.03 MANUFACTURERS

A. One of the following or equal:
    1. ABB.
    2. Eaton.
    3. Schneider Electric.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT

A. Enclosure:
   1. Enclose entire unit including panelboard bus assembly, main breakers, and transformer in a galvanized steel cabinet:
      a. Rated NEMA Type 3R, suitable for indoor/outdoor use.
      b. Steel gauge in accordance with UL 50.
      c. Wire gutter space in accordance with UL 67.
   2. Hinged access door:
      a. Maintained in open position when desired.
      b. With padlock provisions to prevent unauthorized entry.
   3. Dead-front panelboard construction.

B. Panelboard:
   1. Bus:
      a. General:
         1) Tin-plated copper.
      b. Phase bus:
         1) Fully rated for the associated transformer.
         2) Full size without reduction.
      c. Neutral bus:
         1) Ampere rating to match phase bus.
         2) Provide with suitable lugs for the maximum number of circuits that can be connected to the panel.
      d. Ground bus:
         1) Provide suitable lug space to provide a lug for each circuit including spaces.
   2. Label panelboards with UL short circuit current rating.

2.07 COMPONENTS

A. Primary and secondary main breakers:
   1. Sized to protect the transformer.
   2. Integrally mounted and wired.
   3. Provide as specified in Section 16412 - Low Voltage Molded Case Circuit Breakers.
   4. Minimum interrupting rating as indicated on the Drawings, but not less than:
      a. Primary main breaker: 480 VAC, 18,000 AIC.
      b. Secondary main breaker: 120/240 VAC, 10,000 AIC.

B. Branch circuit breakers:
   1. As specified in Section 16412 - Low Voltage Molded Case Circuit Breakers.
   2. Match circuit breaker arrangement to the panel schedules as indicated on the Drawings.
   3. Circuit breakers shall not be restricted to any mounting location due to their physical size.
   4. Install circuit breakers such that they can be replaced without disturbing adjacent units.
      a. Provide wire connectors suitable for wire sizes indicated on the Drawings.

C. Transformer:
   1. General:
      a. Minimum of two 5 percent full capacity primary taps below normal.
      b. Insulation:
         1) Insulating materials for a 185-degree Celsius UL component recognized insulation system.
         2) 115 degrees Celsius temperature rise above 40 degrees Celsius maximum ambient.
      c. Fully encapsulated using a sand-epoxy resin mixture to provide maximum protection against moisture, dust, and corrosive environments.
   2. Configuration:
      a. Single- or 3-phase, as indicated on the Drawings.
      b. kVA rating as indicated on the Drawings.
      c. Primary voltage: 480 VAC.
      d. Secondary voltage: As indicated on the Drawings.

2.08 ACCESSORIES

A. Provide nameplates as specified in Section 16075 - Identification for Electrical Systems.

B. Circuit identification labels:
   1. Index cards behind heavy clear plastic in card holders on inside of doors:
      a. Type all information on cards.
   2. Laminated on both sides.
   3. Circuit identification to follow panel schedules as indicated on the Drawings.

2.09 MIXES (NOT USED)

2.10 FABRICATION (NOT USED)

2.11 FINISHES (NOT USED)

2.12 SOURCE QUALITY CONTROL

A. Source Testing:
   1. Perform the following factory tests. All tests shall be in accordance with the latest version the applicable of ANSI and NEMA standards.
      a. Ratio tests at the rated voltage connection and at all tap connections.
      b. Polarity and phase-relation tests on the rated voltage connection.
      c. Applied potential tests.
      d. Induced potential test.
      e. No-load and excitation current at rated voltage on the rated voltage connection.
   2. Furnish test reports and Manufacturer’s Certificate of Source Testing.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. Provide brackets, hangers, supports, and hardware for mounting in the location as indicated on the Drawings.

C. In wet and damp locations, mount assembly on 7/8-inch-deep stainless steel preformed mounting channel:
   1. Channel shall run vertically from top to bottom of unit.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Field electrical acceptance testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

3.05 OWNER TRAINING (NOT USED)

3.06 ADJUSTING

A. Set transformer taps as required.

END OF SECTION

SECTION 16491

TRANSFER SWITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Transfer switches.

1.02 REFERENCES

A. Abbreviations:
   1. ATS: Automatic transfer switch.
   2. MTS: Manually initiated, electrically operated transfer switch.

B. Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
   2. Underwriters Laboratories (UL):
      a. 1008 - Transfer Switch Equipment.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. SCCR: Short-circuit current rating, the maximum short-circuit current a component and assembly can safely withstand when protected by a specific overcurrent protective device(s) or for a specified time.
   2. WCR: Withstand and closing rating, represents a transfer switch's capability to ride out a fault condition until the overcurrent protective device opens and clears the fault.

1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Manufacturer of transfer switch.
   2. Manufacturer of component parts of the ATS.
   3. Dimensions:
      a. Width.
      b. Length.

c. Height.
d. Weight.

4. Bill of material.
5. Description of operation.
6. Ratings:
   a. Voltage.
   b. Phase.
   c. Current.
   d. Number of poles.
   e. Withstand and closing rating (WCR).
7. List of recommended spare parts.
8. For equipment installed in structures designated as Seismic Design Category C, D, E, or F, submit the following as specified in Section 01850 - Design Criteria:
   a. Manufacturer's statement of seismic qualification with substantiating test data.
   b. Manufacturer's special seismic certification with substantiating test data.

C. Shop Drawings:
1. Layout drawings:
   a. Furnish full-dimension and to-scale equipment layout drawings, which include:
      1) Plan, front, and side views.
      2) Sub-panels.
      3) Interior panels.
      4) Top and bottom conduit windows.
2. Complete electrical wiring diagrams:
   a. Point-to-point connections.
   b. Indicate wire numbers.
3. Complete interface and connection diagrams.
4. Transfer equipment label indicating the short-circuit current rating (SCCR).

D. Calculations:
1. Detailed calculations or details of the actual physical testing performed on the transfer switch to prove the transfer switch is suitable for the seismic requirements at the Project Site.

E. Delegated Design Submittals:
1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
   a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
   b. For equipment installed outdoors.
   c. For wall mounted equipment weighing 125 pounds or more.

F. Installation instructions:
1. Detail the complete installation of the equipment, including rigging, moving, and setting into place.
2. Provide manufacturer's installation instructions.

G. Quality Control Submittals:
   1. Manufacturer's representative qualifications.
   2. Manufacturer's Certificate of Source Testing as specified in Section 01756 - Commissioning.
   3. Manufacturer's Certificate of Installation Verification as specified in Section 01756 - Commissioning.
   4. Test reports.

H. Owner Training Submittals:
   1. As specified in Section 01756 - Commissioning.

I. Operation and maintenance manuals:
   1. As specified in Section 01782 - Operation and Maintenance Manuals.
   2. Operating instructions:
      a. Printed and framed instruction chart suitable for wall hanging.
      b. Detail the operational functions of transfer switch controls.
   3. Maintenance manual:
      a. Furnish maintenance manuals with instructions covering maintenance of equipment and data identifying all parts.
      b. Furnish information needed to maintain the transfer switch, including, but not limited to, the following:
         1) Instructions for testing, adjustment, and start-up.
         2) Detailed control instructions that outline the purpose and operation of every control device used in normal operation.
         3) Description of the sequence of operation that outlines the steps that follow normal power failure, transfer to standby power, return to normal power, and fault conditions.
         4) Schematics and wiring:
            a) Furnished in a reduced 11-inch-by-17-inch fully legible format.
         5) Report listing the installed setting of adjustable parameters for the automatic transfer system.

1.06 QUALITY ASSURANCE

A. Where indicated on the Drawings, the transfer switch shall be UL labeled and listed "Suitable for Service Entrance".

1.07 DELIVERY, STORAGE, AND HANDLING

A. Ship the transfer switch to the job site on a dedicated air-ride vehicle that will allow the Contractor to utilize on-site off-loading equipment.

B. Furnish temporary equipment heaters within the transfer switch to prevent condensation from forming.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.09 ADMINISTRATIVE REQUIREMENTS

1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide transfer switches capable of transferring load circuits from utility power to standby power and back.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the Site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria and as indicated on the Drawings.

B. Non-conditioned spaces:
   1. Provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.

C. Outdoor installations:
   1. Provide conditioning equipment incorporated into the equipment to maintain the enclosures within the equipment manufacturer's specified operating ranges.

D. ATS sequence of operation:
   1. When the voltage of any normal source phase drops below 80 percent and after an adjustable time delay (0 to 6 seconds minimum), the transfer switch shall start the standby generator.
   2. When standby voltage reaches 90 percent of nominal, and frequency is within 2 hertz of nominal, following an adjustable time delay (0 to 10 seconds), the switch shall transfer to standby power.
   3. When normal power has been restored to 90 percent of nominal on all phases, following an adjustable time delay (0 to 30 minutes), the switch shall retransfer to normal power:
      a. If the standby source fails during this time delay, the switch shall automatically retransfer to normal power.
   4. Following an adjustable generator cool-down timer (0 to 60 minutes), the switch shall stop the generator.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. ABB.
   2. ASCO.
   3. Eaton.

4. Russelectric, Inc.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT

A. General:
   1. Capable of switching all classes of load.
   2. Rated for continuous duty when installed in a non-ventilated enclosure.
   3. Provide circuit breakers or contactors rated for continuous duty.
   4. Minimum transfer time for delayed transition ATS: 1 second.
   5. Capable of transferring successfully in either direction with 70 percent of rated voltage applied to the terminals.
   6. Provide automatic transfer switches with provisions for manual operation under no load.
   7. Transfer switch short circuit rating to be coordinated with the overcurrent protective devices at the fault current available on the line side of the transfer switch.

B. Electrical ratings:
   1. Voltage, configuration, and amp ratings as indicated on the Drawings.
   2. WCR in accordance with UL 1008.

C. Contacts:
   1. Mechanically held.
   2. Mechanically interlocked to prevent normal and standby sources from being closed at the same time.
   3. Silver alloy construction.
   4. Neutral contact, when indicated on the Drawings:
      a. Same ratings as the phase contacts.
      b. Break last and make first operation.

D. Controls:
   1. ATS shall have 3-phase over-voltage, under-voltage, over-frequency, and under-frequency on both normal and standby sources.
   2. Control panel:
      a. Microprocessor based.
      b. 4-line, 20-character LCD display. Displayed data shall include:
         1) Normal and standby source parameters.
         2) Diagnostic information.
         3) Switch and timer status.
      c. Keypad for making ATS settings and operating parameters:
         1) Settings shall be password protected.
      d. LED display of the following:
         1) Normal source available.
         2) Connected to normal source.
         3) Standby source available.
         4) Connected to standby source.
      e. Provisions for testing ATS operation by simulating a normal source failure.

f. Generator exerciser:
1) Programmable to start the generator on a daily, weekly, monthly, or yearly basis for an adjustable period of time.
2) Load or no load selectable:
a) When load is selected, ATS will transfer to the generator for the duration of the exercise period. Re-transfer back and cool down the generator.
b) When no load is selected, the ATS will run the generator for the duration of the exercise period and then stop the generator.

3. Status and control contacts:
a. Generator start/stop contact:
1) Single-pole, double-throw.
2) Rated for 5 amps at 30 VDC.
b. Status contacts:
1) Single-pole, double-throw.
2) Rated for 10 amps at 250 VAC.
3) Provide contacts for the following:
a) Normal source available.
b) Normal source failure.
c) Connected to normal source.
d) Standby source available.
e) Standby source failure.
f) Connected to standby source.

E. Enclosure:
1. NEMA 3R.

2.07 COMPONENTS (NOT USED)

2.08 ACCESSORIES

A. Space heater:
1. Provide a thermostatically controlled space heater in NEMA 3R enclosures.
2. Integrally powered from the switch.

2.09 SOURCE QUALITY CONTROL

A. Source Testing:
1. Complete factory test to verify proper operation of timers, settings, and operation.
2. Furnish test reports and Manufacturer’s Certificate of Source Testing.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
   1. Furnish components and equipment as required to complete the installation.
   2. Replace hardware lost or damaged during the installation or handling to provide a complete installation.
   3. Install the transfer switch on a raised concrete housekeeping pad:
      a. Provide structural leveling channels in accordance with the manufacturer's recommendations to provide proper alignment of the units.
      b. Weld and/or bolt the transfer switch frame to the leveling channels.
   4. Provide openings in top or bottom of the enclosure for conduit only, no additional openings will be allowed:
      a. Improperly cut holes will require that the entire panel be replaced:
         1) No hole closers or patches will be allowed.

C. Furnish Manufacturer's Certificate of Installation Verification.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Field electrical acceptance testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

3.05 OWNER TRAINING

A. Not required.

END OF SECTION

SECTION 16494

LOW VOLTAGE FUSES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Fuses: 600-volt class and lower.

1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

1.03 DELEGATED DESIGN (NOT USED)

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures.

B. Product data:
   1. Catalog cut sheets.
   2. Complete fuse schedule.
   3. Manufacturer original 11-inch by 17-inch, time current curves for all fuses furnished.

C. Shop drawings:
   1. Include drawings of spare fuse cabinets.

1.05 QUALITY ASSURANCE

A. All low voltage fuses shall be UL listed and labeled.

1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)

1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

1.10 MAINTENANCE

A. Spare parts:
   1. Provide 3 spare fuses for each size and type used or supplied under any Section of the Contract Documents.
   2. Provide spare fuse cabinet(s):
      a. Metal cabinet with hinged door and shelves or fuse holders.
      b. Gray enamel finish.
      c. Mount near equipment and label "Spare Fuses" on face of cabinet.
      d. Suitable pocket inside door of each cabinet with typewritten spare fuse inventory in clear plastic protective insert.
      e. Provide as many cabinets as required to hold entire spare fuse inventory.

PART 2 PRODUCTS

2.01 GENERAL

A. Fuses for overcurrent protection and/or current limiting applications as indicated on the Drawings.

2.02 DESIGN AND PERFORMANCE CRITERIA (NOT USED)

2.03 MANUFACTURERS

A. One of the following or equal:
   1. Bussmann.
   2. Ferraz Shawmut.
   3. Littelfuse.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS

A. General:
   1. Provide durable, readily visible label inside each fuse enclosure, clearly indicating the correct type, size, and ratings of replacement fuse:
      a. Label shall not cover or interfere with equipment manufacturer's instructions.
   2. Affix a label indicating recommended torque for fuse mounting bolts or studs to the inside of fuse access doors.
   3. To ensure selective coordination of protective devices:
      a. Provide fuses for new facilities by the same manufacturer.
      b. Provide fuses for renovations of the same manufacturer as existing fuses.
   4. Provide fuses rated for the voltage and available short circuit current at which they are applied.

B. Fuses for services, switchboard mains, feeders, and branch circuits:
   1. 600 amperes and less:
      a. Provide UL listed RK1 dual-element, time-delay fuses with ampere ratings as indicated on the Drawings except as may be modified by the Contract Documents.
   2. 601 to 6,000 amperes:
      a. Provide UL listed Class L fuses.

C. Fuses for motor branch circuits:
   1. Ampere ratings shall not exceed motor controller manufacturer's recommended values:
      a. If manufacturer does not have such standards, provide fuses as specified in this Section.
   2. Provide Class RK1 fuses or fuses as indicated on the Drawings and as specified in the Contract Documents, rated in accordance with the fuse manufacturer's recommendations for backup running protection of motor circuits containing overload relays.
   3. Determine fuse ratings for overload protection of motor branch circuits by actual full-load currents of motors provided.
   4. Fuses in motor control centers may be time-delay Class J or Class CC fuses, if MCC manufacturer's standard designs use these fuse types:
      a. Time-delay Class J fuse ratings shall not exceed 150 percent of motor full load current except as permitted.
      b. Follow fuse manufacturer's recommendations for Class CC fuses.
      c. A motor having starting duty or other special characteristics requiring larger fuses than specified above, may have branch circuit fuse ratings increased as necessary to meet motor's requirements, but no larger than maximum permitted by the NEC.
         1) Increased requirements for an individual motor shall not be cause for increasing size of all fuses.
   5. Provide Class L fuses for motor branch circuits requiring fuses over 600 amperes, sized at 150 percent of motor full load current except as permitted below:
      a. A motor having starting duty or other special characteristics requiring larger fuses than specified above, may have branch circuit fuse ratings increased as necessary to meet motor's requirements, but no larger than maximum permitted by the NEC.
         1) Increased requirements for an individual motor shall not be cause for increasing size of all fuses.

D. Fusing of control circuits:
   1. Provide:
      a. RK1 fuses installed in UL listed Class CC fuse blocks as specified in the Contract Documents.
   2. Provide minimum protection for control circuits in accordance with the latest revision of UL Standard 508 for Industrial Control.
   3. Fuse both the primary and secondary circuit of control power transformers:
      a. Fuse ratings shall be in accordance with NEC requirements.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. General:
   1. Install fuses properly aligned, electrically and mechanically secure.
   2. Evenly torque mounting bolts and nuts to ASTM recommendations for type and diameter of mounting bolts or studs provided.
   3. Paralleling of fuses is not permitted.
   4. Install fuses so that the fuse nameplate and rating are easily readable in the equipment.

B. Replace fuses, on all phases, for any fuses that opened during start-up and testing.

C. After completion of testing, deliver spare fuses in quantities specified:
   1. Fuses shall be new, in manufacturer's original packaging, and stored in a clean, dry location.

D. Install spare fuse cabinets where instructed by the Owner.

3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

END OF SECTION

SECTION 16510

LIGHTING: LED LUMINAIRES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. LED luminaires, drivers, poles, and accessories.

1.02 REFERENCES

A. Illuminating Engineering Society (IES):
   1. LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products.
   2. LM-80 - Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules.
   3. RP-7 - Recommended Practice for Lighting Industrial Facilities.
   4. TM-21 - Projecting Long Term Lumen, Photon, and Radiant Flux Maintenance of LED Light Sources.

B. Institute of Electrical and Electronics Engineers (IEEE):
   1. C62.41 - IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.

C. National Electrical Code (NEC).

D. National Electrical Manufacturers Association (NEMA):
   1. 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts.

E. Underwriters Laboratories (UL):
   1. 1598 - Luminaires.
   2. 8750 - Light Emitting Diode (LED) Equipment for Use In Lighting Products.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. CCT (correlated color temperature) - Scientific scale to describe how “warm” or how “cool” the light source is, measured in Kelvin. The lower the Kelvin temperature, the warmer the light feels, or appears.
   2. CRI (color rendering index) - A quantitative measure of the ability of a light source to reveal the colors of various objects faithfully in comparison with an ideal or natural light source.
   3. Driver - Device that manages power and controls the current flow from AC to DC for an LED lighting product.

4. Efficacy - Lumen output of a light source per unit of power supplied to that source (lumens per watt).
5. EMI (electromagnetic interference) - Electrical interference (noise) generated by electrical and electronic devices.
6. FC (foot candles) - Measure of light level on a surface being illuminated.
7. L70 - The extrapolated life in hours of the luminaire when the luminous output depreciates 30 percent from initial values.
8. LED (light emitting diode) - A solid-state semiconductor device that produces light when electrical current flows through it.
9. LED light source - See LED luminaire.
10. LED luminaire - A complete lighting unit consisting of LED-based light emitting elements and a matched driver together with parts to distribute light, to position and protect the light emitting elements, and to connect the unit to a branch circuit.
11. Lumen - The international (SI) unit of luminous flux or quantity of light. The amount of light that is spread over a square foot of surface by 1 candle power when all parts of the surface are exactly 1 foot from the light source.
12. Lumen ambient temperature multiplier - LED light source relative lumen output when compared to a standard ambient temperature.
13. Lumen maintenance factor - How well an LED light source is able to retain its intensity when compared to new.
14. Luminaire - Lighting unit.
15. THD (total harmonic distortion) - The combined effect of harmonic Distortion on the AC waveform produced by a driver or other device.

1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing for light poles.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. LED Luminaires:
      a. Catalog literature for each luminaire specified, cross-referenced to the luminaire type on the Luminaire Schedule in the Drawings.
      b. Provide for each luminaire type:
         1) Materials.
         2) Type of diffuser.
         3) Hardware.
         4) Gasketing.
         5) Reflector.
         6) Chassis.
         7) Finish and color.
         8) Driver type and protection.
         9) LED luminaire:
            a) Initial lumen output at 40 degrees Celsius ambient.
            b) Correlated color temperature.

c) Lumen maintenance factors.
d) Lumen ambient temperature multipliers.
e) Drive current.
f) Efficacy.

10) Picture of luminaire.
11) IES optical distributions.
12) Dimensioned drawings:
    a) Effective projected area rating for pole mounted luminaires.
13) Weight.
14) Photometric data:
    a) Coefficient of utilization tables based on the IES zonal cavity system by an approved testing laboratory.
    b) Luminaire dirt depreciation factor.
    c) Candlepower distribution curves.
    d) Average luminaire brightness.
    e) Lumen output charts.
15) Furnish support method for interior luminaires weighing more than 30 pounds and all wall-mounted luminaires:
    a) Support methods shall be based on seismic requirements at the project site as specified in Section 01850 - Design Criteria.

c. Luminaire substitutions:
    1) Provide complete literature for each luminaire substitution:
    2) Submittals for substituted luminaires shall be sufficient for competent comparison of the proposed luminaire to the originally specified luminaire:
        a) Photometric data:
            (1) IES file in standard IES format.
            (2) Coefficient of utilization tables based on the IES zonal cavity system by an approved testing laboratory.
            (3) Candlepower distribution curves.
            (4) Average luminaire brightness.
            (5) Lumen output charts.
            (6) Power requirements in watts and volt-amperes.
        b) Calculations:
            (1) Provide software generated calculations showing illuminance levels in footcandles and power usage in watts per square foot for each of the areas in which substitutions are proposed:
                (a) Use surface reflectance values in accordance with IES RP-7.
                (b) Use manufacturer Projected Lumen Maintenance factor for minimum of 60,000 hours to perform all calculations.
        c) Specification sheets:
            (1) If lacking sufficient detail to indicate compliance with contract documents, standard specification sheets will not be accepted. This includes, but is not limited to, luminaire type designation, manufacturer’s complete catalog number, voltage, LED type, CCT, CRI, specific driver information, system efficacy, L70 life rating, and any modifications

necessary to meet the requirements of the contract documents.

3) Substitutions for specified luminaires will be evaluated upon quality of construction, light distribution, energy use, appearance, and maintenance.
4) Substitutions shall comply with all applicable building and energy codes.

2. Driver: Provide for each driver type:
   a. Catalog number.
   b. Type of driver.
   c. Output wattage.
   d. Input voltage.
   e. Operating voltage range.
   f. Maximum input power.
   g. Efficiency.
   h. Operating line current.
   i. Power factor.
   j. Operating temperature range.
   k. Current output range in ambient temperatures of 30 to 55 degrees Celsius.
   l. Surge suppression data.
3. Photocell:
   a. Provide for each photocell type:
      1) Switching capacity.
      2) Life expectancy when used on LED sources.
      3) The means of adjusting the lighting pickup level.
      4) Enclosure type.
      5) Mounting method.
4. Luminaire poles:
   a. Submit complete data for each pole type including, but not limited to:
      1) Material.
      2) Finish and color.
      3) Handholes.
      4) Anchoring.
      5) Luminaire attachment methods and fittings.
      6) Pole height.
      7) Pole dimensions.
      8) Bolt hole circle layout and hardware.
      9) Accessories.
      10) Provide the EPA wind load rating.
      11) Installation instructions for rigging, moving and setting into place.

C. Delegated Design Submittals:
   1. Project-specific calculations with anchoring and bracing details based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria.

D. Record documents:
   1. Update the Luminaire Schedule in the Drawings to reflect the acceptable substitutions, after the substitution has been reviewed and accepted by the Engineer.

1.06 QUALITY ASSURANCE

A. Luminaires shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.09 ADMINISTRATIVE REQUIREMENTS

A. Scheduling:
   1. Exterior and outdoor lighting system operation shall be demonstrated during the hours of darkness.
   2. Lighting demonstration shall occur within 2 weeks before substantial completion.

1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

B. LED luminaire:
   1. 5-year warranty from the date of installation including material, workmanship, photometrics, driver, and LED modules.

1.11 MAINTENANCE

A. Furnish 1 complete spare LED luminaire, with driver, of each type used.

PART 2 PRODUCTS

2.01 GENERAL

A. Individual luminaire types are indicated on the Drawings and on the Luminaire Schedule.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide luminaires and accessories for all lighting systems, complete and operable, in accordance with the requirements of the Contract Documents.

2.03 MANUFACTURERS

A. Luminaires:
   1. The following or equal:
      a. As noted on the Luminaire Schedule.

B. Drivers:
   1. One of the following or equal:
      a. eldoLED.
      b. Philips Advance.

c. Thomas Research.

C. Photo-electric cells:
1. One of the following or equal:
a. Cooper.
b. Intermatic.
c. Tork.

D. Substitutions:
1. The lighting design and luminaire selection has been based upon the photometric data of the identified luminaire. It is the Contractor's responsibility to ensure and prove to the Engineer at time of Submittal the substitutions meet the quality and photometric requirements of the original design.

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT

A. LED luminaires:
1. General:
a. Pre-wired with leads of 18-AWG, minimum, for connection to building circuits.
b. Provide the luminaires furnished as indicated on the Luminaire Schedule in the Drawings:
1) The Specifications noted in this Section are an addition or supplement to the Luminaire Schedule.
c. Individual LEDs connected such that a catastrophic loss or the failure of 1 LED will not result in the loss of the entire luminaire.
2. Minimum ambient temperature range of 0 degrees Celsius to 40 degrees Celsius.
3. Minimum rated life:
a. Office areas: 70,000 hours when operated at 25 degrees Celsius.
b. Process areas: 100,000 hours when operated at 40 degrees Celsius.
c. Hazardous areas: 100,000 hours when operated at 40 degrees Celsius.
4. Minimum efficacy of 70 lumens/watt.
a. Hazardous areas: Minimum 60 lumens/watt.
5. Minimum Color Rendering Index of 70.
6. Tested according to IES LM-79 and LM-80.
7. Lumen maintenance projection in accordance with IES TM-21.
8. RoHS compliant.
9. Integral driver.
10. Suitable for dry, damp, or wet locations as indicated on the Drawings or on the Luminaire Schedule.
a. Wet or damp locations: UL 1598 listed.
11. Designed as a complete LED assembly. Retrofit LED lamps in luminaires not designed specifically for LED light sources shall not be used.

12. Exterior/outdoor luminaires:
    a. Luminaires in combination with their mounting pole and bracket shall be capable of withstanding:
        1) Wind levels at the project site without damage.
        2) Seismic levels at the project site.
    b. Corrosion-resistant hardware and hinged doors or lens retainer.
    c. Luminaires furnished with integral photoelectrical control shall be of the luminaire manufacturer's standard design.

13. Luminaires in hazardous areas:
    a. In accordance with NEC Section 500 requirements.
    b. UL labeled and identified for hazardous area.
    c. Marking on Class I and II Division 1 and 2 areas shall identify the applicable material classification group.
    d. Marking shall include the temperature class (T code).

B. Photo-electric cells:
    1. Photoelectric cells for control of multiple luminaires:
        a. Self-contained.
        b. Weatherproof.
        c. Provided with time-delay features.
        d. Sized to meet switching capacity of the circuit:
            1) Based on luminaire VA as indicated on the Drawings.
    2. Photoelectric cell for control of a single luminaire:
        a. Integral to the luminaire.

C. Luminaire control:
    1. Lighting control relays or contactors as specified in Section 16422 - Motor Starters.

D. Drivers:
    1. Dimmable, with dimming signal protocol of 0-10 VDC or DALI.
    2. Input power source:
        a. As indicated on the Drawings.
    3. Drive current:
        a. As indicated in the Luminaire Schedule.
    4. Power factor: Greater than 0.90.
    5. Efficiency: Greater than 80 percent.
    6. Total harmonic distortion (THD) of the input current less than 20 percent.
    7. Rated life of 60,000 hours in an LED luminaire operated at an ambient temperature of 40 degrees Celsius.
    8. Minimum operating temperature of -40 degrees Celsius.
    9. Sound rating: Class A+ or quieter.
    10. UL listed Class 2 Outdoor in accordance with UL 8750.
    11. In accordance with IEEE C62.41 Category A for transient protection.
    12. Driver must limit inrush current:
        a. Meet or exceed NEMA 410 driver inrush standard:
            1) 230 Amps per 10 Amp load with a maximum of 106 Amps squared-seconds at 120 V.
            2) 430 Amps per 10 Amp load with a maximum of 370 Amps squared-seconds at 277 V.

2.07 COMPONENTS

A. Luminaire poles:
   1. As indicated on the Luminaire Schedule.
   2. Anchor bolts:
      a. Use anchor bolts, bolts, or welded studs for anchors for resisting seismic and wind forces.
         1) Standard hex bolt head.
         2) Do not use anchor bolts fabricated from rod stock with an L- or J-shape.
      b. Complete with leveling shims.
   3. Anchor base:
      a. Fabricated from the same type of material as the pole shaft.
      b. Base plate to telescope the pole shaft.
      c. Welded top and bottom along the entire perimeter.
      d. With slotted bolt holes on the bolt circles as submitted.
   4. Pole shaft:
      a. As indicated on the Luminaire Schedule.
   5. Handhole:
      a. Reinforced handhole located approximately 18 inches above the base.
      b. Complete with cover fabricated from the same material as the pole shaft and stainless steel attachment screws.
      c. With an integral ground connection nut, 1/2 inch by 13 inch UNC welded to the pole for connection to the grounding system.
   6. Shroud:
      a. Fabricated from the same type of material as the pole shaft.
      b. 1-piece formed channel section that shall conform to the pole shaft taper.
      c. Secured by a locking device with provisions for a padlock to prevent accidental lowering.
   7. Fastening hardware:
      a. Fasteners shall be stainless steel.
   8. Finish:
      a. As indicated on the Luminaire Schedule.

2.08 ACCESSORIES

A. Pole mounted convenience outlet:
   1. Where indicated, furnish a 120 Volt, GFCI protected receptacle:
      a. Integrally mounted in the pole shaft at 36 inches above the base.
   2. Complete with corrosion resistant and weatherproof cover.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).

2. Install anchors of type and material indicated on approved anchoring designs.
3. Install anchors with embedment indicated on approved anchoring designs.

3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. Special techniques:
   1. Support luminaires from structural elements capable of carrying the total weight.
   2. Install luminaires plumb and square with building and wall intersections:
      a. Suspend pendant-mounted luminaries that are mounted from sloping ceilings with ball hangers, unless otherwise indicated on the Drawings.
      b. Install luminaires in machinery rooms after machines have been installed, so as to ensure no conflict with machinery, piping, or ductwork.
   3. In all cases, coordinate luminaire locations with work of other trades to prevent obstruction of light from the fixtures:
      a. Locate bottom of luminaire approximately at the bottom of ductwork, unless otherwise specified or indicated on the Drawings.
   4. Support luminaires weighing more than 25 pounds independently of the outlet box and the conduit.
   5. Provide ceiling or pendent mounted luminaires with a safety chain connecting the lens, driver, and other components to the building structure.
   6. Provide recessed luminaires with auxiliary safety supports attached directly to the building structure:
      a. The safety supports shall consist of number 12 AWG soft drawn galvanized wires.
   7. Install luminaires in accordance with the architectural reflected ceiling Drawings:
      a. Center luminaires on ceiling tiles unless otherwise indicated.
   8. Support luminaires installed in suspended grid ceilings, independently of the grid:
      a. Provide seismic restraint clips for luminaires installed in suspended grid ceilings.
   9. Provide luminaires equipped with battery backup with an additional unswitched conductor from the power source circuit designated on the Drawing. Wall switches shall be wired to switch luminaires on and off, while maintaining power to the backup batteries.

C. Luminaire poles:
   1. Set poles on anchor bolts and secured with double nuts on each bolt.
   2. Dry-pack the pole base, after the luminaire and pole has been leveled and plumbed.
   3. Bond metal poles to the plant grounding system, utilizing a ground lug connection within the pole:
      a. Route ground conductor through pier and pole base sleeve using Schedule 40 PVC conduit.

3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.05 FIELD QUALITY CONTROL (NOT USED)

3.06 ADJUSTING

A. Aim and verify exterior and outdoor luminaires alignment, during dark evening hours, as directed by the Owner or the Engineer.

3.07 CLEANING

A. Clean all lenses, diffusers, and reflectors.

B. Refinish luminaires' trim, poles, and support brackets, where finish has been damaged.

C. Clean LED luminaires (new and old), used during construction for construction lighting, before substantial completion.

D. Clean and re-lamp existing fluorescent and HID luminaires used during construction for construction lighting, before substantial completion.

3.08 SCHEDULES

A. Refer to the Luminaire Schedule in the Drawings.

END OF SECTION

SECTION 16670

LIGHTNING PROTECTION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Design and installation of a complete lightning protection system.
   2. Materials and components for the lightning protection system.

1.02 REFERENCES

A. Lightning Protection Institute (LPI).
   1. 175 - Standard for the Design - Installation - Inspection of Lightning Protection Systems.
   2. 177 - Inspection Guide for Certified Systems.

B. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).
   2. 780 - Standard for the Installation of Lightning Protection Systems.

C. Underwriters Laboratories, Inc. (UL):
   1. 96 - Standard for Lightning Protection Components.
   2. 96A - Standard for Installation Requirements for Lightning Protection Systems.

1.03 DELEGATED DESIGN (NOT USED)

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Provide samples and pertinent catalog data for:
      a. Air terminals.
      b. Conductors.
      c. Connectors.
      d. Accessories.
      e. Include dimensions and materials of each component and include indication of listing in accordance with UL 96.

C. Shop Drawings:
   1. Including, but not limited to:
      a. Layout of air terminals with the respective configuration of the zone of protection.
      b. Grounding electrodes, and bonding connections to structure and other metal objects.

c. Type, size and locations for:
    1) Terminal.
    2) Electrode.
    3) Conductor.
d. Conductor routing details.
e. Connection details.
f. Termination details.
g. Applicable air terminal and other calculations.

2. Details showing installation of air terminals, conductors, and connectors.

D. Certificates:
1. Submit written confirmation of having obtained UL Master Label or LPI certification for each lightning protection system.
2. Photocopy of UL or LPI Installers' Certificate(s) for installation of lightning protection systems.
3. Proof the manufacturer has been UL listed for at least 5 years.
4. Proof the installer has been UL listed or LPI certified for at least 5 years.

E. Record Documents:
1. Provide as specified in Section 01770 - Closeout Procedures.
2. Accurately record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors.
3. Manufacturer's installation instructions.

1.05 QUALITY ASSURANCE

A. Conform to the requirements of the UL or LPI and NFPA standards for lightning protection systems:
1. Components shall be listed in accordance with UL 96.

B. Manufacturer's qualifications:
1. Company specializing in lightning protection equipment with minimum 5 years of experience:
    a. Listed in section "Lightning Conductor, Air Terminals and Fittings" of the UL "Electrical Construction Materials Directory" for at least 5 years previous to this Contract's bid opening date.

C. Installer's qualifications:
1. Member of the UL quality control program listed in section "Lightning Protection Installation" of the UL "Electrical Construction Materials Directory" or LPI-certified installer for installation of lightning protection systems for at least 5 years previous to this Contract's bid opening date.
    a. Lightning protection system shall meet the applicable requirements of NFPA 780 and UL 96 and 96A, or LPI 175 and 177.

D. Upon completion of installation, the lightning protection contractor to have the building lightning system physically inspected by UL or in accordance with LPI requirements:
1. Furnish a UL Master Label or LPI Installer Certificate for the building:
    a. Application for the UL Master Label without a physical inspection by UL is unacceptable.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Do not store or install aluminum lightning protection components in contact with concrete.

1.07 PROJECT OR SITE CONDITIONS (NOT USED)

1.08 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Pre-installation conference:
      a. Convene a pre-installation conference 2 weeks before commencing the Work of this Section, as specified in Section 01312 - Project Meetings.
   2. Coordinate Work with other trades to ensure neat, correct, and unobtrusive installation.
   3. Coordinate the Work of this Section with roofing and exterior and interior finish installations.

1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL (NOT USED)

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide the services of a lightning protection contractor to design, furnish, and install a complete lightning protection system, connected to the facility grounding system at the following structures:
   1. Caustic Soda Building.
   2. Chlorine Building.
   3. PAC Storage Tanks as specified in Section 13270 - PAC Storage and Handling System:
      a. Coordinate with PAC system supplier.

B. Lightning protection system: NFPA 780; Class I UL 96A master labeled or LPI certified system(s) protecting roof-mounted mechanical equipment, and chimneys and stacks, consisting of:
   1. Air terminals on roof(s).
   2. Bonding of structure and other metal objects.
   3. Grounding electrodes.
   4. Interconnecting conductors.

C. Connect the lightning protection system to the facility grounding electrode:
   1. Provide common ground connections as necessary to the electric service conductors.

D. Installing contractor is responsible for all costs associated with UL or LPI application/inspection of the lightning protection system, including any costs associated with re-inspection necessary to obtain the UL 96A Master Label or LPI 177 Certification.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. Erico.
   2. Harger Lightning and Grounding.
   3. Thompson Lightning Protection, Inc.
   4. VFC, Inc.

2.04 MATERIALS

A. Air terminals:
   1. Material: Aluminum.
   2. Size: 3/8-inch by 18-inch minimum extending a minimum of 12 inches above the object to be protected.
   3. On flat or walkable roofs, provide air terminals with:
      a. Mushroom type blunt tip incapable of impalement if fallen upon.
      b. Spring mounted and capable of being pushed flush to the roof.
   4. Air terminals on stacks and chimneys:
      a. Protected from corrosion.
      b. Sized in accordance with UL and NFPA requirements.
      c. Lead-coated copper.
   5. Air terminal bases:
      a. Cast bronze with bolt pressure cable connections securely mounted with stainless steel screws and bolts.

B. Ground rods and below grade connectors:
   1. As specified in Section 16060 - Grounding and Bonding.

C. Ground plate: Copper.

D. Conductors:
   1. Perimeters:
      a. Aluminum.
   2. Down conductors:
      a. Copper.
   3. Sized in accordance with UL or LPI and NFPA requirements.
   4. UL listed for the application.

E. Cable fasteners:
   1. Electrolytically compatible with conductors and mounting surface:
      a. Spaced in accordance with LPI or NFPA requirements.

F. Above grade connectors:
   1. Make connections between dissimilar metals with approved bimetallic connectors.
   2. Installed by trained personnel.

3. UL listed for the application.

G. Miscellaneous materials:
   1. Copper of type and size recommended by the manufacturer of the lightning protection system.
   2. Stainless steel bolts, screws, and other threaded fasteners.

PART 3 EXECUTION

3.01 EXAMINATION

A. It is the responsibility of the lightning protection subcontractor to review the electrical system design and provide any and all additional equipment and materials needed in order to construct a master labeled UL or LPI certified lightning protection system.

B. Verify that surfaces are ready to receive Work.

C. Field verify that measurements are as indicated on the Drawings.

D. Protect elements surrounding Work of this Section from damage or disfiguration.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. In accordance with the manufacturer's instructions unless otherwise specified in this Section.

B. Installation must be made by a LPI certified master installer or an UL certified installer.
   1. Physically connect lightning protection equipment to structural roof framing members including metal deck.
   2. Roof penetrations are not allowed:
      a. Coordinate attachment of lightning protection components by approved adhesive or clamps with Section 07540 - Thermoplastic Polyolefin (TPO) Membrane Roofing to prevent leakage.
      b. Route down conductors to edge of roof and penetrate wall for concealed down conductors.

C. Conductor installations:
   1. Install the lightning protection roof system(s) grounding and bending conductors exposed on flat roof areas and concealed at ridge roof areas.
   2. Install main downleads completely concealed and sleeved.
   3. Other than for the purpose of protecting downlead conductors from damage up to 6 feet above grade level, do not use exposed conduits to conceal the downleads on the exterior of the outside walls.
   4. Use minimum 1-inch PVC conduits to protect lightning system conductors from damage.

D. Clearances: Ensure 6-foot minimum distance required by NEC:
   1. From lightning rod conductors to non-current-carrying metal parts of electrical equipment unless they are bonded to the rods.
   2. From lightning system conductors to open conductors of communication systems.
   3. From lightning protection grounding electrodes to electrodes of other grounding systems.

E. Extend air terminals a minimum of 12 inches above object to be protected.

F. Maintain horizontal or downward coursing of main conductor and ensure that bends have at least an 8-inch radius and that no bend of a conductor forms an included angle of less than 90 degrees.

G. Grounding electrode system:
   1. Where a grounding electrode system is indicated on the Drawings, modify the installation to meet the applicable lightning protection standards.
      a. Provide additional electrodes where required.
   2. Where a grounding electrode system is not indicated on the Drawings, install grounding electrodes in accordance with the applicable UL or LPI standards.

H. Interconnection of metals:
   1. Bond metal bodies within 6 feet of the conductor to the system with approved fittings and conductor.
   2. Connections between dissimilar metals shall be made with approved bimetallic connections.
   3. Bond metal bodies of inductance located within 6 feet of a conductor or object with secondary bonds.

I. Bond isolated metallic bodies at or below the roof subject to inductance and within 6 feet of lightning protection system conductors.

J. Provide necessary common grounds between the lightning protections system and the electric service entrance wires.

K. Ensure that air terminals are installed to withstand calculated wind force due to 100 mile per hour winds or as specified in Section 01850 - Design Criteria, whichever is greater, with a 1.3 gust factor without structural damage and without damage to integrity of the lightning protection system.

3.04 FIELD QUALITY CONTROL

A. Provide one of the following:
   1. Services of UL to physically inspect the entire lightning protection system and issue the UL Master Label:
      a. Furnish UL Master Label as evidence that the installation has met with UL 96A code requirements.
   2. Obtain LPI system certification reports and LPI system certification.

END OF SECTION

SECTION 16950

FIELD ELECTRICAL ACCEPTANCE TESTS

TABLE OF CONTENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Responsibilities for testing the electrical installation.
   2. Adjusting and calibration.
   3. Acceptance tests.

B. Copyright information:
   1. Some portions of this Section are copyrighted by the InterNational Electrical Testing Association, Inc. (NETA). See NETA publication ATS for details.

1.02 REFERENCES

A. Project references:
   1. Specification sections for the electrical equipment being tested.
   2. Electrical equipment Shop Drawings.

B. Standards:
   1. American National Standards Institute (ANSI).
   2. ASTM International (ASTM):
      a. D877 - Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
      b. D923 - Standard Practices for Sampling Electrical Insulating Liquids.
      c. D924 - Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
      d. D971 - Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method.
      e. D974 - Standard Test Method for Acid and Base Number by Color-Indicator Titration.
      f. D1500 - Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).
      g. D1524 - Standard Test Method for Visual Examination of Used Electrical Insulating Liquids in the Field.
      h. D1533 - Standard Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration.
      i. D1816 - Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using VDE Electrodes.
      j. D3612 - Standard Test Method for Analysis of Gases Dissolved in Electrical Insulating Oil by Gas Chromatography.
   3. Institute of Electrical and Electronics Engineers (IEEE):
      a. 43 - IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
      b. 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.
      c. 95 - IEEE Recommended Practice for Insulation Testing of AC Electric Machinery (2,300 V and Above) With High Direct Voltage.
      d. 450 - IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.

e. 1106 - IEEE Recommended Practice for Installation, Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications.
f. 1188 - IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications.
g. C57.13 - IEEE Standard Requirements for Instrument Transformers.
h. C57.13.1 - IEEE Guide for Field Testing of Relaying Current Transformers.
i. C57.13.3 - IEEE Guide for Grounding of Instrument Transformer Secondary Circuits and Cases.
j. C57.104 - IEEE Guide for the Interpretation of Gases Generated in Oil-Immersed Transformers.

4. Insulated Cable Engineer's Association (ICEA).
5. InterNational Electrical Testing Association (NETA).
   a. ATS- Standard for Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
6. International Electrotechnical Commission (IEC).
7. National Electrical Manufacturers Association (NEMA):
   a. MG1 - Motors and Generators.
8. National Fire Protection Association (NFPA):
   a. 70 - National Electrical Code (NEC).
   b. 110 - Standard for Emergency and Standby Power Systems.
9. National Institute of Standards and Technology (NIST).

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Testing laboratory: Organization performing the acceptance tests.

1.04 DELEGATED DESIGN (NOT USED)

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Copper Ethernet test form:
   1. Cable test reports:
      a. Submit 3 copies of test reports showing the results of all tests specified in this Section:
         1) Test type.
         2) Test location.
         3) Test date.
         4) Cable number.
         5) Cable length.
         6) Certification that the cable meets or exceeds the specified standard.
      b. Furnish hard copy and electronic copy for all traces.

C. Manufacturers' testing procedures:
   1. Submit manufacturers' recommended testing procedures and acceptable test results for review by the Engineer prior to beginning testing.

D. Test report:
   1. Include the following:
      a. Summary of Project.
      b. Description of equipment tested.
      c. Description of tests performed.
      d. Test results.
      e. Conclusions and recommendations.
      f. Completed test forms.
      g. List of test equipment used and calibration dates.
      h. LAN cable test reports.

E. Test data records:
   1. Include the following:
      a. Identification of the testing organization.
      b. Equipment identification.
      c. Nameplate data.
      d. Humidity, temperature or other conditions that may affect the results of the tests and or calibrations.
      e. Dates of inspections, tests, maintenance and or calibrations.
      f. Indication of the inspections, tests, maintenance, and or calibrations to be performed and recorded.
      g. Expected results when calibrations are to be performed.
      h. Indication of as-found and as-left results as applicable.
      i. Indication of test results outside specified tolerances.

F. Testing laboratory qualifications:
   1. Submit a complete resume and statement of qualifications from the proposed testing laboratory detailing their experiences in performing the tests specified:
      a. This statement will be used to determine whether the laboratory is acceptable, and shall include:
         1) Corporate history and references.
         2) Resume of individual performing test.
         3) Equipment list and test calibration data.

G. Division of responsibilities:
   1. Submit a list identifying who is responsible for performing each portion of the testing.

1.06 QUALITY ASSURANCE

A. Testing laboratory qualifications:
   1. May be qualified testing personnel from the electrical subcontractor’s staff or an independent testing company.
   2. NETA certification required.
   3. Selection of the testing laboratory and testing personnel is subject to approval by the Engineer based on testing experience and certifications of the individuals and testing capabilities of the organization.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.09 ADMINISTRATIVE REQUIREMENTS

A. General requirements:
   1. Testing of electrical equipment installed under this Contract in accordance with the manufacturer's requirements and as specified in this Section.
   2. Conduct tests in the presence of the Engineer or the Engineer's representative:
      a. Engineer will witness visual, mechanical, and electrical tests, and inspections.
   3. Testing and inspections shall verify that the equipment is operational within the tolerances required and expected by the manufacturer, and these Specifications.

B. Responsibilities:
   1. Contractor responsibilities:
      a. Ensure that resources are made available for testing and that testing requirements are met.
   2. Electrical subcontractor responsibilities:
      a. Perform routine tests during installation.
      b. Demonstrate operation of electrical equipment.
      c. Commission the electrical installation.
      d. Provide the necessary services during testing, and provide these services to the testing laboratory, Contractor, and other subcontractors, including, but not limited to:
         1) Providing electrical power as required.
         2) Operating of electrical equipment in conjunction with testing of other equipment.
         3) Activating and shutting down electrical circuits.
         4) Making and recording electrical measurements.
         5) Replacing blown fuses.
         6) Installing temporary jumpers.
   3. Testing laboratory responsibilities:
      a. Perform acceptance tests specified in this Section.
      b. Provide required equipment, materials, labor, and technical support during acceptance tests.

C. Sequencing:
   1. Prior to testing:
      a. At least 30 days before commencement of the acceptance tests, submit the manufacturer's complete field testing procedures to the Engineer and to the testing laboratory, complete with expected test results and tolerances for equipment to be tested.
   2. Perform testing in the following sequence:
      a. Perform routine tests as the equipment is installed including:
         1) Insulation-resistance tests.
         2) Continuity tests.
         3) Rotational tests.
      b. Adjusting and preliminary calibration.

c. Acceptance tests.
d. Demonstration.
e. Commissioning and plant start-up.

1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION

A. Test instrument calibration:
   1. Utilize a testing laboratory with a calibration program which maintains applicable test instrumentation within rated accuracy.
      a. Calibrating standard shall be of better accuracy than that of the equipment tested.
   2. Accuracy shall be traceable to the NIST in an unbroken chain.
   3. Calibrate instruments in accordance with the following frequency schedule:
      a. Field instruments: 6 months maximum.
      b. Laboratory instruments: 12 months maximum.
      c. Leased specialty equipment where the accuracy is guaranteed by the lessor (such as Doble): 12 months maximum.
   4. Dated calibration labels shall be visible on test equipment.
   5. Maintain an up-to-date instrument calibration record for each test instrument:
      a. Records shall show the date and results of each calibration or test.
   6. Maintain an up-to-date instrument calibration instruction and procedure for each test instrument.

B. Requirements prior to testing:
   1. Do not begin testing until the following conditions have been met:
      a. Instruments required are available and in proper operating condition.
      b. Required dispensable materials such as solvents, rags, and brushes are available.
      c. Equipment handling devices such as cranes, vehicles, chain falls, and other lifting equipment are available or scheduled.
      d. Instruction books, calibration curves, or other printed material to cover the electrical devices are available.
      e. Datasheets to record test results are available.

C. Engine generator tests:
   1. The following individuals must be present and remain at the site during the entire field testing of the engine generator:
      a. Manufacturer’s field engineer for the voltage regulator.
      b. Manufacturer’s field engineer for the governor and governor controller.

c. Manufacturer's field engineer for the switchgear.
d. Load bank operator.
e. Electrical contractor.

3.03 INSTALLATION

A. Test decal:
1. Testing laboratory shall affix a test decal on the exterior of equipment or equipment enclosure of protective devices after performing electrical tests.
2. Color coded to communicate the condition of maintenance of the protective. Color scheme for condition of maintenance of overcurrent protective devices shall be:
a. White: Electrically and mechanically acceptable.
b. Yellow: Minor deficiency not affecting fault detection and operation, but minor electrical or mechanical condition exists.
3. Shall include the following information at a minimum:
a. Testing organization.
b. Project identifier.
c. Test date.
d. Technician identifier.

3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Functional Testing:
1. Also called Field Acceptance Testing.

C. Panelboards:
1. Cleaning:
a. Visually inspect panelboard for evidence of discoloration, abnormal dust accumulation, metal shards, or any other indication of overheating, wear, or other abnormal conditions prior to cleaning.
b. Clean cabinet with a brush, vacuum cleaner, or clean, dry, lint-free rags to remove any accumulation of dust, dirt, or other foreign matter. Do not use liquids, solvents or detergents when cleaning panelboards or components.
c. Avoid blowing dust into panelboards. Do not use a blower or compressed air.
d. Clean supports, terminals, and other major insulating surfaces with clean, dry, lint-free rags or soft bristled brushes.
e. Remove dust, soot, grease, moisture, and foreign material from surface of circuit breakers.
2. General:
a. Compare equipment nameplate data with the Contract Documents.
b. Check panelboard circuit schedule for accuracy.
c. Verify appropriate anchorage, required area clearances, and correct alignment.
d. Inspect overall general condition for physical damage.
1) Check for broken studs and loose or damaged wires, connector, terminations, etc.
2) Check bolts, nuts, washer, and pins for tightness.

3) Tighten or use manufacturer's replacement parts as required.

e. Inspect cabinets for signs of rust, corrosion, or deteriorating paint. Inspect cabinets for evidence of localized heat damage to the paint. Investigate sources of heat. Repair painted surfaces.

f. Check that covers are in place and fastened. Plug any open unused knockouts.

g. Inspect panelboard for moisture. Seal off any cracks or openings which have allowed moisture to enter the cabinet. Inspect component devices. Replace any components that show evidence of damage from moisture.

h. Look for any recent changes in sprinklers or other plumbing that might expose indoor panelboards to a source of liquids. Eliminate sources of water, moisture, or liquids, or provide adequate barriers to protect panelboards from sources of water, moisture, or liquids.

i. Inspect panelboards and internal components for evidence of overheating, arc spatter, sooty deposits, and tracking.
   1) Investigate and correct sources of arcing or overheating.
   2) Consult the panelboard manufacturer for recommendations.

j. Verify that fuse and/or circuit breaker sizes and types correspond to record drawings, if available, as well as to the circuit breakers' address for microprocessor communications packages, if equipped.

k. Set adjustable circuit breakers in accordance with engineering coordination study supplied by the Contractor.

3. Terminations, connections, and lugs:
   a. Inspect bolted electrical connections for high resistance using one of the following methods:
      1) Use of low-resistance ohmmeter.
         a) Compare bolted connection resistance values to values of similar connections:
            (1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
         a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
   b. Inspect terminations, connection, and lugs for alignment, physical damage, burns, corrosion, discoloration, flaking, heat damage, arcing, pitting, melting, deterioration, carbonization, cracks, chips, breaks, partial discharge, or moisture. Investigate and eliminate sources of any damage.
   c. Follow manufacturer recommendations for cleaning, repairing, and replacing damaged parts.
   d. Replace overheated connections. Tighten connections to proper torque levels as specified above.
4. Conductors and raceways:
   a. Inspect supply conductors and terminations for overheating, discoloration, and oxidation. Investigate and correct any deficiencies.
   b. Ensure the conductors are protected within their ampacities.
   c. Visually check panelboard, cables, and raceways for proper bonding and grounding. Correct improper bonding and grounding.
   d. Inspect conductors for discoloration, arcing, pitting, melting, flaking of insulation and/or metal parts. Repair or replace damaged components in accordance with the manufacturer's recommendations.

e. Inspect for frayed or broken wires. Replace or repair damaged components in accordance with manufacturer recommendations.
f. Inspect for frayed or broken wires. Replace or repair conductors as necessary.
g. Inspect conduits for moisture. Seal conduits which are a source of moisture and provide means to drain moisture away from the panelboard.

5. Circuit breakers:
   a. Perform visual and mechanical inspection as specified in this Section.
   b. Operate several times in order to exercise the mechanisms and the contacts, and to ensure smooth operation. Do not oil or grease parts of molded case circuit breakers.
   c. Visually check for evidence of overheating and thermal damage. Investigate and eliminate sources of overheating.
   d. Check for visual defects, chipping, cracks, breaks, burns, and deterioration. Replace damaged circuit breakers.
   e. Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and anti-pump function.
   f. Inspect interchangeable trip-unit circuit breakers for tightness of trip units.
   g. Check terminals and connections for tightness as specified above.
   h. Breakers rated 100 A and higher:
      1) Perform electrical tests as specified in this Section.

D. Switchgear and switchboard:
   1. Visual and mechanical inspection:
      a. Compare equipment nameplate data with the Contract Documents.
      b. Inspect physical and mechanical condition.
      c. Inspect anchorage, alignment, grounding and required area clearances.
      d. Verify the unit is clean and shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.
      e. Verify that circuit breaker/fuse sizes and types correspond to the approved Submittals and the coordination study as well as to the circuit breakers address for microprocessor-communication packages.
      f. Verify that current and voltage transformer ratios correspond to those indicated on the Drawings.
      g. Verify that wiring connections are tight and that wiring is secure to prevent damage during routine operation of moving parts.
      h. Inspect bolted electrical connections for high resistance using one of the following methods:
         1) Use of low-resistance ohmmeter.
         2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
            a) Refer to the manufacturer’s instructions for proper foot-pound levels or NETA ATS tables.
      i. Verify operation and sequencing of interlocking systems:
         1) Attempt closure on locked-open devices.
         2) Attempt to open locked-closed devices.
         3) Make/attempt key-exchanges in all positions.
      j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

k. Inspect insulators for evidence of physical damage or contaminated surfaces.
l. Verify correct barrier and shutter installation and operation.
m. Exercise active components.
n. Inspect mechanical indicating devices for correct operation.
o. Verify that filters are in place and/or vents are clear.
p. Perform visual and mechanical inspection of instrument transformers as specified in this Section.
q. Perform visual and mechanical inspection of surge arresters as specified in this Section.
r. Control power transformers:
    1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
    2) Verify that primary and secondary fuse/circuit breaker ratings match the Submittal Drawings.
    3) Verify correct functioning of drawout disconnecting contacts grounding contacts, and interlocks.

2. Electrical tests:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground for 1 minute.
        1) Perform test in accordance with NETA ATS tables.
    c. Perform electrical tests on instrument transformers as specified in this Section.
    d. Perform ground-resistance tests:
        1) Perform point-to-point tests to determine the resistance between the main grounding system and major electrical equipment frames, system neutral and derived neutral points.
    e. Test metering devices as specified in this Section.
    f. Control power transformers:
        1) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground:
            a) Test voltages shall be in accordance with NETA ATS tables or as specified by the manufacturer.
            b) Perform a turns-ratio test on all tap positions.
        2) Perform secondary wiring integrity test:
            a) Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source:
                (1) Verify correct potential at all devices.
        3) Verify correct secondary voltage by energizing primary winding with system voltage:
            a) Measure secondary voltage with the secondary wiring disconnected.
    g. Perform current injection tests on the entire current circuit of each switchgear or switchboard:
        1) Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 ampere flows in the secondary circuit:
            a) Verify the correct magnitude of current at each device in the circuit.

h. Perform system function tests.
i. Verify operation of space heaters.
j. Perform electrical tests of surge arresters as specified in this Section.

3. Test values:
   a. Compare bolted connection resistance values to values of similar connections:
      1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
   c. Insulation-resistance values of bus insulation shall be in accordance with the manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
      2) Investigate insulation values less than the allowable minimum.
      3) Do not proceed with dielectric withstand voltage tests until insulation-resistance values are above minimum values.
   d. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.
   e. Instrument transformer test values shall be as specified in this Section.
   f. Meter test values shall be as specified in this Section.
   g. Investigate grounding system point-to-point resistance values that exceed 0.5 ohm.
   h. Control power transformers:
      1) Insulation-resistance values of control power transformers shall be in accordance with the manufacturer's published data:
         a) Refer to NETA ATS tables in the absence of the manufacturer's published data.
         b) Investigate insulation values less than the allowable minimum.
      2) Turns-ratio test results shall not deviate by more than 1/2 percent from either the adjacent coils or the calculated ratio.
         a) Do not proceed with dielectric withstand voltage tests until insulation-resistance values are above minimum values.
      3) Secondary wiring shall be as indicated on the Drawings and specified in the Specifications.
      4) Secondary voltage shall be as indicated on the Drawings.
   i. Current-injection tests shall prove current wiring is as indicated on the Drawings and specified in the Specifications.
   j. Results of system function tests shall match the Drawings and Specifications.
   k. Heaters shall be operational.
   l. Phasing checks shall prove the switchgear or switchboard phasing is correct and in accordance with the system design.
   m. Results of electrical tests on surge arresters shall be as specified in this Section.

E. Dry type transformers:
   1. Visual and mechanical inspection:
      a. Compare equipment nameplate data with the Contract Documents.
      b. Inspect physical and mechanical condition.
      c. Inspect anchorage, alignment, and grounding.
      d. Verify that resilient mounts are free and that any shipping brackets have been removed.
      e. Inspect equipment for cleanliness.
      f. Inspect bolted electrical connections for high resistance using one of the following methods:
         1) Use of low-resistance ohmmeter.
         2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
            a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
      g. Verify that as-left tap connections are as specified.
   2. Electrical tests:
      a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
      b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground:
         1) Apply voltage in accordance with the manufacturer's published data.
            a) Refer to NETA ATS tables in the absence of the manufacturer's published data.
      c. Calculate dielectric absorption ration or polarization index.
      d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral after energization and before loading.
   3. Test values:
      a. Compare bolted connection resistance values to values of similar connections:
         1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
         1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
      c. Tap connections are left as found unless otherwise specified.
      d. Minimum insulation-resistance values of transformer insulation shall be in accordance with the manufacturer's published data:
         1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
         2) Investigate insulation values less than the allowable minimum.
      e. Dielectric absorption ratio or polarization index shall not be less than 1.0.
      f. Turns-ratio results should not deviate more than 1/2 percent from either the adjacent coils or calculated ratio.
      g. Phase-to-phase and phase-to-neutral secondary voltages shall be in agreement with nameplate data.

F. Liquid-filled transformers:
   1. Visual and mechanical inspection:
      a. Compare equipment nameplate data with the Contract Documents.

b. Inspect physical and mechanical condition.
c. Inspect impact recorder before unloading.
d. Test dew point of tank gases, if applicable.
e. Inspect anchorage, alignment, grounding and required clearances.
f. Verify the presence of PCB content labeling.
g. Verify removal of any shipping bracing after placement.
h. Verify the bushings are clean.
i. Verify that alarm, control and trip settings on temperature and level indicators are as specified.
j. Verify operation of alarm, control, and trip circuits from temperature and level indicators, pressure relief device, gas accumulator, and fault pressure relay, if applicable.
k. Verify that cooling fans operate correctly and that fan motors have correct overcurrent protection.
l. Inspect bolted electrical connections for high resistance using one of the following methods:
    1) Use of low-resistance ohmmeter.
    2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
        a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
m. Verify correct liquid level in tanks and bushings.
n. Verify valves are in the correct operating position.
o. Verify that positive pressure is maintained on gas-blanketed transformers.
p. Perform inspections and mechanical tests as recommended by the manufacturer.
q. Test load tap-changer in accordance with NETA ATS requirements.
r. Verify presence of transformer surge arresters.
s. Verify de-energized tap-changer position is left as specified.

2. Electrical tests:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground:
        1) Apply voltage in accordance with the manufacturer's published data:
            a) Refer to NETA ATS tables in the absence of the manufacturer's published data.
        2) Calculate polarization index.
    c. Perform turns ratio tests at all tap positions.
    d. Perform insulation power-factor or dissipation-factor tests on windings in accordance with the test equipment manufacturer's published data.
    e. Perform power-factor or dissipation-factor tests on each bushing equipped with a power-factor/capacitance tap:
        1) In the absence of a power-factor/capacitance tap, perform hot-collar tests.
        2) Perform tests in accordance with the test equipment manufacturer's published data.
    f. Perform excitation-current tests in accordance with the test equipment manufacturer's published data.
    g. Perform sweep frequency response analysis tests.

h. Measure the resistance of each primary winding in each no-load tap changer position. Measure the resistance of each secondary winding in each no-load tap changer position.
i. Remove a sample of insulating liquid in accordance with ASTM D923 and test in accordance with the following standards:
    1) Dielectric breakdown voltage: ASTM D877 or ASTM D1816.
    2) Acid neutralization number: ASTM D974.
    3) Interfacial tension: ASTM D971.
    4) Color: ASTM D1500.
    5) Visual condition: ASTM D1524.
    6) Water in insulating fluids: ASTM D1533.
j. Remove a sample of insulating liquid in accordance with ASTM D924. Sample shall be tested for the following:
    1) Dissolved-gas analysis: IEEE C57.104 or ASTM D3612.
k. Test instrument transformers as specified in this Section.
l. Test surge arresters as specified in this Section, if applicable.
m. Test transformer neutral grounding impedance device, if applicable.
n. Verify operation of cubicle or air terminal compartment space heaters.

3. Test values:
    a. Alarm control and trip circuits from temperature and level indicators, as well as pressure relief device and fault pressure relay, shall operate within the manufacturer's recommendations for their specified settings.
    b. Cooling fans and pumps shall operate.
    c. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    d. Bolt-torque levels shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    e. Liquid levels in the transformer tanks and bushings shall be within indicated tolerances.
    f. Positive pressure shall be indicated on pressure gauge for gas-blanketed transformers.
    g. Minimum insulation-resistance values of transformer insulation shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
        2) Investigate insulation values less than the allowable minimum.
    h. Polarization index shall be greater than 1.0:
        1) Compare to any previous values.
    i. Turns-ratio test result shall not deviate by more than 1/2 percent from either the adjacent coils or the calculated ratio.
    j. Maximum winding insulation power-factor/dissipation-factor values shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    k. Investigate bushing power-factor values that vary from nameplate values by more than 150 percent. Investigate bushing capacitance values that

vary from nameplate values by more than 5 percent. Investigate bushing hot-collar test values that exceed 0.1 watts.

l. Typical excitation-current test data pattern for a 3-legged core transformer is 2 similar current readings and 1 lower current reading.
m. Sweep frequency response analysis test results shall be comparable to previously obtained results.
n. Consult the manufacturer if winding-resistance test values vary by more than 2 percent from factory test values or between adjacent phases.
o. Investigate leakage reactance per phase test results that deviate from the average of the 3 readings by more than 3 percent. 3 phase equivalent test results serve as a benchmark for future tests.
p. Core insulation values shall be comparable to previously obtained results but not be less than 1.0 megohm at 500 VDC.
q. Investigate the presence of oxygen in the nitrogen gas blanket.
r. Insulating liquid values shall be in accordance with NETA ATS tables.
s. Evaluate results of dissolved-gas analysis in accordance with IEEE C57.104.
t. Results of electrical tests on instrument transformers shall be as specified in this Section.
u. Results of surge arrester tests shall be as specified in this Section.
v. Compare grounding impedance device results to the manufacturer's published data.
w. Heaters shall be operational.

G. Low voltage cables, 600 volt maximum:
1. Visual and mechanical inspection:
a. Compare cable data with the Drawings and Specifications.
b. Inspect exposed sections of cable for physical damage and correct connection as indicated on the Drawings.
c. Inspect bolted electrical connections for high resistance by one of the following methods:
1) Use of low-resistance ohmmeter.
2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
d. Inspect compression applied connectors for correct cable match and indentation.
e. Inspect for correct identification and arrangement.
f. Inspect cable jacket insulation and condition.
2. Electrical tests:
a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
b. Perform insulation resistance test on each conductor sized #8 AWG or larger with respect to ground and adjacent conductors:
1) Applied potential shall be 500 volts DC for 300-volt rated cable and 1,000 volts DC for 600-volt rated cable.
2) Test duration shall be 1 minute.
c. Perform continuity tests on power and control conductors to ensure correct cable connection.
d. Verify uniform resistance of parallel conductors.

3. Test values:
    a. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    b. Insulation-resistance values shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
        2) Investigate values of insulation-resistance less than the allowable minimum.
    c. Cable shall exhibit continuity.
    d. Deviations in resistance between parallel conductors shall be investigated.

H. Medium voltage cables:
1. Visual and mechanical inspection:
    a. Compare cable data with the Contract Documents.
    b. Inspect exposed sections of cables for physical damage.
    c. Inspect bolted electrical connections for high resistance using one of the following methods:
        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
            a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
    d. Inspect compression-applied connectors for correct cable match and indentation.
    e. Inspect shield grounding, cable support, and terminations.
    f. Verify the visible bends meet or exceed ICEA and the manufacturer's published minimum allowable bending radius.
    g. If cables are terminated through window-type current transformers, inspect to verify that neutral and ground conductors are correctly placed and that shields are correctly terminated for operation of protective devices.
    h. Inspect for correct identification and arrangements.
    i. Inspect jacket insulation and condition.
2. Electrical tests:
    a. Perform resistance measurements through bolted connections with low-resistance ohmmeter.
    b. Perform an insulation-resistance test individually on each conductor with all other conductors and shields grounded:
        1) Apply voltage in accordance with the manufacturer's published data:
            a) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    c. Perform shield-continuity test on each power cable.
    d. Perform cable and time domain reflectometer (TDR) measurements on each conductor.
    e. In accordance with ICEA, IEC, IEEE, and other power cable consensus standards, testing can be performed by means of direct current, power

frequency alternating current, very low frequency alternating current, or damped alternating current.

1) These sources may be used to perform insulation-resistance tests, and baseline diagnostic tests such as partial discharge analysis, and power factor or power dissipation factor.
2) Selection shall be made after an evaluation of the available test methods and a review of the installed cable system.
3) Some of available test methods are as follows:
    a) Dielectric withstand:
        (1) Direct current dielectric withstand voltage.
        (2) Very low frequency dielectric withstand voltage.
        (3) Power frequency dielectric withstand voltage.
        (4) Damped alternating current voltage.
    b) Baseline diagnostic tests:
        (1) Power factor/dissipation factor (tan delta):
            (a) Power frequency.
            (b) Very low frequency.
        (2) Direct current insulation-resistance.
        (3) Partial discharge:
            (a) Online (50/60 hertz).
            (b) Offline:
                - Power frequency.
                - Very low frequency.

3. Test values:
    a. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    c. Minimum bend radius to which insulated cables may be bent for permanent training shall be in accordance with NETA ATS tables.
    d. Insulation-resistance values shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
        2) Investigate values of insulation-resistance less than the allowable minimum.
    e. Shielding shall exhibit continuity:
        1) Investigate resistance values in excess of 10 ohms per 1,000 feet of cable.
    f. If no evidence of distress of insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.
    g. Based on the test methodology chosen, refer to the applicable standards or manufacturer's literature for acceptable values.

I. Low voltage molded case and insulated case circuit breakers:
   1. Visual and mechanical inspection:
      a. Compare equipment nameplate data with the Contract Documents.
      b. Inspect physical and mechanical condition.
      c. Inspect anchorage and alignment.
      d. Verify the unit is clean.
      e. Operate the circuit breaker to ensure smooth operation.
      f. Inspect bolted electrical connections for high resistance by one of the following methods:
         1) Use of low-resistance ohmmeter.
         2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
            a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
      g. Perform adjustments for final protective device settings in accordance with the coordination study.
   2. Electrical tests:
      a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
      b. For breakers 100 A and higher:
         1) Perform insulation-resistance tests for 1 minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed and across each open pole:
            a) Apply voltage in accordance with the manufacturer's published data.
            b) Refer to NETA ATS tables in the absence of the manufacturer's published data.
         2) Perform a contact/pole-resistance test.
         3) Determine long-time pickup and delay by primary current injection.
         4) Determine short-time pickup and delay by primary current injection.
         5) Determine ground-fault pickup and delay by primary current injection.
         6) Determine instantaneous pickup value by primary current injection.
         7) Perform minimum pickup voltage tests on shunt trip and close coils in accordance with the manufacturer's published data.
         8) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, anti-pump function and trip unit battery condition:
            a) Reset trip logs and indicators.
         9) Verify operation of charging mechanism.
   3. Test values:
      a. Compare bolted connection resistance values to values of similar connections:
         1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
         1) Refer to NETA ATS tables in the absence of the manufacturer's published data.

c. Insulation-resistance values shall be in accordance with the manufacturer's published data:
    1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    2) Investigate values of insulation-resistance less than the allowable minimum.
d. Microhm or DC millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data:
    1) If the manufacturer's data is not available, investigate any values which deviate from adjacent poles or similar breakers by more than 50 percent of the lowest value.
e. Long-time pickup values shall be as specified, and the trip characteristic shall not exceed the manufacturer's published time-current characteristic tolerance band including adjustment factors:
    1) If the manufacturer's curves are not available, trip times shall not exceed the value shown in NETA ATS tables.
f. Short-time pickup values shall be as specified, and the trip characteristic shall not exceed the manufacturer's published time-current tolerance band.
g. Ground fault pickup values shall be as specified, and the trip characteristic shall not exceed the manufacturer's published time-current tolerance band.
h. Instantaneous pickup values shall be as specified and within the manufacturer's published tolerances:
    1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
i. Pickup values and trip characteristics shall be within the manufacturer's published tolerances.
j. Determine energy reducing maintenance switch pickup value by primary current injection.
k. Breaker open, close, trip, trip-free, anti-pump, and auxiliary features shall function as designed.
l. Charging mechanism shall operate in accordance with the manufacturer's published data.

J. Instrument transformers - voltage transformers:
1. Visual and mechanical inspection:
    a. Compare equipment nameplate data with the Contract Documents.
    b. Inspect physical and mechanical condition.
    c. Verify correct connection of transformers with system requirements.
    d. Verify that adequate clearances exist between primary and secondary circuit wiring.
    e. Verify the unit is clean.
    f. Inspect bolted electrical connections for high resistance using one of the following methods:
        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
            a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
    g. Verify that required grounding and connections provide contact.
    h. Verify correct primary and secondary fuse sizes for voltage transformers.

i. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
j. Perform as-left tests.

2. Electrical tests - voltage transformers:
   a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
   b. Perform insulation-resistance tests winding-to-winding and winding-to-ground:
      1) Test voltage shall be applied for 1 minute in accordance with NETA ATS requirements.
      2) For solid state devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.
   c. Perform a polarity test on each voltage transformer to verify the polarity marks on H_1- X_1 relationship as applicable.
   d. Perform a turns ratio test on all tap positions.
   e. Measure voltage circuit burdens at transformer terminals.
   f. Perform a dielectric withstand test on the primary windings with the secondary windings grounded:
      1) Dielectric voltage shall be in accordance with NETA ATS tables.
      2) Apply the test voltage for 1 minute.
   g. Perform power-factor or dissipation-factor tests in accordance with the test equipment manufacturer's published data.
   h. Verify that voltage transformer secondary circuits are grounded and have only 1 grounding point in accordance with IEEE C57.13.3:
      1) That grounding point should be located as specified by the Engineer in the Contract Documents.

3. Test values:
   a. Compare bolted connection resistance values to values of similar connections:
      1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
   c. Insulation-resistance values of instrument transformers shall be in accordance with the manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
   d. Polarity results shall agree with transformer markings.
   e. Ratio errors shall be in accordance with IEEE C57.13.
   f. Measured burdens shall be compared to instrument transformer ratings.
   g. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the primary winding is considered to have passed the test.
   h. Power-factor or dissipation-factor values shall be compared to the manufacturer's published data:
      1) In the absence of the manufacturer's published data, use the test equipment manufacturer's published data.
   i. Test results shall indicate that the circuits have only 1 grounding point.

K. Metering devices, microprocessor based:
   1. Visual and mechanical inspection:
      a. Compare equipment nameplate data with the Contract Documents.
      b. Inspect meters and cases for physical damage.
      c. Clean front panel.
      d. Verify tightness of electrical connections.
      e. Record the following:
         1) Model number.
         2) Serial number.
         3) Firmware revision.
         4) Software revision.
         5) Rated control voltage.
      f. Verify operation of display and indicating devices.
      g. Record passwords.
      h. Verify the unit is grounded in accordance with the manufacturer's instructions.
      i. Set required parameters including instrument transformer ratios, system type, frequency, power demand methods/intervals, and communications requirements.
   2. Electrical tests:
      a. Apply voltage or current as appropriate to each analog input and verify correct measurement and indication.
      b. Confirm correct operation and setting of each auxiliary input/output feature including mechanical relay, digital and analog.
      c. After initial system energization, confirm measurements and indications are consistent with loads present.
   3. Test values:
      a. Nameplate data shall match the Contract Documents.
      b. Tightness of electrical connections shall ensure a low resistance connection.
      c. Display and indicating devices shall operate in accordance with the manufacturer's published data.
      d. Measurement and indication of applied voltages and currents shall be within the manufacturer's published tolerances for accuracy.
      e. Auxiliary input/output features shall operate in accordance with the settings and the manufacturer's published data.
      f. Measure and indications shall be consistent with energized system loads.

L. Grounding systems:
   1. Visual and mechanical inspection:
      a. Inspect ground system for compliance with the Contract Documents and the NEC.
      b. Inspect physical and mechanical condition.
      c. Inspect bolted electrical connections for high resistance using one of the following methods:
         1) Use of low-resistance ohmmeter.
         2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
            a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
      d. Inspect anchorage.

2. Electrical tests:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Perform fall of potential test or alternative test in accordance with IEEE 81 on the main grounding electrode or system.
    c. Perform point-to-point tests to determine the resistance between the main grounding system and major electrical equipment frames, the system neutral and any derived neutral points.
3. Test values:
    a. Grounding system electrical and mechanical connections shall be free of corrosion.
    b. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    c. Bolt-torque levels shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    d. Resistance between the main grounding electrode and ground shall be as specified in Section 16060 - Grounding and Bonding.
    e. Investigate point-to-point resistance values that exceed 0.5 ohm.

M. Rotating machinery, AC induction motors and generators:
1. Visual and mechanical inspection:
    a. Compare equipment nameplate information with the Contract Documents.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, and grounding.
    d. Inspect air baffles, filter media, cooling fans, slip rings, brushes, and brush rigging.
    e. Inspect bolted electrical connections for high resistance using one or more of the following methods:
        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
            a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
    f. Manually rotate the rotor and check for problems with the bearings or shaft.
    g. Rotating equipment:
        1) Operate at rated design load conditions.
        2) Confirm that equipment is properly assembled.
        3) Confirm the equipment moves or rotates in the proper direction.
        4) Confirm shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances.
        5) Confirm that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
    h. Verify correct application of appropriate lubrication and lubrication systems.
    i. Verify that resistance temperature detector (RTD) circuits conform to that indicated on the Drawings.

2. Electrical tests - AC induction:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Perform insulation-resistance test in accordance with IEEE 43:
        1) On motors 200 horsepower and smaller, test duration shall be 1 minute. Calculate dielectric absorption ratio for 60/30-second periods.
        2) On motors larger than 200 horsepower, test duration shall be 10 minutes. Calculate polarization index.
    c. On machines rated at 2,300 volts and greater, perform dielectric withstand voltage tests in accordance with:
        1) IEEE 95 for DC dielectric withstand voltage tests.
        2) NEMA MG1 for AC dielectric withstand voltage tests.
    d. Perform phase-to-phase stator resistance test on machines rated at 2,300 volts and greater.
    e. Perform insulation-resistance test on insulated bearings in accordance with the manufacturer's published data.
    f. Test surge protection devices as specified in this Section.
    g. Test motor starter as specified in this Section.
    h. Perform resistance tests on resistance temperature detector (RTD) circuits.
    i. Verify operation of motor space heater, if applicable.
3. Test values:
    a. Inspection:
        1) Air baffles shall be clean and installed in accordance with the manufacturer's published data.
        2) Filter media shall be clean and installed in accordance with the manufacturer's published data.
        3) Cooling fans shall operate.
        4) Slip ring alignment shall be within the manufacturer's published tolerances.
        5) Brush alignment shall be within the manufacturer's published tolerances.
        6) Brush rigging shall be within the manufacturer's published tolerances.
    b. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    c. Bolt-torque levels shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    d. Airgap spacing and machine alignment shall be in accordance with the manufacturer's published data.
    e. Recommended minimum insulation-resistance ($IR_{1\ min}$) test results in megohms shall be in accordance with NETA ATS tables.
        1) Polarization index value shall not be less than 2.0.
        2) Dielectric absorption ratio shall not be less than 1.4.
    f. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.

g. Investigate phase-to-phase stator resistance values that deviate by more than 5 percent.
h. Power factor or dissipation factor values shall be compared to the manufacturer's published data:
    1) In the absence of the manufacturer's published data, compare values of similar machines.
i. Tip-up values shall indicate no significant increase in power factor.
j. If no evidence of distress, insulation failure, or waveform nesting is observed by the end of the total time of voltage application during the surge comparison test, the test specimen is considered to have passed the test.
k. Bearing insulation-resistance measurements shall be within manufacturer's published tolerances:
    1) In the absence of the manufacturer's published data, compare values of similar machines.
l. Test results of surge protection devices shall be as specified in this Section.
m. Test results of motor starter equipment shall be as specified in this Section.
n. RTD circuits shall conform to the design intent and machine protection device manufacturer's published data.
o. Heaters shall be operational.
p. Vibration amplitudes of the uncoupled and unloaded machine shall be in accordance with the manufacturer's published data:
    1) In the absence of the manufacturer's published data, vibration amplitudes shall not exceed values in NETA ATS tables.
    2) If values exceed those in the NETA ATS tables, perform a complete vibration analysis.

N. Motor starters, low voltage:
1. Visual and mechanical inspection:
    a. Compare equipment nameplate information with the Contract Documents.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, and grounding.
    d. Verify the unit is clean.
    e. Inspect contactors:
        1) Verify mechanical operation.
        2) Verify contact gap, wipe, alignment, and pressure is in accordance with the manufacturer's published data.
    f. Motor-running protection:
        1) Verify overload element rating/motor protection settings are correct for its application.
        2) If motor running protection is provided by fuses, verify correct fuse rating.
    g. Inspect bolted electrical connections for high resistance using one of the following methods:
        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
            a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
    h. Lubrication requirements:
        1) Verify appropriate lubrication on moving current-carrying parts.
        2) Verify appropriate lubrication on moving and sliding surfaces.

2. Electrical tests:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Perform insulation-resistance tests for 1 minute on each pole, phase-to-phase and phase-to-ground with the starter closed, and across each open pole for 1 minute:
        1) Test voltage shall be in accordance with the manufacturer's published data.
        2) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    c. Test motor protection devices in accordance with the manufacturer's published data.
    d. Test circuit breakers as specified in this Section.
    e. Perform operational tests by initiating control devices.
3. Test values:
    a. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    c. Insulation-resistance values shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
        2) Investigate values of insulation-resistance less than the allowable minimum.
    d. Motor protection parameters shall be in accordance with the manufacturer's published data.
    e. Circuit breaker test results shall as be specified in this Section.
    f. Control devices shall perform in accordance with system design requirements.

O. Motor control centers, low voltage:
1. Visual and mechanical inspection:
    a. Compare equipment nameplate data with the Contract Documents.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, grounding and required clearances.
    d. Verify the unit is clean and shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.
    e. Verify that circuit breaker/fuse sizes and types correspond to the approved Submittals and the coordination study.
    f. Verify that current and voltage transformer ratios correspond to those indicated on the Drawings.
    g. Verify that wiring connections are tight and that wiring is secure to prevent damage during routine operation of moving parts.
    h. Inspect bolted electrical connections for high resistance using one of the following methods:
        1) Use of low-resistance ohmmeter.

2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.

i. Verify operation and sequencing of interlocking systems:
1) Attempt closure on locked-open devices.
2) Attempt to open locked-closed devices.
3) Make/attempt key-exchanges in all positions.

j. Lubrication requirements:
1) Verify appropriate lubrication on moving current-carrying parts.
2) Verify appropriate lubrication on moving and sliding surfaces.

k. Inspect insulators for evidence of physical damage or contaminated surfaces.

l. Verify correct barrier and shutter installation and operation.

m. Exercise active components.

n. Inspect indicating devices for correct operation.

o. Verify that filters are in place and/or vents are clear.

p. Perform visual and mechanical inspection of instrument transformers as specified in this Section.

q. Perform visual and mechanical inspection of surge arresters as specified in this Section.

r. Inspect control power transformers:
1) Inspect for physical damage, cracked insulation, broken leads, and tightness of connections, defective wiring, and overall general condition.
2) Verify that primary and secondary fuse/circuit breaker ratings match the Submittal Drawings.
3) Verify correction functioning of grounding contacts.

s. Perform visual and mechanical inspection of motor control center components as specified in this Section.

2. Electrical tests:
a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.

b. Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground for 1 minute:
1) Perform test in accordance with NETA ATS tables.

c. Perform a dielectric withstand test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with the manufacturer's published data or NETA ATS tables. Apply the test voltage for 1 minute.

d. Perform ground-resistance tests:
1) Perform point-to-point tests to determine the resistance between the main grounding system and major electrical equipment frames, system neutral and derived neutral points.

e. Control power transformers:
1) Perform insulation-resistance tests, winding-to-winding and winding-to-ground:
a) Test voltages shall be in accordance with NETA ATS tables or as specified by the manufacturer.

2) Perform secondary wiring integrity test:
a) Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source:
(1) Verify correct potential at all devices.
3) Verify correct secondary voltage by energizing primary winding with system voltage:
a) Measure secondary voltage with the secondary wiring disconnected.

f. Verify operation of space heaters.
g. Perform electrical tests of motor control center components as specified in this Section.

3. Test values:
a. Compare bolted connection resistance values to values of similar connections:
1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
c. Insulation-resistance values for bus and control power transformers shall be in accordance with the manufacturer's published data:
1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
2) Investigate insulation values less than the allowable minimum.
3) Do not proceed with dielectric withstand voltage tests until insulation-resistance values are above minimum values.
d. Bus insulation shall withstand the over potential test voltage applied.
e. Instrument transformer test values shall be as specified in this Section.
f. Investigate grounding system point-to-point resistance values that exceed 0.5 ohm.
g. Meter accuracy shall be in accordance with the manufacturer's published data.
h. Control power transformers:
1) Insulation-resistance values of control power transformers shall be in accordance with the manufacturer's published data:
a) Refer to NETA ATS tables in the absence of the manufacturer's published data.
b) Investigate insulation values less than the allowable minimum.
c) Do not proceed with dielectric withstand voltage tests until insulation-resistance values are above minimum values.
2) Secondary wiring shall be as indicated on the Drawings and specified in the Specifications.
3) Secondary voltage shall be as indicated on the Drawings.
i. Heaters shall be operational.
j. Test values for motor control center components shall be as specified in this Section.

P. Variable frequency drive systems:
1. Visual and mechanical inspection:
a. Compare equipment nameplate data with the Contract Documents.

b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, and grounding.
d. Verify the unit is clean.
e. Ensure vent path openings are free from debris and that heat transfer surfaces are clean.
f. Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.
g. Motor running protection:
    1) Verify drive overcurrent setpoints are correct for their application.
    2) If drive is used to operate multiple motors, verify individual overload element ratings are correct for their application.
    3) Apply minimum and maximum speed setpoints. Verify setpoints are within limitations of the load coupled to the motor.
h. Inspect bolted electrical connections for high resistance using one of the following methods:
    1) Use of low-resistance ohmmeter.
    2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
        a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
i. Verify correct fuse sizing in accordance with the manufacturer's published data.
j. Perform visual and mechanical inspection of input circuit breaker as specified in this Section.

2. Electrical tests:
    a. Perform resistance measurements through bolted connections with low resistance ohmmeter.
    b. Test the motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.
    c. Test for the following parameters in accordance with relay calibration procedures specified in NETA ATS, or as recommended by the manufacturer:
        1) Input phase loss protection.
        2) Input overvoltage protection.
        3) Output phase rotation.
        4) Overtemperature protection.
        5) Direct current overvoltage protection.
        6) Overfrequency protection.
        7) Drive overload protection.
        8) Fault alarm outputs.
    d. Harmonic distortion measurements for both voltage and current is within the specification limits at the installed site.
    e. Peak voltage at the motor terminations is less than 90 percent of the motor insulation dielectric withstand level.
    f. Perform continuity tests on bonding conductors as specified in accordance with NETA ATS.
    g. Perform start-up of drive in accordance with the manufacturer's published data. Calibrate drive to the system's minimum and maximum speed control signals.

h. Perform operational tests by initiating control devices:
    1) Slowly vary drive speed between minimum and maximum. Observe motor and load for unusual noise or vibration.
    2) Verify operation of drive from remote start/stop and speed control signals.
i. Perform electrical tests of input circuit breaker as specified in this Section.
j. Measure fuse resistance.

3. Test values:
    a. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    c. Overload test trip times at 300 percent of overload element rating shall be in accordance with the manufacturer's published time-current curve.
    d. Test values for input circuit breaker shall be as specified in this Section.
    e. Relay calibration results shall be as specified in this Section.
    f. Continuity of bonding conductors shall be in accordance with NETA ATS.
    g. Control devices shall perform in accordance with system requirements.
    h. Operational tests shall conform to system design requirements.
    i. Investigate fuse resistance values that deviate from each other by more than 15 percent.

Q. Single engine generator:
1. Visual and mechanical inspection:
    a. Compare equipment nameplate data with the Contract Documents.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, and grounding.
    d. Verify the unit is clean.
2. Electrical and mechanical tests:
    a. Perform insulation-resistance tests in accordance with IEEE 43:
        1) Machines larger than 150 kilowatts: Test duration shall be 10 minutes. Calculate polarization index.
        2) Machines 150 kilowatts and less: Test duration shall be 1 minute. Calculate the dielectric-absorption rate.
    b. Test protective relay devices as specified in this Section.
    c. Verify phase rotation, phasing, and synchronized operation as required by the application.
    d. Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
    e. Conduct performance test in accordance with NFPA 110.
    f. Verify correct functioning of governor and regulator.
    g. Load bank testing:
        1) Provide a resistive load bank to test the operation of the engine generator.
        2) Load bank shall be capable of loading the engine generator to its full nameplate kilowatt rating at unity power factor.

3) Load steps shall simulate the plant load steps used in sizing the engine generator.
4) Test run at full nameplate kilowatt rating for a minimum of 4 hours:
a) Record at 10-minute intervals:
(1) Voltage.
(2) Frequency.
(3) Current.
(4) Power factor.
(5) Engine oil pressure.
(6) Engine oil temperature.
(7) Air inlet temperature.
(8) Radiator discharge temperature.
(9) Engine coolant temperature.
(10) Vibration levels at each main bearing cap.

3. Test values:
a. Anchorage, alignment, and grounding should be in accordance with the manufacturer's published data and system design.
b. Dielectric absorption ratio or polarization index shall be compared to previously obtained results and should not be less than 1.0. Recommended minimum insulation ($IR_{1\ min}$) test results in megohms shall be corrected to 40 degrees Celsius and read as follows:
1) $IR_{1\ min}$ equals kilovolt + 1 for most windings made before 1970, all field windings, and others not described below.
a) Kilovolt is the rated machine terminal-to-terminal voltage in rms kilovolt.
2) $IR_{1\ min}$ equals 100 megohms for most DC armature and AC windings built after 1970 (form-wound coils).
3) $IR_{1\ min}$ equals 5 megohms for most machines and random-wound stator coils and form-wound coils rated below 1 kilovolt.
a) Dielectric withstand voltage and surge comparison tests shall not be performed on machines having lower values than those indicated above.
c. Polarization index value shall not be less than 2.0.
d. Dielectric absorption ratio shall be greater than 1.0.
e. Protective relay device test results shall be as specified in this Section.
f. Phase rotation, phasing, and synchronizing shall be in accordance with system design requirements.
g. Low oil pressure, over temperature, over speed, and other protection features shall operate in accordance with the manufacturer's published data and system design requirements.
h. Vibration levels shall be in accordance with the manufacturer's published data and shall be compared to baseline data.
i. Performance tests shall conform to the manufacturer's published data and NFPA 110.
j. Governor and voltage regulator shall operate in accordance with the manufacturer's published data and system design requirements:
1) Steady state voltage regulation shall be within 0.5 percent of set point.
2) Output voltage of the generator shall not fall below 10 percent of the power system nominal rating for more than 5 seconds.
3) Output voltage of the generators shall not exceed the power system nominal rating at any time.

4) Steady state frequency regulation shall be within 59.5 hertz to 60.5 hertz.
5) Frequency variations shall not exceed 2 hertz from 60 hertz for more than 2 seconds.

R. Uninterruptible power systems:
1. Testing and settings shall be conducted by the UPS manufacturer's field engineer. Test the complete operation of:
a. Static transfer system.
b. Static bypass system.
c. Maintenance bypass system.
2. Visual and mechanical inspection:
a. Compare equipment nameplate data with the Contract Documents.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and required clearances.
d. Verify that fuse sizes and types correspond to that indicated on the Drawings.
e. Verify the unit is clean.
f. Test electrical and mechanical interlock systems for correct operation and sequencing.
g. Inspect bolted electrical connections for high resistance using one of the following methods:
1) Use of low-resistance ohmmeter.
2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
h. Verify operation of forced ventilation.
i. Verify that filters are in place and/or vents are clear.
3. Electrical tests:
a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
b. Test static transfer from inverter to bypass and back. Use normal load, if possible.
c. Set free running frequency of oscillator.
d. Test DC undervoltage trip level on inverter input breaker. Set according to manufacturer's published data.
e. Test alarm circuits.
f. Verify synchronizing indicators for static switch and bypass switches.
g. Perform electrical tests for:
1) UPS system breakers as specified in this Section.
2) UPS system automatic transfer switches as specified in this Section.
3) UPS system batteries as specified in this Section.
4) UPS rotating machinery as specified in this Section.
4. Test values:
a. Electrical and mechanical interlock systems shall operate in accordance with system design requirements.
b. Compare bolted connection resistance values to values of similar connections:
1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

c. Bolt-torque levels shall be in accordance with the manufacturer's published data:
    1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
d. Static transfer shall function in accordance with the manufacturer's published data.
e. Oscillator free running frequency shall be within the manufacturer's published tolerances.
f. Direct current undervoltage shall trip inverter input breaker.
g. Alarm circuits shall operate in accordance with design requirements.
h. Synchronizing indicators shall operate in accordance with design requirements.
i. Breaker performance shall be as specified in this Section.
j. Automatic transfer switch performance shall be as specified in this Section.
k. Battery test results shall be as specified in this Section.
l. Rotating machinery performance shall be as specified in this Section.

S. Automatic transfer switches:
1. Visual and mechanical inspection:
    a. Compare equipment nameplate data with the Contract Documents.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, grounding, and required clearances.
    d. Verify the unit is clean.
    e. Lubrication requirements:
        1) Verify appropriate lubrication on moving current-carrying parts.
        2) Verify appropriate lubrication on moving and sliding surfaces.
    f. Verify that manual transfer warnings are attached and visible.
    g. Verify tightness of control connections.
    h. Inspect bolted electrical connections for high resistance using one of the following methods:
        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench:
            a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
    i. Perform manual transfer operation.
    j. Verify positive mechanical interlocking between normal and alternate sources.
2. Electrical tests:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.

    b. Perform a contact/pole-resistance test.
    c. Verify settings and operation of control devices.
    d. Calibrate and set relays and timers as specified in this Section.
    e. Verify phase rotation, phasing, and synchronized operation as required by the application.
    f. Perform automatic transfer tests:
        1) Simulate loss of normal power.
        2) Return to normal power.
        3) Simulate loss of emergency power.

4) Simulate all forms of single-phase conditions.

g. Verify correct operation and timing of the following functions:
   1) Normal source voltage-sensing and frequency-sensing relays.
   2) Engine start sequence.
   3) Time delay upon transfer.
   4) Alternate source voltage-sensing and frequency-sensing relays.
   5) Automatic transfer operation.
   6) Interlocks and limit switch function.
   7) Time delay and retransfer upon normal power restoration.
   8) Engine cool down and shutdown feature.

3. Test values:
   a. Compare bolted connection resistance values to values of similar connections:
      1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
   c. Insulation resistance values of transfer switches shall be in accordance with the manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
      2) Values of insulation resistance less than this table or the manufacturer's recommendations shall be investigated.
   d. Microhm or DC millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data:
      1) If the manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
   e. Control devices shall operate in accordance with the manufacturer's published data.
   f. Relay test results shall be as specified in this Section.
   g. Phase rotation, phasing, and synchronization shall be as specified in the system design specifications.
   h. Operation and timing shall be in accordance with the manufacturer's and system design requirements.

T. Fiber-optic cables:
   1. Visual and mechanical inspection:
      a. Compare cable, connector, and splice data with the Contract Documents.
      b. Inspect cable and connections for physical and mechanical damage.
      c. Verify that connectors and splices are correctly installed.
   2. Optical tests:
      a. Perform cable length measurement, fiber fracture inspection, and construction defect inspection using an optical time domain reflectometer (OTDR):
         1) OTDR test performed on fiber cables less than 100 meters shall be performed with the aid of a launch cable.
         2) Adjust OTDR pulse width settings to a maximum setting of 1/1,000th of the cable length or 10 nanoseconds.

b. Perform connector and splice integrity test using an optical time domain reflectometer.
c. Perform cable attenuation loss measurement with an optical power loss test set:
    1) Perform attenuation tests with an optical loss test set capable and calibrated to show anomalies of 0.1 dB as a minimum.
    2) Test multimode fibers at 850 nanometer and 1,300 nanometer.
    3) Test single mode fibers at 1,310 nanometer and 1,550 nanometer.
d. Perform connector and splice attenuation loss measurement from both ends of the optical cable with an optical power loss test set:
    1) At the conclusion of all outdoor splices at 1 location, and before they are enclosed and sealed, splices shall be tested with OTDR at the optimal wavelengths (850 and 1,300 for multimode, 1,310 and 1,550 for single mode), in both directions. Splices shall be tested for integrity as well as attenuation.
e. Perform fiber links integrity and attenuation tests using each link shall be an OTDR and an optical loss test set:
    1) OTDR traces shall be from both directions on each fiber at the 2 optimal wavelengths, 850 nanometer, and 1,300 nanometer for multimode fibers.
    2) Optical loss testing shall be done with handheld test sets in 1 direction at the 2 optimal wavelengths for the appropriate fiber type. Test equipment shall equal or exceed the accuracy and resolution of Agilent/HP 8147 high performance OTDR.

3. Test values:
    a. Cable and connections shall not have been subjected to physical or mechanical damage.
    b. Connectors and splices shall be installed in accordance with industry standards.
    c. Optical time domain reflectometer signal should be analyzed for excessive connection, splice, or cable backscatter by viewing the reflected power/distance graph.
    d. Attenuation loss measurement shall be expressed in dB/km. Losses shall be within the manufacturer's recommendations when no local site specifications are available.
    e. Individual fusion splice losses shall not exceed 0.1 dB. Measurement results shall be recorded, validated by trace, and filed with the records of the respective cable runs.

U. Copper Ethernet cable installation testing:
1. Pre-installation:
    a. Immediately prior to installation, verify that cable to be installed matches that which was submitted.
    b. Verify that no damage has been done to the cable during shipping or handling.
    c. Inspect cable for physical and mechanical damage.
    d. Engineer shall be notified if a cable fails to meet inspection and the cable shall not be installed unless otherwise directed by the Engineer.
2. Post-installation:
    a. Prior to copper Ethernet cable termination, perform cable end-to-end continuity validation testing on installed cables, conductor pairs and cable

shields using toner and probe kit. Any cable that fails testing shall be removed and replaced.

b. Inspect equipment outlet connectors for damage and ensure connectors hold tightly in field device ports.

3. Test equipment:
   a. Certification equipment used for the testing shall be capable of verifying twisted pair cable installation with end-to-end continuity testing.
   b. Use only test cords and adapters that are qualified by the test equipment manufacturer for channel or link test configuration.
   c. Manufacturers: The following or equal:
      1) Fluke Networks, IntelliTone Pro 200 Toner and Probe Kit, MT-8200-60-KIT.
   d. Permanent link testing requirements: As specified in Section 17950 - Commissioning for Instrumentation and Controls.

3.05 FIELD QUALITY CONTROL (NOT USED)

3.06 ADJUSTING (NOT USED)

3.07 CLEANING

A. Dispose of testing expendables.

B. Vacuum cabinets.

C. Sweep clean surrounding areas.

END OF SECTION

SECTION 16990A

CONDUIT SCHEDULE
AREA 01

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 3/CS#16: 3 conductor, 16 gauge, twisted shielded triplet.
   3. */C#Y: Multiconductor cable (* indicates number of conductors, Y indicates conductor size and insulation).
   4. */FO: Fiber optic (* indicates strand count).
   5. CAT6: Category 6 Ethernet cable.
   6. PULL: Pull Rope.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

CONDUIT SCHEDULE AREA 01

JORDAN VALLEY WATER TREATMENT PLANT

SITE

ENGINEER	**SKB**
REVISION	
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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-01-091	02E03	2"	1	PULL	ROPE				FR: SWBD-APF TO: XFMR-APF 1 PULL >> SPARE	
C-01-501	01E02 02E03	2"	4	#14	XHHW-2	1	#14	XHHW-2	FR: CL2-ALARM STROBE TO: PB-15 4 #14 >> CL2-ALARM STROBE CONTROL	C-01-502
C-01-502	02E01	2"	4	#14	XHHW-2	1	#14	XHHW-2	FR: PB-15 TO: PB-14 4 #14 >> CL2-ALARM STROBE CONTROL	C-01-503 C-01-501
C-01-503	02E01	2"	4	#14	XHHW-2	1	#14	XHHW-2	FR: PB-14 TO: PB-13 4 #14 >> CL2-ALARM STROBE CONTROL	C-01-504 C-01-502
C-01-504	02E01 63E05	2"	4	#14	XHHW-2	1	#14	XHHW-2	FR: PB-13 TO: CLIP PANEL 4 #14 >> CL2-ALARM STROBE CONTROL	C-01-503
C-01-601	01E03	1"	3	#14	XHHW-2	1	#14	XHHW-2	FR: LSH-6001 TO: PB #2A 3 #14 >> LSH-6001 CONTROL	C-01-602
C-01-602	01E03	1"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LSH-6002 TO: PB #3A 3 #14 >> LSH-6001 CONTROL 3 #14 >> LSH-6002 CONTROL	C-01-603 C-01-601
C-01-603	01E03	1"	9	#14	XHHW-2	1	#14	XHHW-2	FR: LSH-6003 TO: PB #4A 3 #14 >> LSH-6001 CONTROL 3 #14 >> LSH-6002 CONTROL 3 #14 >> LSH-6003 CONTROL	C-01-604 C-01-602 C-01-602
C-01-604	01E03	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: LSH-6004 TO: PB #5A 3 #14 >> LSH-6001 CONTROL 3 #14 >> LSH-6002 CONTROL 3 #14 >> LSH-6003 CONTROL 3 #14 >> LSH-6004 CONTROL	C-01-605 C-01-603 C-01-603 C-01-603
C-01-605	01E03	2"	33	#14	XHHW-2	1	#14	XHHW-2	FR: LSH-6005 TO: PB-13 3 #14 >> LSH-6001 CONTROL 3 #14 >> LSH-6002 CONTROL 3 #14 >> LSH-6003 CONTROL 3 #14 >> LSH-6004 CONTROL 3 #14 >> LSH-6005 CONTROL 3 #14 >> LSH-6006 CONTROL 3 #14 >> LSH-6007 CONTROL 3 #14 >> LSH-6008 CONTROL 3 #14 >> LSH-6009 CONTROL 3 #14 >> LSH-6010 CONTROL 3 #14 >> LSH-6011 CONTROL	C-01-615 C-01-604 C-01-604 C-01-604 C-01-604 C-01-606 C-01-606 C-01-606 C-01-609 C-01-609 C-01-609
C-01-606	01E03	1"	9	#14	XHHW-2	1	#14	XHHW-2	FR: LSH-6006 TO: PB #5A 3 #14 >> LSH-6006 CONTROL 3 #14 >> LSH-6007 CONTROL 3 #14 >> LSH-6008 CONTROL	C-01-605 C-01-607 C-01-607
C-01-607	01E03	1"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LSH-6007 TO: PB #6A 3 #14 >> LSH-6007 CONTROL 3 #14 >> LSH-6008 CONTROL	C-01-606 C-01-608
C-01-608	01E03	1"	3	#14	XHHW-2	1	#14	XHHW-2	FR: LSH-6008 TO: PB #7A 3 #14 >> LSH-6008 CONTROL	C-01-607
C-01-609	01E03	1"	9	#14	XHHW-2	1	#14	XHHW-2	FR: LSH-6009 TO: PB #5A 3 #14 >> LSH-6009 CONTROL 3 #14 >> LSH-6010 CONTROL 3 #14 >> LSH-6011 CONTROL	C-01-605 C-01-610 C-01-610
C-01-610	01E03 01E04	1"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LSH-6010 TO: PB #9A 3 #14 >> LSH-6010 CONTROL 3 #14 >> LSH-6011 CONTROL	C-01-609 C-01-611
C-01-611	01E04	1"	3	#14	XHHW-2	1	#14	XHHW-2	FR: LSH-6011 TO: PB #10A 3 #14 >> LSH-6011 CONTROL	C-01-610

CONDUIT SCHEDULE AREA 01

JORDAN VALLEY WATER TREATMENT PLANT

SITE

ENGINEER	**SKB**
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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-01-615	02E01 63E05	2"	33	#14	XHHW-2	1	#14	XHHW-2	FR: PB-13 TO: RTU-CL 3 #14 >> LSH-6001 CONTROL 3 #14 >> LSH-6002 CONTROL 3 #14 >> LSH-6003 CONTROL 3 #14 >> LSH-6004 CONTROL 3 #14 >> LSH-6005 CONTROL 3 #14 >> LSH-6006 CONTROL 3 #14 >> LSH-6007 CONTROL 3 #14 >> LSH-6008 CONTROL 3 #14 >> LSH-6009 CONTROL 3 #14 >> LSH-6010 CONTROL 3 #14 >> LSH-6011 CONTROL	 C-01-605 C-01-605 C-01-605 C-01-605 C-01-605 C-01-605 C-01-605 C-01-605 C-01-605 C-01-605 C-01-605
L-01-042	01E02 02E03	2"	2	#12	XHHW-2	1	#12	XHHW-2	FR: POLE LIGHT TO: PB-15 2 #12 >> POLE LIGHT POWER	L-01-043
L-01-043	02E03	2"	2	#12	XHHW-2	1	#12	XHHW-2	FR: PB-15 TO: PB-18 2 #12 >> POLE LIGHT POWER	L-01-503 L-01-042
L-01-051	01E02	2"	2	#10	XHHW-2	1	#10	XHHW-2	FR: BACKWASH TANK LVL HEATER TO: PB-15 2 #10 >> BACKWASH TANK LVL HEATER POWER	L-01-502
L-01-061	01E02	2"	2	#8	XHHW-2	1	#8	XHHW-2	FR: ELECTRONICS ENCLOSURE TO: PB-18 2 #8 >> ELECTRONICS ENCLOSURE POWER	L-01-062
L-01-062	02E03	2"	2	#8	XHHW-2	1	#8	XHHW-2	FR: PB-18 TO: PB-15 2 #8 >> ELECTRONICS ENCLOSURE POWER	L-01-063 L-01-061
L-01-063	02E01	2"	2	#8	XHHW-2	1	#8	XHHW-2	FR: PB-15 TO: PB-14 2 #8 >> ELECTRONICS ENCLOSURE POWER	L-01-064 L-01-062
L-01-064	02E01	2"	2	#8	XHHW-2	1	#8	XHHW-2	FR: PB-14 TO: RTU-CS 2 #8 >> ELECTRONICS ENCLOSURE POWER	 L-01-063
L-01-185	02E02 63E05 68E03	2"	2	#10	XHHW-2	1	#10	XHHW-2	FR: PMP-6852 TO: PNL-CL 2 #10 >> PMP-6852 POWER	
L-01-501	01E02 02E03	2"	2	#10	XHHW-2	1	#10	XHHW-2	FR: SOUTH SECURITY GATE TO: PB-15 2 #10 >> SOUTH SECURITY GATE POWER	L-01-502
L-01-502	02E03	2"	4	#10	XHHW-2	1	#6	XHHW-2	FR: PB-15 TO: PB-18 2 #10 >> BACKWASH TANK LVL HEATER POWER 2 #10 >> SOUTH SECURITY GATE POWER	L-01-503 L-01-051 L-01-501
L-01-503	01E02	2"	4 4	#10 #12	XHHW-2 XHHW-2	1	#6	XHHW-2	FR: PB-18 TO: PNL-CELL 2 #12 >> POLE LIGHT POWER 2 #10 >> BACKWASH TANK LVL HEATER POWER 2 #10 >> SOUTH SECURITY GATE POWER 2 #12 >> S SECURITY GATE CAMERA POWER	 L-01-043 L-01-502 L-01-502 L-01-542
L-01-521	01E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: XFMR-RES TO: PNL-CELL 2 #12 >> XFMR-RES POWER	
L-01-522	01E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: ELECTRONICS ENCLOSURE TO: PNL-CELL 2 #12 >> ELECTRONICS ENCLOSURE POWER	
L-01-531	01E02	1.5"	3	#1/0	XHHW-2	1	#6	XHHW-2	FR: PNL-CELL TO: XFMR-CELL 3 #1/0 >> PNL-CELL POWER	
L-01-541	01E02 02E03	2"	2	#12	XHHW-2	1	#12	XHHW-2	FR: S SECURITY GATE CAMERA TO: PB-15 2 #12 >> S SECURITY GATE CAMERA POWER	L-01-542
L-01-542	02E03	2"	2	#12	XHHW-2	1	#12	XHHW-2	FR: PB-15 TO: PB-18 2 #12 >> S SECURITY GATE CAMERA POWER	L-01-503 L-01-541

CONDUIT SCHEDULE AREA 01

JORDAN VALLEY WATER TREATMENT PLANT

SITE

ENGINEER SKB

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CONDUIT			CONDUCTORS			GROUND							
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE			DESCRIPTION		CONNECTING SEGMENTS
M-01-001	02E03	4"	1	#2/0:15KV	15KV-EPR	1	#2/0	XHHW-2	FR:		XFMR CELL		M-01-002
									TO:		PB-17		
										1	#2/0:15KV	>> XFMR CELL POWER	
M-01-002	02E03	4"	1	#2/0:15KV	15KV-EPR	1	#4	XHHW-2	FR:		PB-17		
									TO:		SECTIONALIZER 2		
										1	#2/0:15KV	>> XFMR CELL POWER	M-01-001
N-01-501	01E02	2"	1		CAT6	1	#14	XHHW-2	FR:		S SECURITY GATE CAMERA		N-01-503
									TO:		WEST GATE OPERATOR		
										1	CAT6	>> S SECURITY GATE CAMERA NETWORK	
N-01-502	01E02	2"	4	2/C-#14		1	#14	XHHW-2	FR:		CALLBOX		N-01-503
									TO:		WEST GATE OPERATOR		
										2	2/C-#14	>> CALLBOX NETWORK (TEMP)	
										2	2/C-#14	>> CALLBOX NETWORK (PERMANENT)	
N-01-503	02E03	2"	4	2/C-#14		1	#14	XHHW-2	FR:		WEST GATE OPERATOR		N-01-504
			1		CAT6				TO:		PB-15		
			1		12/FO					1	CAT6	>> S SECURITY GATE CAMERA NETWORK	N-01-501
										2	2/C-#14	>> CALLBOX NETWORK (TEMP)	N-01-502
										2	2/C-#14	>> CALLBOX NETWORK (PERMANENT)	N-01-502
										1	12/FO	>> S SECURITY GATE NETWORK	
N-01-504	02E03	2"	2	2/C-#14		1	#14	XHHW-2	FR:		PB-15		N-01-521
			1		CAT6				TO:		PB-18		
			1		12/FO					1	CAT6	>> S SECURITY GATE CAMERA NETWORK	N-01-503
										2	2/C-#14	>> CALLBOX NETWORK (TEMP)	N-01-503
										1	12/FO	>> S SECURITY GATE NETWORK	N-01-503
N-01-505	02E01	2"	2	2/C-#14		1	#14	XHHW-2	FR:		PB-15		N-01-506
									TO:		PB-14		
										2	2/C-#14	>> CALLBOX NETWORK (PERMANENT)	N-01-503
N-01-506	02E01	2"	4	2/C-#14		1	#14	XHHW-2	FR:		PB-14		
			1		CAT6				TO:		RTU-CS		
			1		12/FO					1	CAT6	>> S SECURITY GATE CAMERA NETWORK	N-01-505
										2	2/C-#14	>> CALLBOX NETWORK (TEMP)	N-01-505
										2	2/C-#14	>> CALLBOX NETWORK (PERMANENT)	N-01-505
										1	12/FO	>> S SECURITY GATE NETWORK	N-01-505
N-01-511	01E02	2"	1	3/CS-#16		1	#14	XHHW-2	FR:		GATE CARD READER		N-01-521
									TO:		PB-18		
										1	3/CS-#16	>> GATE CARD READER NETWORK	
N-01-521	01E02	2.5"	2	2/C-#14		1	#14	XHHW-2	FR:		PB-18 (INTERCEPTED FIBER OPTIC TO CULINARY RESERVOIR)		
			1		CAT6				TO:		ELECTRONICS ENCLOSURE		
			2		12/FO					1	CAT6	>> S SECURITY GATE CAMERA NETWORK	N-01-504
			1	3/CS-#16						2	2/C-#14	>> CALLBOX NETWORK (TEMP)	N-01-504
										1	12/FO	>> S SECURITY GATE NETWORK	N-01-504
										1	3/CS-#16	>> GATE CARD READER NETWORK	N-01-511
										1	12/FO	>> CULINARY RESERVOIR NETWORK	
N-01-525	01E02	2"	1		12/FO	1	#14	XHHW-2	FR:		ELECTRONICS ENCLOSURE		N-01-526
									TO:		PB-18		
										1	12/FO	>> ELECTRONICS ENCLOSURE NETWORK	
N-01-526	02E03	2"	1		12/FO	1	#14	XHHW-2	FR:		PB-18		N-01-527
									TO:		PB-15		
										1	12/FO	>> ELECTRONICS ENCLOSURE NETWORK	N-01-525
N-01-527	02E01	2"	1		12/FO	1	#14	XHHW-2	FR:		PB-15		N-01-528
									TO:		PB-14		
										1	12/FO	>> ELECTRONICS ENCLOSURE NETWORK	N-01-526
N-01-528	02E01	2"	1		12/FO	1	#14	XHHW-2	FR:		PB-14		
									TO:		RTU-CS		
										1	12/FO	>> ELECTRONICS ENCLOSURE NETWORK	N-01-527
N-01-531	01E02	2"	1		12/FO	1	#14	XHHW-2	FR:		ELECTRONICS ENCLOSURE		N-01-922
	02E03								TO:		PB #2		
										1	12/FO	>> ELECTRONICS ENCLOSURE NETWORK	
N-01-611	02E02	2"	1	PULL	ROPE				FR:		WIRELESS NETWORK J-BOX		
	68E03								TO:		RTU-CL		
										1	PULL	>> SPARE	
N-01-901	68E03	1.5"	1		12/FO	1	#14	XHHW-2	FR:		VCP-6800		N-01-903
									TO:		J-BOX		
										1	12/FO	>> VCP-6800 NETWORK	

CONDUIT SCHEDULE AREA 01

JORDAN VALLEY WATER TREATMENT PLANT

SITE

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
N-01-902	68E03	1.5"	1		12/FO	1	#14	XHHW-2	FR: VCP-6830	N-01-903
									TO: J-BOX	
									1 12/FO >> VCP-6830 NETWORK	
N-01-903	02E02 63E05 68E03	2"	2		12/FO	1	#14	XHHW-2	FR: J-BOX	
									TO: RTU-CL	
									1 12/FO >> VCP-6800 NETWORK	N-01-901
									1 12/FO >> VCP-6830 NETWORK	N-01-902
N-01-911	02E02 63E05	2"	1		12/FO	1	#14	XHHW-2	FR: RTU-CL	N-01-921
									TO: PB-16	
									1 12/FO >> RTU-CL NETWORK	
N-01-912	02E02	2"	1		12/FO	1	#14	XHHW-2	FR: RTU-CS	N-01-921
									TO: PB-16	
									1 12/FO >> RTU-CS NETWORK	
N-01-921	02E02 02E03	2"	2		12/FO	1	#14	XHHW-2	FR: PB-16	N-01-922
									TO: PB #2	
									1 12/FO >> RTU-CL NETWORK	N-01-911
									1 12/FO >> RTU-CS NETWORK	N-01-912
N-01-922	01E03 30E10	3"	3		12/FO	1	#14	XHHW-2	FR: PB #2	N-01-923
									TO: PB #11 (VIA SPARE 3" CONDUIT IN EXISTING DUCT BANK)	
									1 12/FO >> RTU-CL NETWORK	N-01-921
									1 12/FO >> RTU-CS NETWORK	N-01-921
									1 12/FO >> ELECTRONICS ENCLOSURE NETWORK	N-01-531
N-01-923	30E10 71E02	3"	3		12/FO	1	#14	XHHW-2	FR: PB #11	N-01-924
									TO: EXISTING PULLBOX (VIA EXISTING EXPOSED 3" CONDUIT)	
									1 12/FO >> RTU-CL NETWORK	N-01-922
									1 12/FO >> RTU-CS NETWORK	N-01-922
									1 12/FO >> ELECTRONICS ENCLOSURE NETWORK	N-01-922
N-01-924	69E01 71E02	3"	3		12/FO	1	#14	XHHW-2	FR: EXISTING PULLBOX	N-01-925
									TO: EXISTING PULLBOX	
									1 12/FO >> RTU-CL NETWORK	N-01-923
									1 12/FO >> RTU-CS NETWORK	N-01-923
									1 12/FO >> ELECTRONICS ENCLOSURE NETWORK	N-01-923
N-01-925	69E01	2.5"	3		12/FO	1	#14	XHHW-2	FR: EXISTING PULLBOX	
									TO: LEVEL 2 NETWORK ROOM	
									1 12/FO >> RTU-CL NETWORK	N-01-924
									1 12/FO >> RTU-CS NETWORK	N-01-924
									1 12/FO >> ELECTRONICS ENCLOSURE NETWORK	N-01-924
N-01-931	30E19 69E01	1.5"	1	PULL	ROPE				FR: EXISTING PULLBOX	N-01-932
									TO: VIA CABLE TRAY	
									1 PULL >> SPARE	
N-01-932	69E01	2"	1	PULL	ROPE				FR: CABLE TRAY	
									TO: CELL SITE EQUIP ROOM VIA EXISTING CONDUIT	
									1 PULL >> SPARE	N-01-931
P-01-031	02E01	2"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PB-15 (CONNECT EXISTING WIRES IN INTERCEPTED DUCTBANK	P-01-032
									TO: PB-14	
									3 #12 >> RESERVOIR TANK LIGHT & HEATING	
P-01-032	02E01	2"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PB-14	
									TO: PP-CS	
									3 #12 >> RESERVOIR TANK LIGHT & HEATING	P-01-031
P-01-071	01E05 30E03	3"	3	350	XHHW-2	1	#1	XHHW-2	FR: MCC-BL	P-01-072
									TO: PB #7 (VIA EXISTING DUCT BANK)	
									3 350 >> MCC-BL POWER	
P-01-072	02E03	4"	3	350	XHHW-2	1	#1	XHHW-2	FR: PB #7	
									TO: SWBD-APF	
									3 350 >> MCC-BL POWER	P-01-071
P-01-081	01E05 30E03	3"	3	350	XHHW-2	1	#1	XHHW-2	FR: MCC-BL	P-01-082
									TO: PB #7 (VIA EXISTING DUCT BANK)	
									3 350 >> MCC-BL POWER	
P-01-082	02E03	4"	3	350	XHHW-2	1	#1	XHHW-2	FR: PB #7	
									TO: SWBD-APF	
									3 350 >> MCC-BL POWER	P-01-081
P-01-091	02E03	4"	4	500	XHHW-2	1	#1/0	XHHW-2	FR: SWBD-APF	
									TO: XFMR-APF	
									4 500 >> SWBD-APF POWER	

CONDUIT SCHEDULE AREA 01

JORDAN VALLEY WATER TREATMENT PLANT

SITE

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P-01-092	02E03	4"	4	500	XHHW-2	1	#1/0	XHHW-2	FR: SWBD-APF TO: XFMR-APF 4 500 >> SWBD-APF POWER	
P-01-093	02E03	4"	4	500	XHHW-2	1	#1/0	XHHW-2	FR: SWBD-APF TO: XFMR-APF 4 500 >> SWBD-APF POWER	
P-01-101	02E01 65E02	4"	3	#4/0	XHHW-2	1	#2	XHHW-2	FR: MCC-CS TO: PB-14 3 #4/0 >> MCC-CS POWER	P-01-102
P-01-102	02E01	4"	3	#4/0	XHHW-2	1	#2	XHHW-2	FR: PB-14 TO: PB-13 3 #4/0 >> MCC-CS POWER	P-01-103 P-01-101
P-01-103	02E01	4"	3	#4/0	XHHW-2	1	#2	XHHW-2	FR: PB-13 TO: SWBD-CS 3 #4/0 >> MCC-CS POWER	P-01-102
P-01-105	02E01 65E02	4"	3	#4/0	XHHW-2	1	#2	XHHW-2	FR: MCC-CS TO: PB-14 3 #4/0 >> MCC-CS POWER	P-01-106
P-01-106	02E01	4"	3	#4/0	XHHW-2	1	#1	XHHW-2	FR: PB-14 TO: PB-13 3 #4/0 >> MCC-CS POWER	P-01-107 P-01-105
P-01-107	02E01	4"	3	#4/0	XHHW-2	1	#1	XHHW-2	FR: PB-13 TO: SWBD-CS 3 #4/0 >> MCC-CS POWER	P-01-106
P-01-121	02E01 63E05	4"	3	#4/0	XHHW-2	1	#2	XHHW-2	FR: MCC-CL TO: PB-13 3 #4/0 >> MCC-CL POWER	P-01-122
P-01-122	02E01	4"	3	#4/0	XHHW-2	1	#2	XHHW-2	FR: PB-13 TO: SWBD-CS 3 #4/0 >> MCC-CL POWER	P-01-121
P-01-125	02E01 63E05	4"	3	#4/0	XHHW-2	1	#2	XHHW-2	FR: MCC-CL TO: PB-13 3 #4/0 >> MCC-CL POWER	P-01-126
P-01-126	02E01	4"	3	#4/0	XHHW-2	1	#2	XHHW-2	FR: PB-13 TO: SWBD-CS 3 #4/0 >> MCC-CL POWER	P-01-125
P-01-141	02E01	4"	3	500	XHHW-2	1	#1	XHHW-2	FR: SWBD-CS TO: PB-12 3 500 >> SWBD-CS POWER	P-01-151
P-01-142	02E01	4"	3	500	XHHW-2	1	#1	XHHW-2	FR: SWBD-CS TO: PB-12 3 500 >> SWBD-CS POWER	P-01-152
P-01-151	02E01	4"	3	500	XHHW-2	1	#1	XHHW-2	FR: PB-12 TO: UNIT SUBSTATION 3 500 >> SWBD-CS POWER	P-01-141
P-01-152	02E01	4"	3	500	XHHW-2	1	#1	XHHW-2	FR: PB-12 TO: UNIT SUBSTATION 3 500 >> SWBD-CS POWER	P-01-142
P-01-161	02E02 63E05 68E03	4"	3	#3/0	XHHW-2	1	#6	XHHW-2	FR: PP-PAC TO: MCC-CL 3 #3/0 >> PP-PAC POWER	
P-01-201	02E01	2"	1	PULL	ROPE				FR: PB-15 TO: PB-14 1 PULL >> SPARE POWER	P-01-202
P-01-202	02E01	2"	1	PULL	ROPE				FR: PB-14 TO: MCC-CS 1 PULL >> SPARE POWER	P-01-201
P-01-311	02E03	4"	3	500	XHHW-2	1	#2/0	XHHW-2	FR: PB #7 TO: SWBD-APF 3 500 >> ATS MCC-A1 POWER (EXISTING CABLE)	
P-01-321	02E03	4"	3	500	XHHW-2	1	#2/0	XHHW-2	FR: PB #7 TO: SWBD-APF 3 500 >> ATS MCC-A1 POWER (EXISTING CABLE)	

CONDUIT SCHEDULE AREA 01

JORDAN VALLEY WATER TREATMENT PLANT

SITE

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P-01-331	02E03	4"	3	500	XHHW-2	1	#2/0	XHHW-2	FR: PB #7 TO: SWBD-APF 3 500 >> ATS MCC-A1 POWER (NEW SPLICED CE	
P-01-411	01E05	4"	3	350	XHHW-2	1	#1	XHHW-2	FR: MCC-WW TO: PB #7 (VIA EXISTING DUCT BANK) 3 350 >> MCC-WW POWER	P-01-412
P-01-412	02E03	4"	3	350	XHHW-2	1	#1	XHHW-2	FR: PB #7 TO: SWBD-APF 3 350 >> MCC-WW POWER	P-01-411
P-01-421	01E05	4"	3	350	XHHW-2	1	#1	XHHW-2	FR: MCC-WW TO: PB #7 (VIA EXISTING DUCT BANK) 3 350 >> MCC-WW POWER	P-01-422
P-01-422	02E03	4"	3	350	XHHW-2	1	#1	XHHW-2	FR: PB #7 TO: SWBD-APF 3 350 >> MCC-WW POWER	P-01-421
P-01-431	02E03	4"	3	350	XHHW-2	1	#1	XHHW-2	FR: SWBD-APF TO: UNIT SUBSTATION 3 350 >> MCC-WW POWER (EXISTING CABLE)	
P-01-441	02E03	4"	3	350	XHHW-2	1	#1	XHHW-2	FR: SWBD-APF TO: UNIT SUBSTATION 3 350 >> MCC-WW POWER (EXISTING CABLE)	
P-01-521	01E02	2"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PB-18 (INTERCEPTED 480V WIRES TO CULINARY RESERVOIR) TO: XFMR-RES 3 #12 >> CULINARY RESERVOIR POWER (TEMP)	
X-01-011	02E03	4"	1	PULL	ROPE				FR: XFMR CELL TO: PB-17 1 PULL >> SPARE	X-01-012
X-01-012	02E03	4"	1	PULL	ROPE				FR: PB-17 TO: SECTIONALIZER 2 1 PULL >> SPARE	X-01-011
X-01-051	01E02 02E03	2"	1	PULL	ROPE				FR: SOUTH SECURITY GATE TO: PB-15 1 PULL >> SPARE	X-01-052
X-01-052	02E01	2"	1	PULL	ROPE				FR: PB-15 TO: PB-14 1 PULL >> SPARE	X-01-053 X-01-051
X-01-053	02E01	2"	1	PULL	ROPE				FR: PB-14 TO: STUB UP IN CS BLDG ELEC ROOM 1 PULL >> SPARE	X-01-052
X-01-061	02E03	2"	1	PULL	ROPE				FR: SOUTH SECURITY GATE TO: PB-15 1 PULL >> SPARE	X-01-062
X-01-062	02E01	2"	1	PULL	ROPE				FR: PB-15 TO: PB-14 1 PULL >> SPARE	X-01-063 X-01-061
X-01-063	02E01	2"	1	PULL	ROPE				FR: PB-14 TO: STUB-UP IN CS BLDG ELEC ROOM 1 PULL >> SPARE	X-01-062
X-01-071	01E02 02E03	5"	1	PULL	ROPE				FR: RELOCATED PULLBOX TO: PB-17 1 PULL >> SPARE	
X-01-072	02E03	5"	1	PULL	ROPE				FR: PB-17 TO: SECTIONALIZER 2 1 PULL >> SPARE	
X-01-094	02E03	4"	1	PULL	ROPE				FR: SWBD-APF TO: XFMR-APF 1 PULL >> SPARE	
X-01-111	02E01	4"	1	PULL	ROPE				FR: MCC-CS TO: PB-14 1 PULL >> SPARE	X-01-112
X-01-112	02E01	4"	1	PULL	ROPE				FR: PB-14 TO: PB-13 1 PULL >> SPARE	X-01-113 X-01-111

CONDUIT SCHEDULE AREA 01

JORDAN VALLEY WATER TREATMENT PLANT

SITE

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
X-01-113	02E01	4"	1	PULL	ROPE				FR: PB-13 TO: SWBD-CS 1 PULL >> SPARE	X-01-112
X-01-115	02E01	4"	1	PULL	ROPE				FR: MCC-CS TO: PB-14 1 PULL >> SPARE	X-01-116
X-01-116	02E01	4"	1	PULL	ROPE				FR: PB-14 TO: PB-13 1 PULL >> SPARE	X-01-117 X-01-115
X-01-117	02E01	4"	1	PULL	ROPE				FR: PB-13 TO: SWBD-CS 1 PULL >> SPARE	X-01-116
X-01-131	02E01	4"	1	PULL	ROPE				FR: MCC-CL TO: PB-13 1 PULL >> SPARE	X-01-132
X-01-132	02E01	4"	1	PULL	ROPE				FR: PB-13 TO: SWBD-CS 1 PULL >> SPARE	X-01-131
X-01-135	02E01 63E05	4"	1	PULL	ROPE				FR: MCC-CL TO: PB-13 1 PULL >> SPARE	X-01-136
X-01-136	02E01	4"	1	PULL	ROPE				FR: PB-13 TO: SWBD-CS 1 PULL >> SPARE	X-01-135
X-01-143	02E01	4"	1	PULL	ROPE				FR: SWBD-CS TO: PB-12 1 PULL >> SPARE	
X-01-144	02E01	4"	1	PULL	ROPE				FR: SWBD-CS TO: PB-12 1 PULL >> SPARE	
X-01-153	02E01	4"	1	PULL	ROPE				FR: PB-12 TO: UNIT SUBSTATION 1 PULL >> SPARE	
X-01-154	02E01	4"	1	PULL	ROPE				FR: PB-12 TO: UNIT SUBSTATION 1 PULL >> SPARE	
X-01-171	02E02 63E05 68E03	4"	1	PULL	ROPE				FR: PAC ROOM TO: CHLORINE ELECTRICAL ROOM 1 PULL >> SPARE	
X-01-175	02E02 63E05 68E03	2"	1	PULL	ROPE				FR: PAC ROOM TO: CHLORINE ELECTRICAL ROOM 1 PULL >> SPARE	
X-01-213	01E02 02E01	4"	1	PULL	ROPE				FR: HH-101 TO: PB-14 1 PULL >> SPARE	X-01-214
X-01-214	02E01	4"	1	PULL	ROPE				FR: PB-14 TO: STUB-UP IN CS BLDG ELEC ROOM 1 PULL >> SPARE	X-01-213
X-01-223	01E02 02E01	4"	1	PULL	ROPE				FR: HH-101 TO: PB-14 1 PULL >> SPARE	X-01-224
X-01-224	02E01	4"	1	PULL	ROPE				FR: PB-14 TO: STUB-UP IN CS BLDG ELEC ROOM 1 PULL >> SPARE	X-01-223
X-01-301	02E02	2"	1	PULL	ROPE				FR: STUB UP IN CS BLDG ELEC ROOM TO: PB-16 1 PULL >> SPARE	
X-01-311	02E02 63E05	2"	1	PULL	ROPE				FR: STUB UP IN CHLORINE BLDG ELEC ROOM TO: PB-16 1 PULL >> SPARE	
X-01-321	02E02 63E05 68E03	2"	1	PULL	ROPE				FR: PAC ROOM TO: STUB UP IN CHLORINE BLDG ELEC ROOM 1 PULL >> SPARE	

CONDUIT SCHEDULE AREA 01

JORDAN VALLEY WATER TREATMENT PLANT

SITE

ENGINEER	**SKB**
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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
X-01-331	02E02 02E03	2"	1	PULL	ROPE				FR: PB-16 TO: PB #2 1 PULL >> SPARE	
X-01-351	02E01	4"	1	PULL	ROPE				FR: RTU-CS TO: PB-14 1 PULL >> SPARE	
X-01-355	02E01 63E05	4"	1	PULL	ROPE				FR: RTU-CL TO: PB-13 1 PULL >> SPARE	
X-01-461	02E03	4"	1	PULL	ROPE				FR: SWBD-APF TO: PB #7 1 PULL >> SPARE	
X-01-471	02E03	4"	1	PULL	ROPE				FR: SWBD-APF TO: PB #7 1 PULL >> SPARE	
X-01-481	02E03	4"	1	PULL	ROPE				FR: SWBD-APF TO: PB #7 1 PULL >> SPARE	
X-01-551	02E03	2"	1	PULL	ROPE				FR: PB-18 TO: PB-15 1 PULL >> SPARE	
X-01-561	02E03	2"	1	PULL	ROPE				FR: PB-18 TO: PB-15 1 PULL >> SPARE	
X-01-571	02E03	2"	1	PULL	ROPE				FR: PB-18 TO: PB-15 1 PULL >> SPARE	

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 16990B

CONDUIT SCHEDULE
AREA 30

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. */FO: Fiber optic (* indicates strand count).
   4. CAT5e: Category 5 enhanced Ethernet cable.
   5. CAT6: Category 6 Ethernet cable.
   6. MFR: Manufacturer or vendor furnished cable.
   7. PULL: Pull Rope.
   8. RS-485 RS-485 cable.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

CONDUIT SCHEDULE AREA

FILTER AND CHEMICAL FEED UPGRADES

FILTERS

ENGINEER	**AJB**
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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-30-010	30E03	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-BL TO: RTU-BL 7 #14 >> MCC-BL CONTROL 3 #14 >> SPARE 2 #14 >> SPD-3001 CONTROL	
C-30-101	30E06	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3010 TO: RTU-NFL1 2 #14 >> AIT-3010 CONTROL	
C-30-102	30E06	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSL-3010 TO: RTU-NFL1 2 #14 >> FSL-3010 CONTROL	
C-30-103	30E06	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-3011 TO: RTU-NFL1 2 #14 >> FIT-3011 CONTROL	
C-30-104	30E14	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3011 TO: RTU-NFL1 6 #14 >> FV-3011 CONTROL	
C-30-105	30E14	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LIT-3011 TO: RTU-NFL1 2 #14 >> LIT-3011 CONTROL	
C-30-106	30E07	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3012 TO: RTU-NFL1 6 #14 >> FV-3012 CONTROL	
C-30-107	30E06	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3013 TO: RTU-NFL1 6 #14 >> FV-3013 CONTROL	
C-30-108	30E06	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3014 TO: FV-3014 7 #14 >> LCP-3014 CONTROL	
C-30-109	30E06	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3014 TO: RTU-NFL1 8 #14 >> FV-3014 CONTROL	
C-30-111	30E14	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3016 TO: RTU-NFL1 8 #14 >> FV-3016 CONTROL	
C-30-112	30E14	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3017 TO: RTU-NFL1 8 #14 >> FV-3017 CONTROL	
C-30-120	30E14	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3011 TO: RTU-NFL1 2 #14 >> AIT-3011 CONTROL POWER	
C-30-151	30E06	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3020 TO: RTU-SFL2 2 #14 >> AIT-3020 CONTROL	
C-30-152	30E06	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSL-3020 TO: RTU-SFL2 2 #14 >> FSL-3020 CONTROL	
C-30-153	30E06	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-3021 TO: RTU-SFL2 2 #14 >> FIT-3021 CONTROL	
C-30-154	30E18	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3021 TO: RTU-SFL2 6 #14 >> FV-3021 CONTROL	
C-30-155	30E18	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LIT-3021 TO: RTU-SFL2 2 #14 >> LIT-3021 CONTROL	
C-30-156	30E07	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3022 TO: RTU-SFL2 6 #14 >> FV-3022 CONTROL	
C-30-157	30E06	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3023 TO: RTU-SFL2 6 #14 >> FV-3023 CONTROL	
C-30-158	30E06	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3024 TO: FV-3024 7 #14 >> LCP-3024 CONTROL	

CONDUIT SCHEDULE AREA

FILTER AND CHEMICAL FEED UPGRADES

FILTERS

ENGINEER	**AJB**
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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-30-159	30E06	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3024 TO: RTU-SFL2 8 #14 >> FV-3024 CONTROL/STATUS	
C-30-161	30E18	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3026 TO: RTU-SFL2 8 #14 >> FV-3026 CONTROL	
C-30-162	30E18	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3027 TO: RTU-SFL2 8 #14 >> FV-3027 CONTROL	
C-30-170	30E18	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3021 TO: RTU-SFL2 2 #14 >> AIT-3021 CONTROL	
C-30-201	30E06	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3030 TO: RTU-NFL3 2 #14 >> AIT-3030 CONTROL	
C-30-202	30E06	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSL-3030 TO: RTU-NFL3 2 #14 >> FSL-3030 CONTROL	
C-30-203	30E07	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-3031 TO: RTU-NFL3 2 #14 >> FIT-3031 CONTROL	
C-30-204	30E14	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3031 TO: RTU-NFL3 6 #14 >> FV-3031 CONTROL	
C-30-205	30E14	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LIT-3031 TO: RTU-NFL3 2 #14 >> LIT-3031 CONTROL	
C-30-206	30E07	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3032 TO: RTU-NFL3 6 #14 >> FV-3032 CONTROL	
C-30-207	30E06	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3033 TO: RTU-NFL3 6 #14 >> FV-3033 CONTROL	
C-30-208	30E07	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3034 TO: FV-3034 7 #14 >> LCP-3034 CONTROL	
C-30-209	30E06	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3034 TO: RTU-NFL3 8 #14 >> FV-3034 CONTROL	
C-30-211	30E14	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3036 TO: RTU-NFL3 8 #14 >> FV-3036 CONTROL	
C-30-212	30E14	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3037 TO: RTU-NFL3 8 #14 >> FV-3037 CONTROL	
C-30-220	30E14	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3031 TO: RTU-NFL3 2 #14 >> AIT-3031 CONTROL	
C-30-251	30E06	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3040 TO: RTU-SFL4 2 #14 >> AIT-3040 CONTROL	
C-30-252	30E06	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSL-3040 TO: RTU-SFL4 2 #14 >> FSL-3040 CONTROL	
C-30-253	30E07	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-3041 TO: RTU-SFL4 2 #14 >> FIT-3041 CONTROL	
C-30-254	30E18	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3041 TO: RTU-SFL4 6 #14 >> FV-3041 CONTROL	
C-30-255	30E18	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LIT-3041 TO: RTU-SFL4 2 #14 >> LIT-3041 CONTROL	

CONDUIT SCHEDULE AREA

FILTER AND CHEMICAL FEED UPGRADES

FILTERS

ENGINEER	**AJB**
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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-30-256	30E07	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3042 TO: RTU-SFL4 6 #14 >> FV-3042 CONTROL	
C-30-257	30E06	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3043 TO: RTU-SFL4 6 #14 >> FV-3043 CONTROL	
C-30-258	30E07	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3044 TO: FV-3044 7 #14 >> LCP-3044 CONTROL	
C-30-259	30E06	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3044 TO: RTU-SFL4 8 #14 >> FV-3044 CONTROL	
C-30-261	30E18	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3046 TO: RTU-SFL4 8 #14 >> FV-3046 CONTROL	
C-30-262	30E18	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3047 TO: RTU-SFL4 8 #14 >> FV-3047 CONTROL	
C-30-270	30E18	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3041 TO: RTU-SFL4 2 #14 >> AIT-3041 CONTROL	
C-30-301	30E06	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3050 TO: RTU-NFL5 2 #14 >> AIT-3050 CONTROL	
C-30-302	30E06	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSL-3050 TO: RTU-NFL5 2 #14 >> FSL-3050 CONTROL	
C-30-303	30E07	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-3051 TO: RTU-NFL5 2 #14 >> FIT-3051 CONTROL	
C-30-304	30E14	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3051 TO: RTU-NFL5 6 #14 >> FV-3051 CONTROL	
C-30-305	30E14	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LIT-3051 TO: RTU-NFL5 2 #14 >> LIT-3051 CONTROL	
C-30-306	30E07	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3052 TO: RTU-NFL5 6 #14 >> FV-3052 CONTROL	
C-30-307	30E06	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3053 TO: RTU-NFL5 6 #14 >> FV-3053 CONTROL	
C-30-308	30E07	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3054 TO: FV-3054 7 #14 >> LCP-3054 CONTROL	
C-30-309	30E06	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3054 TO: RTU-NFL5 8 #14 >> FV-3054 CONTROL	
C-30-311	30E14	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3056 TO: RTU-NFL5 8 #14 >> FV-3056 CONTROL	
C-30-312	30E14	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3057 TO: RTU-NFL5 8 #14 >> FV-3057 CONTROL	
C-30-320	30E14	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3051 TO: RTU-NFL5 2 #14 >> AIT-3051 CONTROL	
C-30-351	30E06	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3060 TO: RTU-SFL6 2 #14 >> AIT-3060 CONTROL	
C-30-352	30E06	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSL-3060 TO: RTU-SFL6 2 #14 >> FSL-3060 CONTROL	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-30-353	30E07	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-3061 TO: RTU-SFL6 2 #14 >> FIT-3061 CONTROL	
C-30-354	30E18	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3061 TO: RTU-SFL6 6 #14 >> FV-3061 CONTROL	
C-30-355	30E18	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LIT-3061 TO: RTU-SFL6 2 #14 >> LIT-3061 CONTROL	
C-30-356	30E07	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3062 TO: RTU-SFL6 6 #14 >> FV-3062 CONTROL	
C-30-357	30E06	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3063 TO: RTU-SFL6 6 #14 >> FV-3063 CONTROL	
C-30-358	30E07	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3064 TO: FV-3064 7 #14 >> LCP-3064 CONTROL	
C-30-359	30E06	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3064 TO: RTU-SFL6 8 #14 >> FV-3064 CONTROL	
C-30-361	30E18	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3066 TO: RTU-SFL6 8 #14 >> FV-3066 CONTROL	
C-30-362	30E18	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3067 TO: RTU-SFL6 8 #14 >> FV-3067 CONTROL	
C-30-370	30E18	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3061 TO: RTU-SFL6 2 #14 >> AIT-3061 CONTROL	
C-30-401	30E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3070 TO: RTU-NFL7 2 #14 >> AIT-3070 CONTROL	
C-30-402	30E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSL-3070 TO: RTU-NFL7 2 #14 >> FSL-3070 CONTROL	
C-30-403	30E05 30E13	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3071 TO: RTU-NFL7 2 #14 >> AIT-3071 CONTROL	
C-30-404	30E13	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3071 TO: RTU-NFL7 8 #14 >> FV-3071 CONTROL	
C-30-405	30E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-3071 TO: RTU-NFL7 2 #14 >> FIT-3071 CONTROL	
C-30-406	30E13	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LIT-3071 TO: RTU-NFL7 2 #14 >> LIT-3071 24VDC POWER	
C-30-407	30E05	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3072 TO: FV-3072 7 #14 >> LCP-3072 CONTROL	
C-30-408	30E05	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3072 TO: RTU-NFL7 6 #14 >> FV-3072 CONTROL	
C-30-410	30E05	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3073 TO: FV-3073 7 #14 >> LCP-3073 CONTROL	
C-30-411	30E05	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3073 TO: RTU-NFL7 6 #14 >> FV-3073 CONTROL	
C-30-413	30E05	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3074 TO: FV-3074 7 #14 >> LCP-3074 CONTROL	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-30-414	30E05	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3074 TO: RTU-NFL7 8 #14 >> FV-3074 CONTROL	
C-30-417	30E13	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3076 TO: FV-3076 7 #14 >> LCP-3076 CONTROL	
C-30-418	30E13	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3076 TO: RTU-NFL7 8 #14 >> FV-3076 CONTROL	
C-30-420	30E13	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3077 TO: RTU-NFL7 6 #14 >> FV-3077 CONTROL	
C-30-451	30E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3080 TO: RTU-SFL8 2 #14 >> AIT-3080 CONTROL	
C-30-452	30E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSL-3080 TO: RTU-SFL8 2 #14 >> RTU-SFL8	
C-30-453	30E05 30E17	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3081 TO: RTU-SFL8 2 #14 >> AIT-3081 CONTROL	
C-30-454	30E17	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3081 TO: RTU-SFL8 8 #14 >> FV-3081 CONTROL	
C-30-455	30E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-3081 TO: RTU-SFL8 2 #14 >> FIT-3081 CONTROL	
C-30-456	30E17	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LIT-3081 TO: RTU-SFL8 2 #14 >> LIT-3081 24VDC POWER	
C-30-457	30E05	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3082 TO: FV-3082 7 #14 >> LCP-3082 CONTROL	
C-30-458	30E05	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3082 TO: RTU-SFL8 6 #14 >> FV-3082 CONTROL	
C-30-460	30E05	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3083 TO: FV-3083 7 #14 >> LCP-3083 CONTROL	
C-30-461	30E05	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3083 TO: RTU-SFL8 6 #14 >> FV-3083 CONTROL	
C-30-463	30E05	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3084 TO: FV-3084 7 #14 >> LCP-3084 CONTROL	
C-30-464	30E05	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3084 TO: RTU-SFL8 8 #14 >> FV-3084 CONTROL	
C-30-467	30E17	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3086 TO: FV-3086 7 #14 >> LCP-3086 CONTROL	
C-30-468	30E17	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3086 TO: RTU-SFL8 8 #14 >> FV-3086 CONTROL	
C-30-470	30E17	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3087 TO: RTU-SFL8 6 #14 >> FV-3087 CONTROL	
C-30-501	30E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3090 TO: RTU-NFL9 2 #14 >> AIT-3090 CONTROL	
C-30-502	30E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSL-3090 TO: RTU-NFL9 2 #14 >> FSL-3090 STATUS	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-30-503	30E05 30E13	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3091 TO: RTU-NFL9 2 #14 >> AIT-3091 CONTROL	
C-30-504	30E13	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3091 TO: RTU-NFL9 8 #14 >> FV-3091 CONTROL	
C-30-505	30E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-3091 TO: RTU-NFL9 2 #14 >> FIT-3091 CONTROL	
C-30-506	30E13	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LIT-3091 TO: RTU-NFL9 2 #14 >> LIT-3091 24VDC POWER	
C-30-507	30E05	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3092 TO: FV-3092 7 #14 >> LCP-3092 CONTROL	
C-30-508	30E05	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3092 TO: RTU-NFL9 6 #14 >> FV-3092 CONTROL	
C-30-510	30E05	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3093 TO: FV-3093 7 #14 >> LCP-3093 CONTROL	
C-30-511	30E05	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3093 TO: RTU-NFL9 6 #14 >> FV-3093 CONTROL	
C-30-513	30E05	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3094 TO: FV-3094 7 #14 >> LCP-3094 CONTROL	
C-30-514	30E05	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3094 TO: RTU-NFL9 8 #14 >> FV-3094 CONTROL	
C-30-517	30E13	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3096 TO: FV-3096 7 #14 >> LCP-3096 CONTROL	
C-30-518	30E13	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3096 TO: RTU-NFL9 8 #14 >> FV-3096 CONTROL	
C-30-520	30E13	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3097 TO: RTU-NFL9 6 #14 >> FV-3097 CONTROL	
C-30-551	30E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3100 TO: RTU-SFL10 2 #14 >> AIT-3100 CONTROL	
C-30-552	30E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSL-3100 TO: RTU-SFL10 2 #14 >> FSL-3100 STATUS	
C-30-553	30E05 30E17	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3101 TO: RTU-SFL10 2 #14 >> AIT-3101 CONTROL	
C-30-554	30E17	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3101 TO: RTU-SFL10 8 #14 >> FV-3101 CONTROL	
C-30-555	30E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-3101 TO: RTU-SFL10 2 #14 >> FIT-3101 CONTROL	
C-30-556	30E17	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LIT-3101 TO: RTU-SFL10 6 #14 >> LIT-3101 CONTROL	
C-30-557	30E05	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3102 TO: FV-3102 7 #14 >> LCP-3102 CONTROL	
C-30-558	30E05	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3102 TO: RTU-SFL10 6 #14 >> FV-3102 CONTROL	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-30-560	30E05	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3103 TO: FV-3103 7 #14 >> LCP-3103 CONTROL	
C-30-561	30E05	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3103 TO: RTU-SFL10 6 #14 >> FV-3103 CONTROL	
C-30-563	30E05	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3104 TO: FV-3104 7 #14 >> LCP-3104 CONTROL	
C-30-564	30E05	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3104 TO: RTU-SFL10 8 #14 >> FV-3104 CONTROL	
C-30-567	30E17	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3106 TO: FV-3106 7 #14 >> LCP-3106 CONTROL	
C-30-568	30E17	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3106 TO: RTU-SFL10 8 #14 >> FV-3106 CONTROL	
C-30-570	30E17	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3107 TO: RTU-SFL10 6 #14 >> FV-3107 CONTROL	
C-30-601	30E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3110 TO: RTU-NFL11 2 #14 >> AIT-3110 CONTROL	
C-30-602	30E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSL-3110 TO: RTU-NFL11 2 #14 >> FSL-3110 STATUS	
C-30-603	30E05 30E13	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3111 TO: RTU-NFL11 2 #14 >> AIT-3111 CONTROL	
C-30-604	30E13	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3111 TO: RTU-NFL11 8 #14 >> FV-3111 CONTROL	
C-30-605	30E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-3111 TO: RTU-NFL11 2 #14 >> FIT-3111 CONTROL	
C-30-606	30E13	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LIT-3111 TO: RTU-NFL11 2 #14 >> LIT-3111 24VDC POWER	
C-30-607	30E05	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3112 TO: FV-3112 7 #14 >> LCP-3112 CONTROL	
C-30-608	30E05	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3112 TO: RTU-NFL11 6 #14 >> FV-3112 CONTROL	
C-30-610	30E05	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3113 TO: FV-3113 7 #14 >> LCP-3113 CONTROL	
C-30-611	30E05	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3113 TO: RTU-NFL11 6 #14 >> FV-3113 CONTROL	
C-30-613	30E05	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3114 TO: FV-3114 7 #14 >> LCP-3114 CONTROL	
C-30-614	30E05	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3114 TO: RTU-NFL11 8 #14 >> FV-3114 CONTROL	
C-30-617	30E13	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3116 TO: FV-3116 7 #14 >> LCP-3116 CONTROL	
C-30-618	30E13	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3116 TO: RTU-NFL11 8 #14 >> FV-3116 CONTROL	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-30-620	30E13	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3117 TO: RTU-NFL11 6 #14 >> FV-3117 CONTROL	
C-30-651	30E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3120 TO: RTU-SFL12 2 #14 >> AIT-3120 CONTROL	
C-30-652	30E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSL-3120 TO: RTU-SFL12 2 #14 >> FSL-3120 STATUS	
C-30-653	30E05 30E17	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3121 TO: RTU-SFL12 2 #14 >> AIT-3121 CONTROL	
C-30-654	30E17	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3121 TO: RTU-SFL12 8 #14 >> FV-3121 CONTROL	
C-30-655	30E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-3121 TO: RTU-SFL12 2 #14 >> FIT-3121 CONTROL	
C-30-656	30E17	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LIT-3121 TO: RTU-SFL12 2 #14 >> LIT-3121 24VDC POWER	
C-30-657	30E05	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3122 TO: FV-3122 7 #14 >> LCP-3122 CONTROL	
C-30-658	30E05	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3122 TO: RTU-SFL12 6 #14 >> FV-3122 CONTROL	
C-30-660	30E05	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3123 TO: FV-3123 7 #14 >> LCP-3123 CONTROL	
C-30-661	30E05	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3123 TO: RTU-SFL12 6 #14 >> FV-3123 CONTROL	
C-30-663	30E05	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3124 TO: FV-3124 7 #14 >> LCP-3124 CONTROL	
C-30-664	30E05	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3124 TO: RTU-SFL12 8 #14 >> FV-3124 CONTROL	
C-30-667	30E17	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3126 TO: FV-3126 7 #14 >> LCP-3126 CONTROL	
C-30-668	30E17	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3126 TO: RTU-SFL12 8 #14 >> FV-3126 CONTROL	
C-30-670	30E17	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3127 TO: RTU-SFL12 6 #14 >> FV-3127 CONTROL	
C-30-691	30E19	1"	1	PULL	ROPE				FR: FILTER 8 EXIT DOOR SECURITY J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
C-30-695	30E19	1"	1	PULL	ROPE				FR: FILTER 7 EXIT DOOR SECURITY J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
C-30-698	30E19	1"	1	PULL	ROPE				FR: LEVEL 1 TUNNEL DOOR SECURITY J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
C-30-701	30E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3130 TO: RTU-NFL13 2 #14 >> AIT-3130 CONTROL	
C-30-702	30E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSL-3130 TO: RTU-NFL13 2 #14 >> FSL-3130 CONTROL	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-30-703	30E04 30E12	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3131 TO: RTU-NFL13 2 #14 >> AIT-3131 CONTROL	
C-30-704	30E12	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3131 TO: RTU-NFL13 8 #14 >> FV-3131 CONTROL	
C-30-705	30E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-3131 TO: RTU-NFL13 2 #14 >> FIT-3131 CONTROL	
C-30-706	30E12	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LIT-3131 TO: RTU-NFL13 2 #14 >> LIT-3131 24VDC POWER	
C-30-707	30E04	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3132 TO: FV-3132 7 #14 >> LCP-3132 CONTROL	
C-30-708	30E04	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3132 TO: RTU-NFL13 6 #14 >> FV-3132 CONTROL	
C-30-710	30E04	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3133 TO: FV-3133 7 #14 >> LCP-3133 CONTROL	
C-30-711	30E04	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3133 TO: RTU-NFL13 6 #14 >> FV-3133 CONTROL	
C-30-713	30E04	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3134 TO: FV-3134 7 #14 >> LCP-3134 CONTROL	
C-30-714	30E04	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3134 TO: RTU-NFL13 8 #14 >> FV-3134 CONTROL	
C-30-717	30E12	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3136 TO: FV-3136 7 #14 >> LCP-3136 CONTROL	
C-30-718	30E12	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3136 TO: RTU-NFL13 8 #14 >> FV-3136 CONTROL	
C-30-720	30E12	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3137 TO: RTU-NFL13 6 #14 >> FV-3137 CONTROL	
C-30-751	30E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3140 TO: RTU-SFL14 2 #14 >> AIT-3140 CONTROL	
C-30-752	30E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSL-3140 TO: RTU-SFL14 2 #14 >> FSL-3140 CONTROL	
C-30-753	30E04 30E16	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3141 TO: RTU-SFL14 2 #14 >> AIT-3141 CONTROL	
C-30-754	30E16	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3141 TO: RTU-SFL14 8 #14 >> FV-3141 CONTROL	
C-30-755	30E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-3141 TO: RTU-SFL14 2 #14 >> FIT-3141 CONTROL	
C-30-756	30E16	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LIT-3141 TO: RTU-SFL14 2 #14 >> LIT-3141 CONTROL POWER	
C-30-757	30E04	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3142 TO: FV-3142 7 #14 >> LCP-3142 CONTROL	
C-30-758	30E04	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3142 TO: RTU-SFL14 6 #14 >> FV-3142 CONTROL	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-30-760	30E04	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3143 TO: FV-3143 7 #14 >> LCP-3143 CONTROL	
C-30-761	30E04	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3143 TO: RTU-SFL14 6 #14 >> FV-3143 CONTROL	
C-30-763	30E04	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3144 TO: FV-3144 7 #14 >> LCP-3144 CONTROL	
C-30-764	30E04	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3144 TO: RTU-SFL14 8 #14 >> FV-3144 CONTROL	
C-30-767	30E16	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3146 TO: FV-3146 7 #14 >> LCP-3146 CONTROL	
C-30-768	30E16	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3146 TO: RTU-SFL14 8 #14 >> FV-3146 CONTROL	
C-30-770	30E16	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3147 TO: RTU-SFL14 6 #14 >> FV-3147 CONTROL	
C-30-801	30E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3150 TO: RTU-NFL15 2 #14 >> AIT-3150 CONTROL	
C-30-802	30E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSL-3150 TO: RTU-NFL15 2 #14 >> FSL-3150 CONTROL	
C-30-803	30E04 30E12	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3151 TO: RTU-NFL15 2 #14 >> AIT-3151 CONTROL	
C-30-804	30E12	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3151 TO: RTU-NFL15 8 #14 >> FV-3151 CONTROL	
C-30-805	30E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-3151 TO: RTU-NFL15 2 #14 >> FIT-3151 CONTROL	
C-30-806	30E12	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LIT-3151 TO: RTU-NFL15 2 #14 >> LIT-3151 24VDC POWER	
C-30-807	30E04	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3152 TO: FV-3152 7 #14 >> LCP-3152 CONTROL	
C-30-808	30E04	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3152 TO: RTU-NFL15 6 #14 >> FV-3152 CONTROL	
C-30-810	30E04	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3153 TO: FV-3153 7 #14 >> LCP-3153 CONTROL	
C-30-811	30E04	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3153 TO: RTU-NFL15 6 #14 >> FV-3153 CONTROL	
C-30-813	30E04	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3154 TO: FV-3154 7 #14 >> LCP-3154 CONTROL	
C-30-814	30E04	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3154 TO: RTU-NFL15 8 #14 >> FV-3154 CONTROL	
C-30-817	30E12	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3156 TO: FV-3156 7 #14 >> LCP-3156 CONTROL	
C-30-818	30E12	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3156 TO: RTU-NFL15 8 #14 >> FV-3156 CONTROL	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-30-820	30E12	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3157 TO: RTU-NFL15 6 #14 >> FV-3157 CONTROL	
C-30-851	30E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3160 TO: RTU-SFL16 2 #14 >> AIT-3160 CONTROL	
C-30-852	30E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSL-3160 TO: RTU-SFL16 2 #14 >> FSL-3160 CONTROL	
C-30-853	30E04 30E16	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: AIT-3161 TO: RTU-SFL16 2 #14 >> AIT-3161 CONTROL	
C-30-854	30E16	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3161 TO: RTU-SFL16 8 #14 >> FV-3161 CONTROL	
C-30-855	30E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-3161 TO: RTU-SFL16 2 #14 >> FIT-3161 CONTROL	
C-30-856	30E16	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LIT-3161 TO: RTU-SFL16 2 #14 >> LIT-3161 CONTROL	
C-30-857	30E04	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3162 TO: FV-3162 7 #14 >> LCP-3162 CONTROL	
C-30-858	30E04	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3162 TO: RTU-SFL16 6 #14 >> FV-3162 CONTROL	
C-30-860	30E04	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3163 TO: FV-3163 7 #14 >> LCP-3163 CONTROL	
C-30-861	30E04	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3163 TO: RTU-SFL16 6 #14 >> FV-3163 CONTROL	
C-30-863	30E04	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3164 TO: FV-3164 7 #14 >> LCP-3164 CONTROL	
C-30-864	30E04	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3164 TO: RTU-SFL16 8 #14 >> FV-3164 CONTROL	
C-30-867	30E16	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-3166 TO: FV-3166 7 #14 >> LCP-3166 CONTROL	
C-30-868	30E16	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3166 TO: RTU-SFL16 8 #14 >> FV-3166 CONTROL	
C-30-870	30E16	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-3167 TO: RTU-SFL16 6 #14 >> FV-3167 CONTROL	
C-30-901	30E05	0.75"	2 2	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: PMP-3911 TO: MCC-A 2 #12 >> MWH-3911 POWER 2 #14 >> TSH-3911 CONTROL	
C-30-902	30E05	0.75"	2 2	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: PMP-3921 TO: MCC-A 2 #12 >> MWH-3921 POWER 2 #14 >> TSH-3921 CONTROL	
C-30-906	30E07	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-4051 TO: RTU-ELEC2C 6 #14 >> FV-4051 CONTROL	
C-30-907	30E06	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-4051 TO: FV-4051 7 #14 >> LCP-4051 CONTROL	

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C-30-908	30E07	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-4061 TO: RTU-ELEC2C 6 #14 >> FV-4061 CONTROL	
C-30-909	30E06	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-4061 TO: FV-4061 7 #14 >> LCP-4061 CONTROL	
C-30-910	30E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-4135 TO: RTU-FBW 2 #14 >> FIT-4135 CONTROL POWER	
C-30-911	30E06	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-4136 TO: RTU-FBW 2 #14 >> FIT-4136 CONTROL POWER	
C-30-912	30E02	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-4411 TO: RTU-FBW 6 #14 >> FV-4411 CONTROL	
C-30-913	30E02	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-4411 TO: FV-4411 7 #14 >> LCP-4411 CONTROL	
C-30-914	30E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-4411 TO: RTU-FBW 2 #14 >> FIT-4411 24VDC CONTROL POWER	
C-30-915	01E04 01E05 30E03	1"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LSH-4425 TO: RTU-BL 2 #14 >> LSH-4425 CONTROL	
C-30-916	01E04 01E05 30E03	1"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LSHH-4427 TO: RTU-BL 2 #14 >> LSHH-4427 CONTROL	
C-30-930	30E13	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LIT-3001 TO: RTU-FBW 2 #14 >> LIT-3001 CONTROL POWER	
C-30-932	30E17	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LIT-3002 TO: RTU-FBW 2 #14 >> LIT-3002 CONTROL	
C-30-951	30E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LSHH-3931 TO: RTU-FBW 2 #14 >> LSHH-3931 STATUS	
C-30-952	30E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSH-3942 TO: RTU-FBW 2 #14 >> FSH-3942 STATUS	
L-30-005	30E03	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: RTU-BL TO: UPS-S 2 #12 >> RTU-BL POWER	
L-30-691	30E19	1"	2	#12	XHHW-2	1	#12	XHHW-2	FR: SECURITY PANEL TO: PNL-B1 2 #12 >> SECURITY PANEL POWER	
L-30-695	30E19	1"	2	#12	XHHW-2	1	#12	XHHW-2	FR: SECURITY PANEL TO: UPS-B 2 #12 >> SECURITY PANEL POWER	
L-30-696	30E19	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: LOI-FB TO: UPS-B 2 #12 >> LOI-FB POWER	
L-30-950	30E05	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: PMP-3931 TO: PANELBOARD FGA, CKT 5 2 #12 >> PMP-3931 POWER	
L-30-951	30E05	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: PMP-3941 TO: PANELBOARD FGA, CKT 7 2 #12 >> PMP-3941 POWER	
N-30-005	30E03	2"	1		12/FO	1	#14	XHHW-2	FR: RTU-BL TO: LEVEL 2 NETWORK ROOM 1 12/FO >> RTU-BL NETWORK	
N-30-010	30E03	0.75"	1		CAT5E	1	#14	XHHW-2	FR: MCC-BL TO: RTU-BL 1 CAT5E >> MCC-BL NETWORK	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
N-30-101	30E06	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3010 TO: RTU-NFL1 1 CAT6 >> AIT-3010 NETWORK	
N-30-102	30E06	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-3011 TO: RTU-NFL1 1 RS-485 >> FIT-3011 NETWORK	
N-30-103	30E06	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3019 TO: RTU-NFL1 1 CAT6 >> AIT-3019 NETWORK	
N-30-151	30E06	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3020 TO: RTU-SFL2 1 CAT6 >> AIT-3020 NETWORK	
N-30-152	30E06	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-3021 TO: RTU-SFL2 1 RS-485 >> FIT-3021 NETWORK	
N-30-153	30E06	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3029 TO: RTU-SFL2 1 CAT6 >> AIT-3029 NETWORK	
N-30-201	30E06	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3030 TO: RTU-NFL3 1 CAT6 >> AIT-3030 NETWORK	
N-30-202	30E07	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-3031 TO: RTU-NFL3 1 RS-485 >> FIT-3031 NETWORK	
N-30-203	30E06	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3039 TO: RTU-NFL3 1 CAT6 >> AIT-3039 NETWORK	
N-30-251	30E06	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3040 TO: RTU-SFL4 1 CAT6 >> AIT-3040 NETWORK	
N-30-252	30E07	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-3041 TO: RTU-SFL4 1 RS-485 >> FIT-3041 NETWORK	
N-30-253	30E06	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3049 TO: RTU-SFL4 1 CAT6 >> AIT-3049 NETWORK	
N-30-301	30E06	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3050 TO: RTU-NFL5 1 CAT6 >> AIT-3050 NETWORK	
N-30-302	30E07	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-3051 TO: RTU-NFL5 1 RS-485 >> FIT-3051 NETWORK	
N-30-303	30E06	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3059 TO: RTU-NFL5 1 CAT6 >> AIT-3059 NETWORK	
N-30-351	30E06	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3060 TO: RTU-SFL6 1 CAT6 >> AIT-3060 NETWORK	
N-30-352	30E07	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-3061 TO: RTU-SFL6 1 RS-485 >> FIT-3061 NETWORK	
N-30-353	30E06	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3069 TO: RTU-SFL6 1 CAT6 >> AIT-3069 NETWORK	
N-30-401	30E05	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3070 TO: RTU-NFL7 1 CAT6 >> AIT-3070 NETWORK	
N-30-402	30E05	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-3071 TO: RTU-NFL7 1 RS-485 >> FIT-3071 NETWORK	
N-30-403	30E05	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3079 TO: RTU-NFL7 1 CAT6 >> AIT-3079 NETWORK	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
N-30-451	30E05	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3080 TO: RTU-SFL8 1 CAT6 >> AIT-3080 NETWORK	
N-30-452	30E05	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-3081 TO: RTU-SFL8 1 RS-485 >> FIT-3081 NETWORK	
N-30-453	30E05	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3089 TO: RTU-SFL8 1 CAT6 >> AIT-3089 NETWORK	
N-30-501	30E05	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3090 TO: RTU-NFL9 1 CAT6 >> AIT-3090 NETWORK	
N-30-502	30E05	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-3091 TO: RTU-NFL9 1 RS-485 >> FIT-3091 NETWORK	
N-30-503	30E05	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3099 TO: RTU-NFL9 1 CAT6 >> AIT-3099 NETWORK	
N-30-551	30E05	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3100 TO: RTU-SFL10 1 CAT6 >> AIT-3100 NETWORK	
N-30-552	30E05	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-3101 TO: RTU-SFL10 1 RS-485 >> FIT-3101 NETWORK	
N-30-553	30E05	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3109 TO: RTU-SFL10 1 CAT6 >> AIT-3109 NETWORK	
N-30-601	30E05	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3110 TO: RTU-NFL11 1 CAT6 >> AIT-3110 NETWORK	
N-30-602	30E05	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-3111 TO: RTU-NFL11 1 RS-485 >> FIT-3111 NETWORK	
N-30-603	30E05	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3119 TO: RTU-NFL11 1 CAT6 >> AIT-3119 NETWORK	
N-30-651	30E05	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3120 TO: RTU-SFL12 1 CAT6 >> AIT-3120 NETWORK	
N-30-652	30E05	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-3121 TO: RTU-SFL12 1 RS-485 >> FIT-3121 NETWORK	
N-30-653	30E05	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3129 TO: RTU-SFL12 1 CAT6 >> AIT-3129 NETWORK	
N-30-691	30E19	1"	1	PULL	ROPE				FR: SECURITY PANEL TO: NETWORK RACK 1 PULL >> SPARE	
N-30-695	30E19	1"	1		CAT6	1	#14	XHHW-2	FR: LOI-FB TO: NETWORK ROOM FIBER PATCH PANEL 1 CAT6 >> LOI-FB NETWORK	
N-30-701	30E04	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3130 TO: RTU-NFL13 1 CAT6 >> AIT-3130 NETWORK	
N-30-702	30E04	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-3131 TO: RTU-NFL13 1 RS-485 >> FIT-3131 NETWORK	
N-30-703	30E04	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3139 TO: RTU-NFL13 1 CAT6 >> AIT-3139 NETWORK	
N-30-751	30E04	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3140 TO: RTU-SFL14 1 CAT6 >> AIT-3140 NETWORK	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
N-30-752	30E04	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-3141 TO: RTU-SFL14 1 RS-485 >> FIT-3141 NETWORK	
N-30-753	30E04	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3149 TO: RTU-SFL14 1 CAT6 >> AIT-3149 NETWORK	
N-30-801	30E04	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3150 TO: RTU-NFL15 1 CAT6 >> AIT-3150 NETWORK	
N-30-802	30E04	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-3151 TO: RTU-NFL15 1 RS-485 >> FIT-3151 NETWORK	
N-30-803	30E04	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3159 TO: RTU-NFL15 1 CAT6 >> AIT-3159 NETWORK	
N-30-851	30E04	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3160 TO: RTU-SFL16 1 CAT6 >> AIT-3160 NETWORK	
N-30-852	30E04	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-3161 TO: RTU-SFL16 1 RS-485 >> FIT-3161 NETWORK	
N-30-853	30E04	0.75"	1		CAT6	1	#14	XHHW-2	FR: AIT-3169 TO: RTU-SFL16 1 CAT6 >> AIT-3169 NETWORK	
N-30-902	30E04	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-4135 TO: RTU-FBW 1 RS-485 >> FIT-4135 MBRTU	
N-30-904	30E02	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-4411 TO: RTU-FBW 1 RS-485 >> FIT-4411 NETWORK	
P-30-011	30E03	3"	3 2 2	300 #12 #14	XHHW-2 XHHW-2 XHHW-2	1	#1/0	XHHW-2	FR: BLO-4201 TO: MCC-BL 3 300 >> BLO-4201 POWER 2 #12 >> BLO-4201 MWH POWER 2 #14 >> BLO-4201 TSH CONTROL	
P-30-012	30E03	3"	3	300	XHHW-2	1	#1/0	XHHW-2	FR: BLO-4201 TO: MCC-BL 3 300 >> BLO-4201 POWER	
P-30-021	30E03	3"	3 2 2	300 #12 #14	XHHW-2 XHHW-2 XHHW-2	1	#1/0	XHHW-2	FR: BLO-4211 TO: MCC-BL 3 300 >> BLO-4211 POWER 2 #12 >> BLO-4211 MWH POWER 2 #14 >> BLO-4211 TSH CONTROL	
P-30-022	30E03	3"	3	300	XHHW-2	1	#1/0	XHHW-2	FR: BLO-4211 TO: MCC-BL 3 300 >> BLO-4211 POWER	
P-30-101	30E14	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3011 TO: FV-3011 3 #12 >> FV-3011 POWER	
P-30-102	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3012 TO: FV-3012 3 #12 >> FV-3012 POWER	
P-30-103	30E06	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3013 TO: FV-3013 3 #12 >> FV-3013 POWER	
P-30-104	30E06	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3014 TO: FV-3014 3 #12 >> FV-3014 POWER	
P-30-106	30E14	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3016 TO: FV-3016 3 #12 >> FV-3016 POWER	
P-30-107	30E14	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3017 TO: FV-3017 3 #12 >> FV-3017 POWER	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P-30-111	30E14	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3011 TO: PP-6 3 #12 >> DISC-3011 POWER	
P-30-112	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3012 TO: PP-6 3 #12 >> DISC-3012 POWER	
P-30-113	30E06	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3013 TO: PP-6 3 #12 >> DISC-3013 POWER	
P-30-114	30E06	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3014 TO: PP-6 3 #12 >> DISC-3014 POWER	
P-30-116	30E14	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3016 TO: PP-6 3 #12 >> DISC-3016 POWER	
P-30-117	30E14	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3017 TO: PP-6 3 #12 >> DISC-3017 POWER	
P-30-151	30E18	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3021 TO: FV-3021 3 #12 >> FV-3021 POWER	
P-30-152	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3022 TO: FV-3022 3 #12 >> FV-3022 POWER	
P-30-153	30E06	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3023 TO: FV-3023 3 #12 >> FV-3023 POWER	
P-30-154	30E06	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3024 TO: FV-3024 3 #12 >> FV-3024 POWER	
P-30-156	30E18	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3026 TO: FV-3026 3 #12 >> FV-3026 POWER	
P-30-157	30E18	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3027 TO: FV-3027 3 #12 >> FV-3027 POWER	
P-30-161	30E18	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3021 TO: PP-6 3 #12 >> DISC-3021 POWER	
P-30-162	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3022 TO: PP-6 3 #12 >> DISC-3022 POWER	
P-30-163	30E06	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3023 TO: PP-6 3 #12 >> DISC-3023 POWER	
P-30-164	30E06	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3024 TO: PP-6 3 #12 >> DISC-3024 POWER	
P-30-166	30E18	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3026 TO: PP-6 3 #12 >> DISC-3026 POWER	
P-30-167	30E18	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3027 TO: PP-6 3 #12 >> DISC-3027 POWER	
P-30-201	30E14	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3031 TO: FV-3031 3 #12 >> FV-3031 POWER	
P-30-202	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3032 TO: FV-3032 3 #12 >> FV-3032 POWER	
P-30-203	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3033 TO: FV-3033 3 #12 >> FV-3033 POWER	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P-30-204	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3034 TO: FV-3034 3 #12 >> FV-3034 POWER	
P-30-206	30E14	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3036 TO: FV-3036 3 #12 >> FV-3036 POWER	
P-30-207	30E14	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3037 TO: FV-3037 3 #12 >> FV-3037 POWER	
P-30-211	30E14	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3031 TO: PP-7 3 #12 >> DISC-3031 POWER	
P-30-212	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3032 TO: PP-7 3 #12 >> DISC-3032 POWER	
P-30-213	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3033 TO: PP-7 3 #12 >> DISC-3033 POWER	
P-30-214	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3034 TO: PP-7 3 #12 >> DISC-3034 POWER	
P-30-216	30E14	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3036 TO: PP-7 3 #12 >> DISC-3036 POWER	
P-30-217	30E14	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3037 TO: PP-7 3 #12 >> DISC-3037 POWER	
P-30-251	30E18	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3041 TO: FV-3041 3 #12 >> FV-3041 POWER	
P-30-252	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3042 TO: FV-3042 3 #12 >> FV-3042 POWER	
P-30-253	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3043 TO: FV-3043 3 #12 >> FV-3043 POWER	
P-30-254	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3044 TO: FV-3044 3 #12 >> FV-3044 POWER	
P-30-256	30E18	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3046 TO: FV-3046 3 #12 >> FV-3046 POWER	
P-30-257	30E18	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3047 TO: FV-3047 3 #12 >> FV-3047 POWER	
P-30-261	30E18	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3041 TO: PP-7 3 #12 >> DISC-3041 POWER	
P-30-262	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3042 TO: PP-7 3 #12 >> DISC-3042 POWER	
P-30-263	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3043 TO: PP-7 3 #12 >> DISC-3043 POWER	
P-30-264	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3044 TO: PP-7 3 #12 >> DISC-3044 POWER	
P-30-266	30E18	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3046 TO: PP-7 3 #12 >> DISC-3046 POWER	
P-30-267	30E18	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3047 TO: PP-7 3 #12 >> DISC-3047 POWER	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P-30-301	30E14	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3051 TO: FV-3051 3 #12 >> FV-3051 POWER	
P-30-302	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3052 TO: FV-3052 3 #12 >> FV-3052 POWER	
P-30-303	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3053 TO: FV-3053 3 #12 >> FV-3053 POWER	
P-30-304	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3054 TO: FV-3054 3 #12 >> FV-3054 POWER	
P-30-306	30E14	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3056 TO: FV-3056 3 #12 >> FV-3056 POWER	
P-30-307	30E14	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3057 TO: FV-3057 3 #12 >> FV-3057 POWER	
P-30-311	30E14	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3051 TO: PP-8 3 #12 >> DISC-3051 POWER	
P-30-312	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3052 TO: PP-8 3 #12 >> DISC-3052 POWER	
P-30-313	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3053 TO: PP-8 3 #12 >> DISC-3053 POWER	
P-30-314	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3054 TO: PP-8 3 #12 >> DISC-3054 POWER	
P-30-316	30E14	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3056 TO: PP-8 3 #12 >> DISC-3056 POWER	
P-30-317	30E14	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3057 TO: PP-8 3 #12 >> DISC-3057 POWER	
P-30-351	30E18	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3061 TO: FV-3061 3 #12 >> FV-3061 POWER	
P-30-352	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3062 TO: FV-3062 3 #12 >> FV-3062 POWER	
P-30-353	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3063 TO: FV-3063 3 #12 >> FV-3063 POWER	
P-30-354	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3064 TO: FV-3064 3 #12 >> FV-3064 POWER	
P-30-356	30E18	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3066 TO: FV-3066 3 #12 >> FV-3066 POWER	
P-30-357	30E18	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3067 TO: FV-3067 3 #12 >> FV-3067 POWER	
P-30-361	30E18	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3061 TO: PP-8 3 #12 >> DISC-3061 POWER	
P-30-362	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3062 TO: PP-8 3 #12 >> DISC-3062 POWER	
P-30-363	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3063 TO: PP-8 3 #12 >> DISC-3063 POWER	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P-30-364	30E07	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3064 TO: PP-8 3 #12 >> DISC-3064 POWER	
P-30-366	30E18	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3066 TO: PP-8 3 #12 >> DISC-3066 POWER	
P-30-367	30E18	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3067 TO: PP-8 3 #12 >> DISC-3067 POWER	
P-30-401	30E13	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3071 TO: FV-3071 3 #12 >> FV-3071 POWER	
P-30-402	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3072 TO: FV-3072 3 #12 >> FV-3072 POWER	
P-30-403	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3073 TO: FV-3073 3 #12 >> FV-3073 POWER	
P-30-404	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3074 TO: FV-3074 3 #12 >> FV-3074 POWER	
P-30-406	30E13	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3076 TO: FV-3076 3 #12 >> FV-3076 POWER	
P-30-407	30E13	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3077 TO: FV-3077 3 #12 >> FV-3077 POWER	
P-30-411	30E13	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3071 TO: PP-1 3 #12 >> DISC-3071 POWER	
P-30-412	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3072 TO: PP-1 3 #12 >> DISC-3072 POWER	
P-30-413	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3073 TO: PP-1 3 #12 >> DISC-3073 POWER	
P-30-414	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3074 TO: PP-1 3 #12 >> DISC-3074 POWER	
P-30-416	30E13	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3076 TO: PP-1 3 #12 >> DISC-3076 POWER	
P-30-417	30E13	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3077 TO: PP-1 3 #12 >> DISC-3077 POWER	
P-30-451	30E17	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3081 TO: FV-3081 3 #12 >> FV-3081 POWER	
P-30-452	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3082 TO: FV-3082 3 #12 >> FV-3082 POWER	
P-30-453	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3083 TO: FV-3083 3 #12 >> FV-3083 POWER	
P-30-454	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3084 TO: FV-3084 3 #12 >> FV-3084 POWER	
P-30-456	30E17	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3086 TO: FV-3086 3 #12 >> FV-3086 POWER	
P-30-457	30E17	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3087 TO: FV-3087 3 #12 >> FV-3087 POWER	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P-30-461	30E17	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3081 TO: PP-1 3 #12 >> DISC-3081 POWER	
P-30-462	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3082 TO: PP-1 3 #12 >> DISC-3082 POWER	
P-30-463	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3083 TO: PP-1 3 #12 >> DISC-3083 POWER	
P-30-464	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3084 TO: PP-1 3 #12 >> DISC-3084 POWER	
P-30-466	30E17	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3086 TO: PP-1 3 #12 >> DISC-3086 POWER	
P-30-467	30E17	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3087 TO: PP-1 3 #12 >> DISC-3087 POWER	
P-30-501	30E13	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3091 TO: FV-3091 3 #12 >> FV-3091 POWER	
P-30-502	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3092 TO: FV-3092 3 #12 >> FV-3092 POWER	
P-30-503	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3093 TO: FV-3093 3 #12 >> FV-3093 POWER	
P-30-504	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3094 TO: FV-3094 3 #12 >> FV-3094 POWER	
P-30-506	30E13	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3096 TO: FV-3096 3 #12 >> FV-3096 POWER	
P-30-507	30E13	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3097 TO: FV-3097 3 #12 >> FV-3097 POWER	
P-30-511	30E13	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3091 TO: PP-2 3 #12 >> DISC-3091 POWER	
P-30-512	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3092 TO: PP-2 3 #12 >> DISC-3092 POWER	
P-30-513	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3093 TO: PP-2 3 #12 >> DISC-3093 POWER	
P-30-514	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3094 TO: PP-2 3 #12 >> DISC-3094 POWER	
P-30-516	30E13	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3096 TO: PP-2 3 #12 >> DISC-3096 POWER	
P-30-517	30E13	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3097 TO: PP-2 3 #12 >> DISC-3097 POWER	
P-30-551	30E17	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3101 TO: FV-3101 3 #12 >> FV-3101 POWER	
P-30-552	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3102 TO: FV-3102 3 #12 >> FV-3102 POWER	
P-30-553	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3103 TO: FV-3103 3 #12 >> FV-3103 POWER	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P-30-554	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3104 TO: FV-3104 3 #12 >> FV-3104 POWER	
P-30-556	30E17	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3106 TO: FV-3106 3 #12 >> FV-3106 POWER	
P-30-557	30E17	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3107 TO: FV-3107 3 #12 >> FV-3107 POWER	
P-30-561	30E17	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3101 TO: PP-2 3 #12 >> DISC-3101 POWER	
P-30-562	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3102 TO: PP-2 3 #12 >> DISC-3102 POWER	
P-30-563	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3103 TO: PP-2 3 #12 >> DISC-3103 POWER	
P-30-564	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3104 TO: PP-2 3 #12 >> DISC-3104 POWER	
P-30-566	30E17	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3106 TO: PP-2 3 #12 >> DISC-3106 POWER	
P-30-567	30E17	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3107 TO: PP-2 3 #12 >> DISC-3107 POWER	
P-30-601	30E13	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3111 TO: FV-3111 3 #12 >> FV-3111 POWER	
P-30-602	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3112 TO: FV-3112 3 #12 >> FV-3112 POWER	
P-30-603	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3113 TO: FV-3113 3 #12 >> FV-3113 POWER	
P-30-604	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3114 TO: FV-3114 3 #12 >> FV-3114 POWER	
P-30-606	30E13	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3116 TO: FV-3116 3 #12 >> FV-3116 POWER	
P-30-607	30E13	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3117 TO: FV-3117 3 #12 >> FV-3117 POWER	
P-30-611	30E13	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3111 TO: PP-3 3 #12 >> DISC-3111 POWER	
P-30-612	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3112 TO: PP-3 3 #12 >> DISC-3112 POWER	
P-30-613	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3113 TO: PP-3 3 #12 >> DISC-3113 POWER	
P-30-614	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3114 TO: PP-3 3 #12 >> DISC-3114 POWER	
P-30-616	30E13	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3116 TO: PP-3 3 #12 >> DISC-3116 POWER	
P-30-617	30E13	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3117 TO: PP-3 3 #12 >> DISC-3117 POWER	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P-30-651	30E17	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3121 TO: FV-3121 3 #12 >> FV-3121 POWER	
P-30-652	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3122 TO: FV-3122 3 #12 >> FV-3122 POWER	
P-30-653	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3123 TO: FV-3123 3 #12 >> FV-3123 POWER	
P-30-654	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3124 TO: FV-3124 3 #12 >> FV-3124 POWER	
P-30-656	30E17	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3126 TO: FV-3126 3 #12 >> FV-3126 POWER	
P-30-657	30E17	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3127 TO: FV-3127 3 #12 >> FV-3127 POWER	
P-30-661	30E17	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3121 TO: PP-3 3 #12 >> DISC-3121 POWER	
P-30-662	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3122 TO: PP-3 3 #12 >> DISC-3122 POWER	
P-30-663	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3123 TO: PP-3 3 #12 >> DISC-3123 POWER	
P-30-664	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3124 TO: PP-3 3 #12 >> DISC-3124 POWER	
P-30-666	30E17	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3126 TO: PP-3 3 #12 >> DISC-3126 POWER	
P-30-667	30E17	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3127 TO: PP-3 3 #12 >> DISC-3127 POWER	
P-30-701	30E12	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3131 TO: FV-3131 3 #12 >> FV-3131 POWER	
P-30-702	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3132 TO: FV-3132 3 #12 >> FV-3132 POWER	
P-30-703	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3133 TO: FV-3133 3 #12 >> FV-3133 POWER	
P-30-704	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3134 TO: FV-3134 3 #12 >> FV-3134 POWER	
P-30-706	30E12	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3136 TO: FV-3136 3 #12 >> FV-3136 POWER	
P-30-707	30E12	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3137 TO: FV-3137 3 #12 >> FV-3137 POWER	
P-30-711	30E12	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3131 TO: PP-4 3 #12 >> DISC-3131 POWER	
P-30-712	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3132 TO: PP-4 3 #12 >> DISC-3132 POWER	
P-30-713	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3133 TO: PP-4 3 #12 >> DISC-3133 POWER	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P-30-714	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3134 TO: PP-4 3 #12 >> DISC-3134 POWER	
P-30-716	30E12	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3136 TO: PP-4 3 #12 >> DISC-3136 POWER	
P-30-717	30E12	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3137 TO: PP-4 3 #12 >> DISC-3137 POWER	
P-30-751	30E16	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3141 TO: FV-3141 3 #12 >> FV-3141 POWER	
P-30-752	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3142 TO: FV-3142 3 #12 >> FV-3142 POWER	
P-30-753	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3143 TO: FV-3143 3 #12 >> FV-3143 POWER	
P-30-754	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3144 TO: FV-3144 3 #12 >> FV-3144 POWER	
P-30-756	30E16	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3146 TO: FV-3146 3 #12 >> FV-3146 POWER	
P-30-757	30E16	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3147 TO: FV-3147 3 #12 >> FV-3147 POWER	
P-30-761	30E16	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3141 TO: PP-4 3 #12 >> DISC-3141 POWER	
P-30-762	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3142 TO: PP-4 3 #12 >> DISC-3142 POWER	
P-30-763	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3143 TO: PP-4 3 #12 >> DISC-3143 POWER	
P-30-764	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3144 TO: PP-4 3 #12 >> DISC-3144 POWER	
P-30-766	30E16	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3146 TO: PP-4 3 #12 >> DISC-3146 POWER	
P-30-767	30E16	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3147 TO: PP-4 3 #12 >> DISC-3147 POWER	
P-30-801	30E12	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3151 TO: FV-3151 3 #12 >> FV-3151 POWER	
P-30-802	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3152 TO: FV-3152 3 #12 >> FV-3152 POWER	
P-30-803	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3153 TO: FV-3153 3 #12 >> FV-3153 POWER	
P-30-804	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3154 TO: FV-3154 3 #12 >> FV-3154 POWER	
P-30-806	30E12	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3156 TO: FV-3156 3 #12 >> FV-3156 POWER	
P-30-807	30E12	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3157 TO: FV-3157 3 #12 >> FV-3157 POWER	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P-30-811	30E12	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3151 TO: PP-5 3 #12 >> DISC-3151 POWER	
P-30-812	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3152 TO: PP-5 3 #12 >> DISC-3152 POWER	
P-30-813	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3153 TO: PP-5 3 #12 >> DISC-3153 POWER	
P-30-814	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3154 TO: PP-5 3 #12 >> DISC-3154 POWER	
P-30-816	30E12	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3156 TO: PP-5 3 #12 >> DISC-3156 POWER	
P-30-817	30E12	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3157 TO: PP-5 3 #12 >> DISC-3157 POWER	
P-30-851	30E16	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3161 TO: FV-3161 3 #12 >> FV-3161 POWER	
P-30-852	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3162 TO: FV-3162 3 #12 >> FV-3162 POWER	
P-30-853	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3163 TO: FV-3163 3 #12 >> FV-3163 POWER	
P-30-854	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3164 TO: FV-3164 3 #12 >> FV-3164 POWER	
P-30-856	30E16	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3166 TO: FV-3166 3 #12 >> FV-3166 POWER	
P-30-857	30E16	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3167 TO: FV-3167 3 #12 >> FV-3167 POWER	
P-30-861	30E16	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3161 TO: PP-5 3 #12 >> DISC-3161 POWER	
P-30-862	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3162 TO: PP-5 3 #12 >> DISC-3162 POWER	
P-30-863	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3163 TO: PP-5 3 #12 >> DISC-3163 POWER	
P-30-864	30E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3164 TO: PP-5 3 #12 >> DISC-3164 POWER	
P-30-866	30E16	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3166 TO: PP-5 3 #12 >> DISC-3166 POWER	
P-30-867	30E16	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-3167 TO: PP-5 3 #12 >> DISC-3167 POWER	
P-30-901	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PMP-3911 TO: MCC-A 3 #12 >> PMP-3911 POWER	
P-30-902	30E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PMP-3921 TO: MCC-A 3 #12 >> PMP-3921 POWER	
P-30-904	30E06	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-4051 TO: FV-4051 3 #12 >> FV-4051 POWER	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P-30-905	30E06	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-4061 TO: FV-4061 3 #12 >> FV-4061 POWER	
P-30-906	30E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-4411 TO: FV-4411 2 #12 >> FV-4411 POWER	
P-30-914	30E06	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-4051 TO: PP-CL 3 #12 >> DISC-4051 POWER	
P-30-915	30E06	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-4061 TO: PP-CL 3 #12 >> DISC-4061 POWER	
P-30-916	30E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-4411 TO: MCC-A 2 #12 >> DISC-4411 POWER	
S-30-102	30E06	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-3011 TO: FIT-3011 1 MFR >> FE-3011 SIGNAL	
S-30-103	30E14	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE-3011 TO: LIT-3011 1 MFR >> LE-3011 SIGNAL	
S-30-104	30E14	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-3011 TO: RTU-NFL1 1 2/CS-#16 >> LIT-3011 SIGNAL	
S-30-105	30E14	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3011 TO: RTU-NFL1 2 2/CS-#16 >> FV-3011 SIGNAL	
S-30-106	30E06	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: PIT-3011 TO: RTU-NFL1 1 2/CS-#16 >> PIT-3011 SIGNAL	
S-30-107	30E07	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3012 TO: RTU-NFL1 2 2/CS-#16 >> FV-3012 SIGNAL	
S-30-108	30E06	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3013 TO: RTU-NFL1 2 2/CS-#16 >> FV-3013 SIGNAL	
S-30-110	30E14	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3011 TO: AIT-3011 1 MFR >> AE-3011 SIGNAL	
S-30-111	30E14	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: AIT-3011 TO: RTU-NFL1 1 2/CS-#16 >> AIT-3011 SIGNAL	
S-30-112		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3010 TO: AIT-3010 1 MFR >> AE-3010 SIGNAL	
S-30-113		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3019 TO: AIT-3019 1 MFR >> AE-3019 SIGNAL	
S-30-152	30E06	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-3021 TO: FIT-3021 1 MFR >> FE-3021 SIGNAL	
S-30-153	30E18	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE-3021 TO: LIT-3021 1 MFR >> LE-3021 SIGNAL	
S-30-154	30E18	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-3021 TO: RTU-SFL2 1 2/CS-#16 >> LIT-3021 SIGNAL	
S-30-155	30E18	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3021 TO: RTU-SFL2 2 2/CS-#16 >> FV-3021 SIGNAL	
S-30-156	30E06	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: PIT-3021 TO: RTU-SFL2 1 2/CS-#16 >> PIT-3021 SIGNAL	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
S-30-157	30E07	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3022 TO: RTU-SFL2 2 2/CS-#16 >> FV-3022 SIGNAL	
S-30-158	30E06	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3023 TO: RTU-SFL2 2 2/CS-#16 >> FV-3023 SIGNAL	
S-30-160	30E18	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3021 TO: AIT-3021 1 MFR >> AE-3021 SIGNAL	
S-30-161	30E18	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: AIT-3021 TO: RTU-SFL2 2 2/CS-#16 >> AIT-3021 SIGNAL	
S-30-162		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3020 TO: AIT-3020 1 MFR >> AE-3020 SIGNAL	
S-30-163		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3029 TO: AIT-3029 1 MFR >> AE-3029 SIGNAL	
S-30-202	30E06	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-3031 TO: FIT-3031 1 MFR >> FE-3031 SIGNAL	
S-30-203	30E14	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE-3031 TO: LIT-3031 1 MFR >> LE-3031 SIGNAL	
S-30-204	30E14	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-3031 TO: RTU-NFL3 1 2/CS-#16 >> LIT-3031 SIGNAL	
S-30-205	30E14	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3031 TO: RTU-NFL3 2 2/CS-#16 >> FV-3031 SIGNAL	
S-30-206	30E06	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: PIT-3031 TO: RTU-NFL3 2 2/CS-#16 >> PIT-3031 SIGNAL	
S-30-207	30E07	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3032 TO: RTU-NFL3 2 2/CS-#16 >> FV-3032 SIGNAL	
S-30-208	30E06	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3033 TO: RTU-NFL3 2 2/CS-#16 >> FV-3033 SIGNAL	
S-30-210	30E14	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3031 TO: AIT-3031 1 MFR >> AE-3031 SIGNAL	
S-30-211	30E14	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: AIT-3031 TO: RTU-NFL3 1 2/CS-#16 >> AIT-3031 SIGNAL	
S-30-212		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3030 TO: AIT-3030 1 MFR >> AE-3030 SIGNAL	
S-30-213		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3039 TO: AIT-3039 1 MFR >> AE-3039 SIGNAL	
S-30-252	30E06	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-3041 TO: FIT-3041 1 MFR >> FE-3041 SIGNAL	
S-30-253	30E18	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE-3041 TO: LIT-3041 1 MFR >> LE-3041 SIGNAL	
S-30-254	30E18	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-3041 TO: RTU-SFL4 1 2/CS-#16 >> LIT-3041 SIGNAL	
S-30-255	30E18	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3041 TO: RTU-SFL4 2 2/CS-#16 >> FV-3041 SIGNAL	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
S-30-256	30E06	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: PIT-3041 TO: RTU-SFL4 1 2/CS-#16 >> PIT-3041 SIGNAL	
S-30-257	30E07	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: FV-3042 TO: RTU-SFL4 1 2/CS-#16 >> FV-3042 SIGNAL	
S-30-258	30E06	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3043 TO: RTU-SFL4 2 2/CS-#16 >> FV-3043 SIGNAL	
S-30-260	30E18	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3041 TO: AIT-3041 1 MFR >> AE-3041 SIGNAL	
S-30-261	30E18	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: AIT-3041 TO: RTU-SFL4 1 2/CS-#16 >> AIT-3041 SIGNAL	
S-30-262		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3040 TO: AIT-3040 1 MFR >> AE-3040 SIGNAL	
S-30-263		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3049 TO: AIT-3049 1 MFR >> AE-3049 SIGNAL	
S-30-302	30E06	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-3051 TO: FIT-3051 1 MFR >> FE-3051 SIGNAL	
S-30-303	30E14	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE-3051 TO: LIT-3051 1 MFR >> LE-3051 SIGNAL	
S-30-304	30E14	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-3051 TO: RTU-NFL5 1 2/CS-#16 >> LIT-3051 SIGNAL	
S-30-305	30E14	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3051 TO: RTU-NFL5 2 2/CS-#16 >> FV-3051 SIGNAL	
S-30-306	30E06	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: PIT-3051 TO: RTU-NFL5 1 2/CS-#16 >> PIT-3051 SIGNAL	
S-30-307	30E07	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3052 TO: RTU-NFL5 2 2/CS-#16 >> FV-3052 SIGNAL	
S-30-308	30E06	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3053 TO: RTU-NFL5 2 2/CS-#16 >> FV-3053 SIGNAL	
S-30-310	30E14	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3051 TO: AIT-3051 1 MFR >> AE-3051 SIGNAL	
S-30-311	30E14	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: AIT-3051 TO: RTU-NFL5 1 2/CS-#16 >> AIT-3051 SIGNAL	
S-30-312		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3050 TO: AIT-3050 1 MFR >> AE-3050 SIGNAL	
S-30-313		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3059 TO: AIT-3059 1 MFR >> AE-3059 SIGNAL	
S-30-352	30E06	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-3061 TO: FIT-3061 1 MFR >> FE-3061 SIGNAL	
S-30-353	30E18	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE-3061 TO: LIT-3061 1 MFR >> LE-3061 SIGNAL	
S-30-354	30E18	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-3061 TO: RTU-SFL6 1 2/CS-#16 >> LIT-3061 SIGNAL	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
S-30-355	30E18	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3061 TO: RTU-SFL6 2 2/CS-#16 >> FV-3061 SIGNAL	
S-30-356	30E06	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: PIT-3061 TO: RTU-SFL6 1 2/CS-#16 >> PIT-3061 SIGNAL	
S-30-357	30E07	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3062 TO: RTU-SFL6 2 2/CS-#16 >> FV-3062 SIGNAL	
S-30-358	30E06	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3063 TO: RTU-SFL6 2 2/CS-#16 >> FV-3063 SIGNAL	
S-30-360	30E18	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3061 TO: AIT-3061 1 MFR >> AE-3061 SIGNAL	
S-30-361	30E18	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: AIT-3061 TO: RTU-SFL6 2 2/CS-#16 >> AIT-3061 SIGNAL	
S-30-362		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3060 TO: AIT-3060 1 MFR >> AE-3060 SIGNAL	
S-30-363		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3069 TO: AIT-3069 1 MFR >> AE-3069 SIGNAL	
S-30-402	30E13	0.75"	2	MFR	CABLE	1	#14	XHHW-2	FR: AE-3071 TO: AIT-3071 2 MFR >> AE-3071 SIGNAL	
S-30-403	30E05 30E13	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: AIT-3071 TO: RTU-NFL7 2 2/CS-#16 >> AIT-3071 SIGNAL	
S-30-404	30E05	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-3071 TO: FIT-3071 1 MFR >> FE-3071 SIGNAL	
S-30-405	30E13	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE-3071 TO: LIT-3071 1 MFR >> LE-3071 SIGNAL	
S-30-406	30E13	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: LIT-3071 TO: RTU-NFL7 2 2/CS-#16 >> LIT-3071 SIGNAL	
S-30-407	30E05	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: PIT-3071 TO: RTU-NFL7 1 2/CS-#16 >> PIT-3071 SIGNAL	
S-30-408	30E05	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3072 TO: RTU-NFL7 2 2/CS-#16 >> FV-3072 SIGNAL	
S-30-409	30E05	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3073 TO: RTU-NFL7 2 2/CS-#16 >> FV-3073 SIGNAL	
S-30-410	30E13	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3077 TO: RTU-NFL7 2 2/CS-#16 >> FV-3077 SIGNAL	
S-30-412		0.75"	2	MFR	CABLE	1	#14	XHHW-2	FR: AE-3070 TO: AIT-3070 2 MFR >> AE-3070 SIGNAL	
S-30-413		0.75"	2	MFR	CABLE	1	#14	XHHW-2	FR: AE-3079 TO: AIT-3079 2 MFR >> AE-3079 SIGNAL	
S-30-452	30E17	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3081 TO: AIT-3081 1 MFR >> AE-3081 SIGNAL	
S-30-453	30E05 30E17	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: AIT-3081 TO: RTU-SFL8 2 2/CS-#16 >> AIT-3081 SIGNAL	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
S-30-454	30E05	0.75"	2	MFR	CABLE	1	#14	XHHW-2	FR: FE-3081 TO: FIT-3081 2 MFR >> FE-3081 SIGNAL	
S-30-455	30E17	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE-3081 TO: LIT-3081 1 MFR >> LE-3081 SIGNAL	
S-30-456	30E17	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-3081 TO: RTU-SFL8 1 2/CS-#16 >> LIT-3081 SIGNAL	
S-30-457	30E05	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: PIT-3081 TO: RTU-SFL8 2 2/CS-#16 >> PIT-3081 SIGNAL	
S-30-458	30E05	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3082 TO: RTU-SFL8 2 2/CS-#16 >> FV-3082 SIGNAL	
S-30-459	30E05	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3083 TO: RTU-SFL8 2 2/CS-#16 >> FV-3083 SIGNAL	
S-30-460	30E17	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3087 TO: RTU-SFL8 2 2/CS-#16 >> FV-3087 SIGNAL	
S-30-462		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3080 TO: AIT-3080 1 MFR >> AE-3080 SIGNAL	
S-30-463		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3089 TO: AIT-3089 1 MFR >> AE-3089 SIGNAL	
S-30-502	30E13	0.75"	2	MFR	CABLE	1	#14	XHHW-2	FR: AE-3091 TO: AIT-3091 2 MFR >> AE-3091 SIGNAL	
S-30-503	30E05 30E13	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: AIT-3091 TO: RTU-NFL9 2 2/CS-#16 >> AIT-3091 SIGNAL	
S-30-504	30E05	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-3091 TO: FIT-3091 1 MFR >> FE-3091 SIGNAL	
S-30-505	30E13	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE-3091 TO: LIT-3091 1 MFR >> LE-3091 SIGNAL	
S-30-506	30E13	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: LIT-3091 TO: RTU-NFL9 2 2/CS-#16 >> LIT-3091 SIGNAL	
S-30-507	30E05	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: PIT-3091 TO: RTU-NFL9 1 2/CS-#16 >> PIT-3091 SIGNAL	
S-30-508	30E05	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3092 TO: RTU-NFL9 2 2/CS-#16 >> FV-3092 SIGNAL	
S-30-509	30E05	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3093 TO: RTU-NFL9 2 2/CS-#16 >> FV-3093 SIGNAL	
S-30-510	30E13	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3097 TO: RTU-NFL9 2 2/CS-#16 >> FV-3097 SIGNAL	
S-30-512		0.75"	2	MFR	CABLE	1	#14	XHHW-2	FR: AE-3090 TO: AIT-3090 2 MFR >> AE-3090 SIGNAL	
S-30-513		0.75"	2	MFR	CABLE	1	#14	XHHW-2	FR: AE-3099 TO: AIT-3099 2 MFR >> AE-3099 SIGNAL	
S-30-552	30E17	0.75"	2	MFR	CABLE	1	#14	XHHW-2	FR: AE-3101 TO: AIT-3101 2 MFR >> AE-3101 SIGNAL	

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NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
S-30-553	30E05 30E17	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: AIT-3101 TO: RTU-SFL10 2 2/CS-#16 >> AIT-3101 SIGNAL	
S-30-554	30E05	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-3101 TO: FIT-3101 1 MFR >> FE-3101 SIGNAL	
S-30-555	30E17	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE-3101 TO: LIT-3101 1 MFR >> LE-3101 SIGNAL	
S-30-556	30E17	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-3101 TO: RTU-SFL10 1 2/CS-#16 >> LIT-3101 SIGNAL	
S-30-557	30E05	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: PIT-3101 TO: RTU-SFL10 1 2/CS-#16 >> PIT-3101 SIGNAL	
S-30-558	30E05	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3102 TO: RTU-SFL10 2 2/CS-#16 >> FV-3102 SIGNAL	
S-30-559	30E05	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3103 TO: RTU-SFL10 2 2/CS-#16 >> FV-3103 SIGNAL	
S-30-560	30E17	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3107 TO: RTU-SFL10 2 2/CS-#16 >> FV-3107 SIGNAL	
S-30-562		0.75"	2	MFR	CABLE	1	#14	XHHW-2	FR: AE-3100 TO: AIT-3100 2 MFR >> AE-3100	
S-30-563		0.75"	2	MFR	CABLE	1	#14	XHHW-2	FR: AE-3109 TO: AIT-3109 2 MFR >> AE-3109	
S-30-602	30E13	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3111 TO: AIT-3111 1 MFR >> AE-3111 SIGNAL	
S-30-603	30E05 30E13	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: AIT-3111 TO: RTU-NFL11 2 2/CS-#16 >> AIT-3111 SIGNAL	
S-30-604	30E05	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-3111 TO: FIT-3111 1 MFR >> FE-3111 SIGNAL	
S-30-605	30E13	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE-3111 TO: LIT-3111 1 MFR >> LE-3111 SIGNAL	
S-30-606	30E13	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-3111 TO: RTU-NFL11 1 2/CS-#16 >> LIT-3111 SIGNAL	
S-30-607	30E05	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: PIT-3111 TO: RTU-NFL11 1 2/CS-#16 >> PIT-3111 SIGNAL	
S-30-608	30E05	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3112 TO: RTU-NFL11 2 2/CS-#16 >> FV-3112 SIGNAL	
S-30-609	30E05	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3113 TO: RTU-NFL11 2 2/CS-#16 >> FV-3113 SIGNAL	
S-30-610	30E13	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3117 TO: RTU-NFL11 2 2/CS-#16 >> FV-3117 SIGNAL	
S-30-612		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3110 TO: AIT-3110 1 MFR >> AE-3110 SIGNAL	
S-30-613		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3119 TO: AIT-3119 1 MFR >> AE-3119 SIGNAL	

CONDUIT SCHEDULE AREA

FILTER AND CHEMICAL FEED UPGRADES

FILTERS

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
S-30-652	30E17	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3121 TO: AIT-3121 1 MFR >> AE-3121 SIGNAL	
S-30-653	30E05 30E17	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: AIT-3121 TO: RTU-SFL12 2 2/CS-#16 >> AIT-3121 SIGNAL	
S-30-654	30E05	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-3121 TO: FIT-3121 1 MFR >> FE-3121 SIGNAL	
S-30-655	30E17	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE-3121 TO: LIT-3121 1 MFR >> LE-3121 SIGNAL	
S-30-656	30E17	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-3121 TO: RTU-SFL12 1 2/CS-#16 >> LIT-3121 SIGNAL	
S-30-657	30E05	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: PIT-3121 TO: RTU-SFL12 1 2/CS-#16 >> PIT-3121 SIGNAL	
S-30-658	30E05	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3122 TO: RTU-SFL12 2 2/CS-#16 >> FV-3122 SIGNAL	
S-30-659	30E05	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3123 TO: RTU-SFL12 2 2/CS-#16 >> FV-3123 SIGNAL	
S-30-660	30E17	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3127 TO: RTU-SFL12 2 2/CS-#16 >> FV-3127 SIGNAL	
S-30-662		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3120 TO: AIT-3120 1 MFR >> AE-3120 SIGNAL	
S-30-663		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3129 TO: AIT-3129 1 MFR >> AE-3129 SIGNAL	
S-30-702	30E12	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3131 TO: AIT-3131 1 MFR >> AE-3131 SIGNAL	
S-30-703	30E04 30E12	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: AIT-3131 TO: RTU-NFL13 2 2/CS-#16 >> AIT-3131 SIGNAL	
S-30-704	30E04	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-3131 TO: FIT-3131 1 MFR >> FE-3131 SIGNAL	
S-30-705	30E12	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE-3131 TO: LIT-3131 1 MFR >> LE-3131 SIGNAL	
S-30-706	30E12	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-3131 TO: RTU-NFL13 1 2/CS-#16 >> LIT-3131 SIGNAL	
S-30-707	30E04	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: PIT-3131 TO: RTU-NFL13 1 2/CS-#16 >> PIT-3131 SIGNAL	
S-30-708	30E04	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3132 TO: RTU-NFL13 2 2/CS-#16 >> FV-3132 SIGNAL	
S-30-709	30E04	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3133 TO: RTU-NFL13 2 2/CS-#16 >> FV-3133 SIGNAL	
S-30-710	30E12	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3137 TO: RTU-NFL13 2 2/CS-#16 >> FV-3137 SIGNAL	
S-30-712		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3130 TO: AIT-3130 1 MFR >> AE-3130 SIGNAL	

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
S-30-713		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3139 TO: AIT-3139 1 MFR >> AE-3139 SIGNAL	
S-30-752	30E16	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3141 TO: AIT-3141 1 MFR >> AE-3141 SIGNAL	
S-30-753	30E04 30E16	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: AIT-3141 TO: RTU-SFL14 2 2/CS-#16 >> AIT-3141 SIGNAL	
S-30-754	30E04	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-3141 TO: FIT-3141 1 MFR >> FE-3141 SIGNAL	
S-30-755	30E16	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE-3141 TO: LIT-3141 1 MFR >> LE-3141 SIGNAL	
S-30-756	30E16	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-3141 TO: RTU-SFL14 1 2/CS-#16 >> LIT-3141 SIGNAL	
S-30-757	30E04	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: PIT-3141 TO: RTU-SFL14 1 2/CS-#16 >> PIT-3141 SIGNAL	
S-30-758	30E04	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3142 TO: RTU-SFL14 2 2/CS-#16 >> FV-3142 SIGNAL	
S-30-759	30E04	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3143 TO: RTU-SFL14 2 2/CS-#16 >> FV-3143 SIGNAL	
S-30-760	30E16	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3147 TO: RTU-SFL14 2 2/CS-#16 >> FV-3147 SIGNAL	
S-30-762		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3140 TO: AIT-3140 1 MFR >> AE-3140 SIGNAL	
S-30-763		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3149 TO: AIT-3149 1 MFR >> AE-3149 SIGNAL	
S-30-802	30E12	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3151 TO: AIT-3151 1 MFR >> AE-3151 SIGNAL	
S-30-803	30E04 30E12	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: AIT-3151 TO: RTU-NFL15 2 2/CS-#16 >> AIT-3151 SIGNAL	
S-30-804	30E04	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-3151 TO: FIT-3151 1 MFR >> FE-3151 SIGNAL	
S-30-805	30E12	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE-3151 TO: LIT-3151 1 MFR >> LE-3151 SIGNAL	
S-30-806	30E12	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-3151 TO: RTU-NFL15 1 2/CS-#16 >> LIT-3151 SIGNAL	
S-30-807	30E04	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: PIT-3151 TO: RTU-NFL15 1 2/CS-#16 >> PIT-3151 SIGNAL	
S-30-808	30E04	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3152 TO: RTU-NFL15 2 2/CS-#16 >> FV-3152 SIGNAL	
S-30-809	30E04	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3153 TO: RTU-NFL15 2 2/CS-#16 >> FV-3153 SIGNAL	
S-30-810	30E12	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3157 TO: RTU-NFL15 2 2/CS-#16 >> FV-3157 SIGNAL	

CONDUIT SCHEDULE AREA

FILTER AND CHEMICAL FEED UPGRADES

FILTERS

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
S-30-812		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3150 TO: AIT-3150 1 MFR >> AE-3150 SIGNAL	
S-30-813		0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AE-3159 TO: AIT-3159 1 MFR >> AE-3159 SIGNAL	
S-30-852	30E16	0.75"	2	MFR	CABLE	1	#14	XHHW-2	FR: AE-3161 TO: AIT-3161 2 MFR >> AE-3161 SIGNAL	
S-30-853	30E04 30E16	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: AIT-3161 TO: RTU-SFL16 2 2/CS-#16 >> AIT-3161 SIGNAL	
S-30-854	30E04	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-3161 TO: FIT-3161 1 MFR >> FE-3161 SIGNAL	
S-30-855	30E16	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE-3161 TO: LIT-3161 1 MFR >> LE-3161 SIGNAL	
S-30-856	30E16	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-3161 TO: RTU-SFL16 1 2/CS-#16 >> LIT-3161 SIGNAL	
S-30-857	30E04	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: PIT-3161 TO: RTU-SFL16 1 2/CS-#16 >> PIT-3161 SIGNAL	
S-30-858	30E04	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3162 TO: RTU-SFL16 2 2/CS-#16 >> FV-3162 SIGNAL	
S-30-859	30E04	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3163 TO: RTU-SFL16 2 2/CS-#16 >> FV-3163 SIGNAL	
S-30-860	30E16	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-3167 TO: RTU-SFL16 2 2/CS-#16 >> FV-3167 SIGNAL	
S-30-862		0.75"	2	MFR	CABLE	1	#14	XHHW-2	FR: AE-3160 TO: AIT-3160 2 MFR >> AE-3160 SIGNAL	
S-30-863		0.75"	2	MFR	CABLE	1	#14	XHHW-2	FR: AE-3169 TO: AIT-3169 2 MFR >> AE-3169 SIGNAL	
S-30-903	30E07	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-4051 TO: RTU-ELEC2C 2 2/CS-#16 >> FV-4051 SIGNAL	
S-30-904	30E07	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-4061 TO: RTU-ELEC2C 2 2/CS-#16 >> FV-4061 SIGNAL	
S-30-905	30E04	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-4135 TO: FIT-4135 1 MFR >> FE-4135 SIGNAL	
S-30-906	30E07	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-4136 TO: FIT-4136 1 MFR >> FE-4136 SIGNAL	
S-30-907	30E02	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: FV-4411 TO: RTU-FBW 2 2/CS-#16 >> FV-4411 SIGNAL	
S-30-908	30E02	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-4411 TO: FIT-4411 1 MFR >> FE-4411 SIGNAL	
S-30-914	30E06	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: FIT-4136 TO: RTU-FBW 1 2/CS-#16 >> FIT-4136 SIGNAL	
S-30-930	30E13	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE-3001 TO: LIT-3001 1 MFR >> LE-3001 SIGNAL	

CONDUIT SCHEDULE AREA

FILTER AND CHEMICAL FEED UPGRADES

FILTERS

ENGINEER	**AJB**
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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
S-30-931	30E13	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-3001 TO: RTU-FBW 1 2/CS-#16 >> LIT-3001 SIGNAL	
S-30-932	30E17	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE-3002 TO: LIT-3002 1 MFR >> LE-3002 SIGNAL	
S-30-933	30E17	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-3002 TO: RTU-FBW 1 2/CS-#16 >> LIT-3002 SIGNAL	

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 16990C

CONDUIT SCHEDULE
AREA 41

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. */C#Y: Multiconductor cable (* indicates number of conductors, Y indicates conductor size and insulation).
   4. MFR: Manufacturer or vendor furnished cable.
   5. PULL: Pull Rope.
   6. VFD: Shielded VFD cable with integral ground.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

CONDUIT SCHEDULE AREA 41

FILTER AND CHEMICAL FEED UPGRADES

BACKWASH TANK AND VAULT

ENGINEER SKB

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
C-41-115	02E01 41E01	2"	1	PULL	ROPE				FR: STUB-UP AT BACKWASH TANK TO: PB-15 1 PULL >> SPARE	
C-41-211	41E01	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-4112 TO: J-BOX 10 #14 >> FV-4112 CONTROL	C-41-226
C-41-221	41E01	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-4122 TO: J-BOX 10 #14 >> FV-4122 CONTROL	C-41-226
C-41-225	41E01	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LSHH-4123 TO: J-BOX 2 #14 >> LSHH-4123 CONTROL	C-41-226
C-41-226	02E01 41E01	2"	22	#14	XHHW-2	1	#14	XHHW-2	FR: J-BOX TO: PB-15 10 #14 >> FV-4112 CONTROL 10 #14 >> FV-4122 CONTROL 2 #14 >> LSHH-4123 CONTROL	C-41-227 C-41-211 C-41-221 C-41-225
C-41-227	02E01	2"	22	#14	XHHW-2	1	#14	XHHW-2	FR: PB-15 TO: PB-14 10 #14 >> FV-4112 CONTROL 10 #14 >> FV-4122 CONTROL 2 #14 >> LSHH-4123 CONTROL	C-41-228 C-41-226 C-41-226 C-41-226
C-41-228	02E01	2"	22	#14	XHHW-2	1	#14	XHHW-2	FR: PB-14 TO: RTU-CS 10 #14 >> FV-4112 CONTROL 10 #14 >> FV-4122 CONTROL 2 #14 >> LSHH-4123 CONTROL	 C-41-227 C-41-227 C-41-227
C-41-412	30E09	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: VFD-4101 TO: RTU-ELEC1 8 #14 >> VFD-4101 CONTROL (120VAC) 4 #14 >> SPARE	
C-41-415	30E09	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: VFD-4101 TO: RTU-ELEC1 5 #14 >> VFD-4101 CONTROL (24VDC) 2 #14 >> SPARE	
C-41-422	30E09	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: VFD-4102 TO: RTU-ELEC1 8 #14 >> VFD-4102 CONTROL (120VAC) 4 #14 >> SPARE	
C-41-425	30E09	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: VFD-4102 TO: RTU-ELEC1 5 #14 >> VFD-4102 CONTROL (24VDC) 2 #14 >> SPARE	
L-41-224	41E01	1"	2	#4	XHHW-2	1	#4	XHHW-2	FR: PMP-4125 TO: J-BOX 2 #4 >> PMP-4125 POWER	L-41-225
L-41-225	02E01 41E01	2"	2 2 4	#4 #6 #12	XHHW-2 XHHW-2 XHHW-2	1	#4	XHHW-2	FR: J-BOX TO: PB-15 2 #4 >> PMP-4125 POWER 2 #12 >> FAN-4151 POWER 2 #12 >> BACKWASH VALVE VAULT LIGHTING 2 #6 >> BACKWASH VALVE VAULT RECEPTACLI	L-41-226 L-41-224
L-41-226	02E01	2"	2 2 4	#4 #6 #12	XHHW-2 XHHW-2 XHHW-2	1	#4	XHHW-2	FR: PB-15 TO: PB-14 2 #4 >> PMP-4125 POWER 2 #12 >> FAN-4151 POWER 2 #12 >> BACKWASH VALVE VAULT LIGHTING 2 #6 >> BACKWASH VALVE VAULT RECEPTACLI	L-41-227 L-41-225 L-41-225 L-41-225 L-41-225
L-41-227	02E01	2"	2 2 4	#4 #6 #12	XHHW-2 XHHW-2 XHHW-2	1	#4	XHHW-2	FR: PB-14 TO: PNL-CS 2 #4 >> PMP-4125 POWER 2 #12 >> FAN-4151 POWER 2 #12 >> BACKWASH VALVE VAULT LIGHTING 2 #6 >> BACKWASH VALVE VAULT RECEPTACLI	 L-41-226 L-41-226 L-41-226 L-41-226
P-41-211	41E01	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: FV-4112 TO: DISC-4112 3 #12 >> FV-4112 POWER	P-41-212

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FILTER AND CHEMICAL FEED UPGRADES

BACKWASH TANK AND VAULT

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P-41-212	41E01	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-4112 TO: CONDUIT TEE 3 #12 >> FV-4112 POWER	P-41-223 P-41-211
P-41-221	41E01	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: FV-4122 TO: DISC-4122 3 #12 >> FV-4122 POWER	P-41-222
P-41-222	41E01	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-4112 TO: CONDUIT TEE 3 #12 >> FV-4122 POWER	P-41-223 P-41-221
P-41-223	02E01 41E01	2"	6	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE TO: PB-15 3 #12 >> FV-4112 POWER 3 #12 >> FV-4122 POWER	P-41-224 P-41-212 P-41-222
P-41-224	02E01	2"	6	#12	XHHW-2	1	#12	XHHW-2	FR: PB-15 TO: PB-14 3 #12 >> FV-4112 POWER 3 #12 >> FV-4122 POWER	P-41-225 P-41-223 P-41-223
P-41-225	02E01	2"	6	#12	XHHW-2	1	#12	XHHW-2	FR: PB-14 TO: PP-CS 3 #12 >> FV-4112 POWER 3 #12 >> FV-4122 POWER	 P-41-224 P-41-224
P-41-411	30E04	3.5"	1 2 2	3/C-#4/0:VFD #12 #14	VFD XHHW-2 XHHW-2			INTEGRAL	FR: PMP-4101 TO: VFD-4101 1 3/C-#4/0:VFD >> PMP-4101 POWER 2 #12 >> MWH-4101 POWER 2 #14 >> TSH-4101 CONTROL	
P-41-412	30E09	2.5"	3	350	XHHW-2	1	#4	XHHW-2	FR: VFD-4101 TO: MCC-A 3 350 >> VFD-4101 POWER	
P-41-421	30E04	3.5"	1 2 2	3/C-#4/0:VFD #12 #14	VFD XHHW-2 XHHW-2			INTEGRAL	FR: PMP-4102 TO: VFD-4102 1 3/C-#4/0:VFD >> PMP-4102 POWER 2 #12 >> MWH-4102 POWER 2 #14 >> TSH-4102 CONTROL	
P-41-422	30E09	2.5"	3	350	XHHW-2	1	#4	XHHW-2	FR: VFD-4102 TO: MCC-A1 3 350 >> VFD-4102 POWER	
S-41-121	41E01	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE-4122 TO: LIT-4122 1 MFR >> LE-4122 SIGNAL	
S-41-122	02E01 41E01	2"	2 1	#10 2/CS-#16	XHHW-2	1	#10	XHHW-2	FR: LIT-4122 TO: PB-14 1 2/CS-#16 >> LIT-4122 SIGNAL 2 #10 >> LIT-4122 POWER (24VDC)	S-41-123
S-41-123	02E01	2"	2 1	#10 2/CS-#16	XHHW-2	1	#10	XHHW-2	FR: PB-14 TO: RTU-CS 1 2/CS-#16 >> LIT-4122 SIGNAL 2 #10 >> LIT-4122 POWER (24VDC)	 S-41-122 S-41-122
S-41-412	30E09	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: VFD-4101 TO: RTU-ELEC1 2 2/CS-#16 >> VFD-4101 SIGNAL	
S-41-422	30E09	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: VFD-4102 TO: RTU-ELEC1 2 2/CS-#16 >> VFD-4102 SIGNAL	
X-41-311	02E01	2"	1	PULL	ROPE				FR: BACKWASH TANK VAULT TO: PB-15 1 PULL >> SPARE	X-41-312
X-41-312	02E01	2"	1	PULL	ROPE				FR: PB-15 TO: PB-14 1 PULL >> SPARE	X-41-313 X-41-311
X-41-313	02E01	2"	1	PULL	ROPE				FR: PB-14 TO: STUB-UP IN CAUSTIC SODA ELEC ROOM 1 PULL >> SPARE	 X-41-312

CONDUIT SCHEDULE AREA 41

FILTER AND CHEMICAL FEED UPGRADES

BACKWASH TANK AND VAULT

ENGINEER	SKB
REVISION	
DATE	2/11/25

CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
X-41-351	02E01 41E01	2"	1	PULL	ROPE				FR: STUB-UP AT BACKWASH TANK TO: PB-15 1 PULL >> SPARE	
X-41-361	02E01 41E01	2"	1	PULL	ROPE				FR: STUB-UP AT BACKWASH TANK TO: PB-14 1 PULL >> SPARE	

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 16990D

CONDUIT SCHEDULE
AREA 55

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. PULL: Pull Rope.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

CONDUIT SCHEDULE AREA 55

FILTER AND CHEMICAL FEED UPGRADES

CULINARY PUMP STATION

ENGINEER SKB

REVISION

DATE 2/11/25

CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
C-55-201	55E01	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: ATS-5501 TO: RTU-CPS 6 #14 >> ATS-5501 CONTROL	
C-55-202	02E02 55E01	2"	10	#14	XHHW-2	1	#14	XHHW-2	FR: GEN-5501 TO: RTU-CPS 10 #14 >> GEN-5501 CONTROL	
C-55-211	02E02 55E01	2"	12	#14	XHHW-2	1	#14	XHHW-2	FR: ATS-5501 TO: GEN-5501 12 #14 >> ATS-5501 CONTROL	
L-55-202	02E02 55E01	2"	4	#8	XHHW-2	1	#10	XHHW-2	FR: GEN-5501 TO: PANEL CPS 4 #8 >> GEN-5501 POWER	
L-55-252	02E02 55E01	2"	2	#10	XHHW-2	1	#10	XHHW-2	FR: SWBD-CPS TO: PNL-CPS 2 #10 >> SWBD-CPS POWER	
P-55-101	02E02	4"	3	350	XHHW-2	1	#1	XHHW-2	FR: GEN-5501 TO: SWBD-CPS 3 350 >> GEN-5501 POWER	
P-55-102	02E02	4"	3	350	XHHW-2	1	#1	XHHW-2	FR: GEN-5501 TO: SWBD-CPS 3 350 >> GEN-5501 POWER	
P-55-111	02E02 55E01	4"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: SWBD-CPS TO: ATS-5501 3 #4/0 >> SWBD-CPS POWER	
P-55-112	02E02 55E01	4"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: SWBD-CPS TO: ATS-5501 3 #4/0 >> SWBD-CPS POWER	
P-55-121	55E01	2"	3	#2/0	XHHW-2	1	#4	XHHW-2	FR: ATS-5501 TO: XFMR-CPS 3 #2/0 >> ATS-5501 POWER	
P-55-122	55E01	2"	3	#2/0	XHHW-2	1	#4	XHHW-2	FR: ATS-5501 TO: XFMR-CPS 3 #2/0 >> ATS-5501 POWER	
P-55-301	55E01	2"	3	#2/0	XHHW-2	1	#1	XHHW-2	FR: MCC-CPS TO: ATS-5501 3 #2/0 >> MCC-CPS POWER	
P-55-302	55E01	2"	3	#2/0	XHHW-2	1	#1	XHHW-2	FR: MCC-CPS TO: ATS-5501 3 #2/0 >> MCC-CPS POWER	
X-55-401	02E02 55E01	2"	1	PULL	ROPE				FR: GEN-5501 TO: STUB-UP AT CPS 1 PULL >> SPARE	
X-55-402	02E02 55E01	2"	1	PULL	ROPE				FR: GEN-5501 TO: STUB-UP AT CPS 1 PULL >> SPARE	
X-55-421	02E02	4"	1	PULL	ROPE				FR: GEN-5501 TO: SWBD-CPS 1 PULL >> SPARE	
X-55-422	02E02	2"	1	PULL	ROPE				FR: GEN-5501 TO: SWBD-CPS 1 PULL >> SPARE	
X-55-423	02E02	2"	1	PULL	ROPE				FR: GEN-5501 TO: SWBD-CPS 1 PULL >> SPARE	
X-55-425	02E02 55E01	4"	1	PULL	ROPE				FR: SWBD-CPS TO: STUB-UP AT CPS 1 PULL >> SPARE	

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 16990E

CONDUIT SCHEDULE
AREA 62 & 66

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. PULL: Pull Rope.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

CONDUIT SCHEDULE AREA 62 & 66

FILTER AND CHEMICAL FEED UPGRADES

PRIMARY COAGULANT BUILDING & FLUORIDE BUILDING

ENGINEER SKB

REVISION

DATE 2/11/25

CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
C-62-201	71E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSH-6201 TO: RTU-PEA 2 #14 >> RTU-PEA CONTROL	
C-62-211	62E01	0.75"	3	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6201 TO: J-BOX 3 #14 >> PISH-6201 CONTROL	C-62-225
C-62-221	62E01	0.75"	3	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6202 TO: J-BOX 3 #14 >> PISH-6202 CONTROL	C-62-225
C-62-225	01E03 62E01	1"	6	#14	XHHW-2	1	#14	XHHW-2	FR: J-BOX TO: MCC-CDS 3 #14 >> PISH-6201 CONTROL 3 #14 >> PISH-6202 CONTROL	 C-62-211 C-62-221
C-62-251	77E01	1.5"	48	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-CDS TO: RTU-CDS 24 #14 >> FVNR-6201 CONTROL 24 #14 >> FVNR-6202 CONTROL	
C-62-311	62E01	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-6201 TO: J-BOX 6 #14 >> LCP-6201 CONTROL	C-62-325
C-62-321	62E01	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-6202 TO: J-BOX 6 #14 >> LCP-6202 CONTROL	C-62-325
C-62-325	01E03 62E01	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: J-BOX TO: RTU-CDS 6 #14 >> LCP-6201 CONTROL 6 #14 >> LCP-6202 CONTROL	 C-62-311 C-62-321
P-62-211	01E03 62E01	1"	5 2	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: PMP-6201 TO: MCC-CDS 3 #12 >> PMP-6201 POWER 2 #12 >> MWH-6201 POWER 2 #14 >> TSH-6201 CONTROL	
P-62-221	01E03 62E01	1"	5 2	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: PMP-6202 TO: MCC-CDS 3 #12 >> PMP-6202 POWER 2 #12 >> MWH-6202 POWER 2 #14 >> TSH-6202 CONTROL	
X-62-411	01E03	1"	1	PULL	ROPE				FR: PRIMARY COAGULANT BUILDING TO: RTU-CDS 1 PULL >> SPARE	
L-66-111	66E01	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: FIT-6691 TO: RTU-FL 2 #12 >> FIT-6691 POWER	
S-66-111	66E01	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: FIT-6691 TO: RTU-FL 1 2/CS-#16 >> FIT-6691 SIGNAL	

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 16990F

CONDUIT SCHEDULE
AREA 63

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. */FO: Fiber optic (* indicates strand count).
   4. CAT6: Category 6 Ethernet cable.
   5. PULL: Pull Rope.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

CONDUIT SCHEDULE AREA 63

JVWTP FILTER AND CHEMICAL FEED UPGRADES

CHLORINE BUILDING

ENGINEER	MJG
REVISION	
DATE	2/11/25

CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
C-63-001	63E03	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6301 TO: VCP-6301 10 #14 >> FV-6301 CONTROL	
C-63-002	63E03	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6302 TO: VCP-6301 10 #14 >> FV-6302 CONTROL	
C-63-003	63E03	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6303 TO: VCP-6303 10 #14 >> FV-6303 CONTROL	
C-63-004	63E03	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6304 TO: VCP-6303 10 #14 >> FV-6304 CONTROL	
C-63-005	63E03	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6305 TO: VCP-6305 10 #14 >> FV-6305 CONTROL	
C-63-006	63E03	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6306 TO: VCP-6305 10 #14 >> FV-6306 CONTROL	
C-63-007	63E03	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6307 TO: VCP-6307 10 #14 >> FV-6307 CONTROL	
C-63-008	63E03	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6308 TO: VCP-6307 10 #14 >> FV-6308 CONTROL	
C-63-009	63E03	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6309 TO: VCP-6309 10 #14 >> FV-6309 CONTROL	
C-63-010	63E03	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6310 TO: VCP-6309 10 #14 >> FV-6310 CONTROL	
C-63-011	63E04	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6311 TO: VCP-6311 10 #14 >> FV-6311 CONTROL	
C-63-012	63E04	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6312 TO: VCP-6311 10 #14 >> FV-6312 CONTROL	
C-63-013	63E04	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6313 TO: VCP-6314 10 #14 >> FV-6313 CONTROL	
C-63-014	63E04	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6314 TO: VCP-6314 10 #14 >> FV-6314 CONTROL	
C-63-015	63E04	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6315 TO: VCP-6316 10 #14 >> FV-6315 CONTROL	
C-63-016	63E04	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6316 TO: VCP-6316 10 #14 >> FV-6316 CONTROL	
C-63-017	63E04	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6317 TO: VCP-6318 10 #14 >> FV-6317 CONTROL	
C-63-018	63E04	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6318 TO: VCP-6318 10 #14 >> FV-6318 CONTROL	
C-63-019	63E04	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6319 TO: VCP-6320 10 #14 >> FV-6319 CONTROL	
C-63-020	63E04	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6320 TO: VCP-6320 10 #14 >> FV-6320 CONTROL	
C-63-022	63E03	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6301 TO: LCP-6361 8 #14 >> VCP-6301 CONTROL	

CONDUIT SCHEDULE AREA 63

JVWTP FILTER AND CHEMICAL FEED UPGRADES

CHLORINE BUILDING

ENGINEER	MJG
REVISION	
DATE	2/11/25

CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
C-63-024	63E03	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6303 TO: LCP-6361 8 #14 >> VCP-6303 CONTROL	
C-63-026	63E03	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6305 TO: LCP-6361 8 #14 >> VCP-6305 CONTROL	
C-63-028	63E03	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6307 TO: LCP-6361 8 #14 >> VCP-6307 CONTROL	
C-63-030	63E03	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6309 TO: LCP-6361 8 #14 >> VCP-6309 CONTROL	
C-63-032	63E04	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6311 TO: LCP-6361 8 #14 >> VCP-6311 CONTROL	
C-63-034	63E04	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6314 TO: LCP-6361 8 #14 >> VCP-6314 CONTROL	
C-63-036	63E04	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6316 TO: LCP-6361 8 #14 >> VCP-6316 CONTROL	
C-63-038	63E04	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6318 TO: LCP-6361 8 #14 >> VCP-6318 CONTROL	
C-63-040	63E04	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6320 TO: LCP-6361 8 #14 >> VCP-6320 CONTROL	
C-63-041	63E06	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSH-6301 TO: RTU-CL 2 #14 >> FSH-6301 CONTROL	
C-63-042	63E07	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSH-6302 TO: RTU-CL 2 #14 >> FSH-6302 CONTROL	
C-63-043	63E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSH-6333 TO: RTU-CL 2 #14 >> FSH-6333 CONTROL	
C-63-044	63E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSH-6331 TO: RTU-CL 2 #14 >> FSH-6331 CONTROL	
C-63-051	63E02	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6331 TO: RTU-CL 12 #14 >> VCP-6331 CONTROL	
C-63-052	63E02	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6332 TO: RTU-CL 12 #14 >> VCP-6332 CONTROL	
C-63-053	63E02	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6333 TO: RTU-CL 12 #14 >> VCP-6333 CONTROL	
C-63-054	63E02	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6334 TO: RTU-CL 12 #14 >> VCP-6334 CONTROL	
C-63-055	63E02	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6335 TO: RTU-CL 12 #14 >> VCP-6335 CONTROL	
C-63-056	63E02	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6336 TO: RTU-CL 12 #14 >> VCP-6336 CONTROL	
C-63-060	63E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISL-6350 TO: RTU-CL 2 #14 >> PISL-6350 CONTROL	
C-63-062	63E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISL-6352 TO: RTU-CL 2 #14 >> PISL-6352 CONTROL	

CONDUIT SCHEDULE AREA 63

JVWTP FILTER AND CHEMICAL FEED UPGRADES

CHLORINE BUILDING

ENGINEER	MJG
REVISION	
DATE	2/11/25

CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
C-63-063	63E09	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LSHH-6319 TO: PNL-CL 2 #14 >> LSHH-6319 CONTROL	
C-63-071	63E08	0.75"	2 2	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: BLR-6391 TO: MCC-CL 2 #12 >> MWH-6391 CONTROL 2 #14 >> TSH-6391 CONTROL	
C-63-072	63E08	0.75"	2 2	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: BLR-6392 TO: MCC-CL 2 #12 >> MWH-6392 CONTROL 2 #14 >> TSH-6392 CONTROL	
C-63-073	63E08	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: FSL-6391 TO: RTU-CL 2 #14 >> FSL-6391 CONTROL POWER 2 #14 >> FSL-6391 CONTROL	
C-63-074	63E08	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: FSL-6392 TO: RTU-CL 2 #14 >> FSL-6392 CONTROL POWER 2 #14 >> FSL-6392 CONTROL	
C-63-075	63E08	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-6391 TO: MCC-CL 6 #14 >> LCP-6391 CONTROL	
C-63-076	63E08	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-6392 TO: MCC-CL 6 #14 >> LCP-6392 CONTROL	
C-63-081	63E12	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: HP-6351 TO: AHU-6351 6 #14 >> HP-6351 CONTROL	
C-63-082	63E05	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: TSHL-6351 TO: AHU-6351 6 #14 >> TSHL-6351 CONTROL	
C-63-083	63E12	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: HP-6352 TO: AHU-6352 6 #14 >> HP-6352 CONTROL	
C-63-084	63E05	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: TSHL-6352 TO: AHU-6352 6 #14 >> TSHL-6352 CONTROL	
C-63-085	63E05	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: PPU-6353 TO: RTU-CL 12 #14 >> PPU-6353 CONTROL	
C-63-086	63E07	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: TSHL-6354 TO: MAU-6354 6 #14 >> TSHL-6354 CONTROL	
C-63-087	63E12	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: XS-6354 TO: MAU-6354 4 #14 >> XS-6354 CONTROL	
C-63-088	63E12	1"	14	#14	XHHW-2	1	#14	XHHW-2	FR: MAU-6354 TO: RTU-CL 14 #14 >> MAU-6354 CONTROL	
C-63-089	63E10	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LVR-6355 TO: RTU-CL 7 #14 >> LVR-6355 (24VDC) CONTROL	
C-63-090	63E12	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: XS-6355 TO: MCC-CL 6 #14 >> XS-6355 CONTROL	
C-63-092	63E09	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LVR-6356 TO: RTU-CL 7 #14 >> LVR-6356 (24VDC) CONTROL	
C-63-093	63E12	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: XS-6356 TO: MCC-CL 6 #14 >> XS-6356 CONTROL	
C-63-095	63E02	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FVNR-6368 TO: RTU-CL 8 #14 >> LCP-6368 CONTROL	

CONDUIT SCHEDULE AREA 63

JVWTP FILTER AND CHEMICAL FEED UPGRADES

CHLORINE BUILDING

ENGINEER MJG

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
C-63-096	63E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: TSH-6368 TO: FVNR-6368 2 #14 >> TSH-6368 CONTROL	
C-63-097	63E02	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: FVNR-6357 TO: RTU-CL 8 #14 >> LCP-6357 CONTROL	
C-63-098	63E11	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LVR-6357 TO: RTU-CL 7 #14 >> LVR-6357 (24VDC) CONTROL	
C-63-100	63E05	1.5"	28	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-CL TO: RTU-CL 2 #14 >> CL-6301 SPD FAIL STATUS 7 #14 >> EF-6355 STARTER CONTROLS 7 #14 >> EF-6356 STARTER CONTROLS 6 #14 >> RVSS-6391 CONTROLS 6 #14 >> RVSS-6392 CONTROLS	
C-63-101	63E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: ZSC-6381 TO: LCP-6361 2 #14 >> ZSC-6381 CONTROL	
C-63-102	63E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: ZSC-6382 TO: LCP-6361 2 #14 >> ZSC-6382 CONTROL	
C-63-103	63E07	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: ZSC-6383 TO: LCP-6361 2 #14 >> ZSC-6383 CONTROL	
C-63-104	63E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: ZSC-6384 TO: LCP-6361 2 #14 >> ZSC-6384 CONTROL	
C-63-105	63E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: ZSC-6385 TO: LCP-6361 2 #14 >> ZSC-6385 CONTROL	
C-63-106	63E09	1"	15	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-6381 TO: LCP-6361 15 #14 >> LCP-6381 CONTROL	
C-63-107	63E10	1"	15	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-6382 TO: LCP-6361 15 #14 >> LCP-6382 CONTROL	
C-63-108	63E07	1"	15	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-6383 TO: LCP-6361 15 #14 >> LCP-6383 CONTROL	
C-63-109	63E02	1"	15	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-6384 TO: LCP-6361 15 #14 >> LCP-6384 CONTROL	
C-63-110	63E02	1"	15	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-6385 TO: LCP-6361 15 #14 >> LCP-6385 CONTROL	
C-63-111	63E05	1.5"	4	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-6361 TO: MCC-CL 2 #14 >> RVSS-6391 FAIL (24VDC) STATUS 2 #14 >> RVSS-6392 FAIL (24VDC) STATUS	
C-63-112	63E05	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-6361 TO: MCC-CL 2 #14 >> EF-6355 START CONTROL 2 #14 >> EF-6356 START CONTROL 2 #14 >> EF-6357 START CONTROL 2 #14 >> SF-6358 START CONTROL 2 #14 >> RVSS-6391 START CONTROL 2 #14 >> RVSS-6392 START CONTROL	
C-63-113	63E05	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-6361 TO: PANEL-MOUNTED BEACONS 6 #14 >> BEACON CONTROLS	
C-63-114	63E11	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: XH3-6361 & XH5-6361 TO: LCP-6361 4 #14 >> CL2 STORAGE HORN & STROBE CONTF	

CONDUIT SCHEDULE AREA 63

JVWTP FILTER AND CHEMICAL FEED UPGRADES

CHLORINE BUILDING

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NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
C-63-115	63E11	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: XH2-6361 & XH4-6361 TO: LCP-6361 4 #14 >> CL2 FEED HORN & STROBE CONTROLS	
C-63-116	63E09	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: ZSC-6386 TO: LCP-6361 2 #14 >> ZSC-6386 CONTROL	
C-63-117	63E10	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: ZSC-6387 TO: LCP-6361 2 #14 >> ZSC-6387 CONTROL	
C-63-611	63E16	1"	1	PULL	ROPE				FR: DOOR 63-D102-03 SECURITY J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
C-63-621	63E16	1"	1	PULL	ROPE				FR: DOOR 63-D102-02 SECURITY J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
C-63-631	63E16	1"	1	PULL	ROPE				FR: DOOR 63-D105-01 SECURITY J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
C-63-641	63E16	1"	1	PULL	ROPE				FR: DOOR 63-D104-01 SECURITY J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
C-63-651	63E16	1"	1	PULL	ROPE				FR: DOOR 63-D103-01 SECURITY J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
C-63-661	63E16	1"	1	PULL	ROPE				FR: DOOR 63-D101-01 SECURITY J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
C-63-671	63E16	1"	1	PULL	ROPE				FR: DOOR 63-D101-02 SECURITY J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
L-63-021	63E03	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6301 TO: PNL-UPS-CL 2 #12 >> VCP-6301 POWER	
L-63-023	63E03	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6303 TO: PNL-UPS-CL 2 #12 >> VCP-6303 POWER	
L-63-025	63E03	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6305 TO: PNL-UPS-CL 2 #12 >> VCP-6305 POWER	
L-63-027	63E03	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6307 TO: PNL-UPS-CL 2 #12 >> VCP-6307 POWER	
L-63-029	63E03	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6309 TO: PNL-UPS-CL 2 #12 >> VCP-6309 POWER	
L-63-031	63E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6311 TO: PNL-UPS-CL 2 #12 >> VCP-6311 POWER	
L-63-033	63E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6314 TO: PNL-UPS-CL 2 #12 >> VCP-6314 POWER	
L-63-035	63E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6316 TO: PNL-UPS-CL 2 #12 >> VCP-6316 POWER	
L-63-037	63E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6318 TO: PNL-UPS-CL 2 #12 >> VCP-6318 POWER	
L-63-039	63E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6320 TO: PNL-UPS-CL 2 #12 >> VCP-6320 POWER	
L-63-041	63E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: HTU-6331 TO: PNL-CL 2 #12 >> HTU-6331 POWER	

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JVWTP FILTER AND CHEMICAL FEED UPGRADES

CHLORINE BUILDING

ENGINEER	MJG
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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
L-63-042	63E02	0.75"	2	#10	XHHW-2	1	#10	XHHW-2	FR: HTU-6332 TO: PNL-CL 2 #10 >> HTU-6332 POWER	
L-63-051	63E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6331 TO: RTU-CL 2 #12 >> VCP-6331 POWER	
L-63-052	63E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6332 TO: RTU-CL 2 #12 >> VCP-6332 POWER	
L-63-053	63E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6333 TO: RTU-CL 2 #12 >> VCP-6333 POWER	
L-63-054	63E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6334 TO: RTU-CL 2 #12 >> VCP-6334 POWER	
L-63-055	63E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6335 TO: RTU-CL 2 #12 >> VCP-6335 POWER	
L-63-056	63E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6336 TO: RTU-CL 2 #12 >> VCP-6336 POWER	
L-63-060	63E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: PISL-6350 TO: RTU-CL 2 #12 >> PISL-6350 POWER	
L-63-062	63E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: PISL-6352 TO: RTU-CL 2 #12 >> PISL-6352 POWER	
L-63-063	63E09	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: PMP-6319 TO: PNL-CL 2 #12 >> PMP-6319 POWER	
L-63-071	63E05	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: SECURITY PANEL TO: PNL-CL 2 #12 >> SECURITY PANEL (UTILITY) POWER	
L-63-072	63E05	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: SECURITY PANEL TO: PNL-UPS-CL 2 #12 >> SECURITY PANEL (UPS) POWER	
L-63-085	63E12	0.75"	2	#10	XHHW-2	1	#10	XHHW-2	FR: HP-6351 TO: CONDUIT TEE 2 #10 >> HP-6351 POWER	L-63-087
L-63-086	63E12	0.75"	2	#10	XHHW-2	1	#10	XHHW-2	FR: HP-6352 TO: CONDUIT TEE 2 #10 >> HP-6352 POWER	L-63-087
L-63-087	63E12	0.75"	4	#10	XHHW-2	1	#10	XHHW-2	FR: CONDUIT TEE TO: PNL-CL 2 #10 >> HP-6351 POWER 2 #10 >> HP-6352 POWER	 L-63-085 L-63-086
L-63-088	63E10	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: LVR-6355 TO: PNL-CL 2 #12 >> LVR-6355 POWER	
L-63-089	63E09	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: LVR-6356 TO: PNL-CL 2 #12 >> LVR-6356 POWER	
L-63-090	63E11	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: SF-6368 TO: FVNR-6368 2 #12 >> SF-6368 POWER	
L-63-091	63E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: FVNR-6368 TO: PNL-CL 2 #12 >> FVNR-6368 POWER	
L-63-093	63E11	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: EF-6357 TO: FVNR-6357 2 #12 >> EF-6357 POWER	

CONDUIT SCHEDULE AREA 63

JVWTP FILTER AND CHEMICAL FEED UPGRADES

CHLORINE BUILDING

ENGINEER	MJG
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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
L-63-094	63E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: FVNR-6357 TO: PNL-CL 2 #12 >> DISC-6357 POWER	
L-63-096	63E11	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: LVR-6357 TO: PNL-CL 2 #12 >> LVR-6357 POWER	
L-63-097	63E05	0.75"	2	#10	XHHW-2	1	#10	XHHW-2	FR: RTU-CL TO: PNL-CL 2 #10 >> RTU-CL (UTILITY) POWER	
L-63-098	63E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: LOI-CL TO: RTU-CL 2 #12 >> LOI-CL (UPS) POWER	
L-63-099	63E05	0.75"	2	#10	XHHW-2	1	#10	XHHW-2	FR: LCP-6361 TO: PNL-UPS-CL 2 #10 >> LCP-6361 (UPS) POWER	
L-63-100	63E05	0.75"	2	#10	XHHW-2	1	#10	XHHW-2	FR: RTU-CL TO: PNL-UPS-CL 2 #10 >> RTU-CL (UPS) POWER	
L-63-101	63E11	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: GUH-6358 TO: PNL-CL 2 #12 >> GUH-6358 POWER	
L-63-102	63E11	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: GUH-6359 TO: PNL-CL 2 #12 >> GUH-6359 POWER	
L-63-103	63E11	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: GUH-6360 TO: PNL-CL 2 #12 >> GUH-6360 POWER	
L-63-104	63E11	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: GUH-6361 TO: PNL-CL 2 #12 >> GUH-6361 POWER	
L-63-105	63E11	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: GUH-6362 TO: PNL-CL 2 #12 >> GUH-6362 POWER	
L-63-106	63E11	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: GUH-6363 TO: PNL-CL 2 #12 >> GUH-6363 POWER	
L-63-107	63E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: GUH-6364 TO: PNL-CL 2 #12 >> GUH-6364 POWER	
L-63-108	63E05	1"	3	#6	XHHW-2	1	#10	XHHW-2	FR: UPS-CL TO: UPS BYPASS DISC 3 #6 >> UPS-CL (BYPASS) POWER	
L-63-109	63E05	1"	3	#6	XHHW-2	1	#10	XHHW-2	FR: UPS BYPASS DISC TO: PNL-CL 3 #6 >> UPS BYPASS DISC POWER	
L-63-110	63E05	3"	4	250	XHHW-2	1	#2	XHHW-2	FR: PNL-CL TO: XFMR-CL 4 250 >> PNL-CL POWER	
L-63-111	63E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: TWH-6365 TO: PNL-CL 2 #12 >> TWH-6365 POWER	
L-63-112	63E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: TWH-6366 TO: PNL-CL 2 #12 >> TWH-6366 POWER	
L-63-113	63E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: TWH-6367 TO: PNL-CL 2 #12 >> TWH-6367 POWER	
L-63-120	63E05	1"	3	#6	XHHW-2	1	#10	XHHW-2	FR: PNL-UPS-CL TO: UPS-CL 3 #6 >> PNL-UPS-CL POWER	

CONDUIT SCHEDULE AREA 63

JVWTP FILTER AND CHEMICAL FEED UPGRADES

CHLORINE BUILDING

ENGINEER	MJG
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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
N-63-100	63E05	1"	3		CAT6	1	#14	XHHW-2	FR: MCC-CL TO: RTU-CL 1 CAT6 >> SSM-6301 POWER MONITOR NETWORK 1 CAT6 >> RVSS-6391 NETWORK 1 CAT6 >> RVSS-6392 NETWORK	
N-63-101	63E05	0.75"	1		CAT6	1	#14	XHHW-2	FR: LCP-6361 TO: RTU-CL 1 CAT6 >> LCP-6361 NETWORK	
N-63-102	63E05	4"	1		12/FO	1	#14	XHHW-2	FR: LOI-FB TO: LCP-6361 1 12/FO >> LOI-FB NETWORK	
N-63-103	63E05	0.75"	1		CAT6	1	#14	XHHW-2	FR: LOI-CL TO: LCP-6361 1 CAT6 >> LOI-CL NETWORK	
N-63-611	63E16	1"	1	PULL	ROPE				FR: SECURITY CAMERA J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
N-63-621	63E16	1"	1	PULL	ROPE				FR: SECURITY CAMERA J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
N-63-631	63E16	1"	1	PULL	ROPE				FR: SECURITY CAMERA J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
N-63-641	63E16	1"	1	PULL	ROPE				FR: SECURITY CAMERA J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
N-63-651	63E16	1"	1	PULL	ROPE				FR: SECURITY CAMERA J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
N-63-661	63E16	1"	1	PULL	ROPE				FR: SECURITY CAMERA J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
N-63-671	63E16	1"	1	PULL	ROPE				FR: SECURITY CAMERA J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
N-63-681	63E16	1"	1	PULL	ROPE				FR: WIRELESS NETWORK J-BOX TO: RTU-CL 1 PULL >> SPARE	
N-63-682	63E16	1"	1	PULL	ROPE				FR: WIRELESS NETWORK J-BOX TO: RTU-CL 1 PULL >> SPARE	
N-63-683	63E16	1"	1	PULL	ROPE				FR: WIRELESS NETWORK J-BOX TO: RTU-CL 1 PULL >> SPARE	
N-63-684	63E16	1"	1	PULL	ROPE				FR: WIRELESS NETWORK J-BOX TO: RTU-CL 1 PULL >> SPARE	
P-63-001	63E08	1"	3	#6	XHHW-2	1	#8	XHHW-2	FR: BLR-6391 TO: MCC-CL 3 #6 >> BLR-6391 POWER	
P-63-002	63E08	1"	3	#6	XHHW-2	1	#8	XHHW-2	FR: BLR-6392 TO: MCC-CL 3 #6 >> BLR-6392 POWER	
P-63-003	63E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PPU-6353 TO: DISC-6353 3 #12 >> PPU-6353 POWER	
P-63-004	63E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-6353 TO: PP-CL 3 #12 >> DISC-6353 POWER	
P-63-005	63E12	0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR: MAU-6354 TO: PP-CL 3 #10 >> MAU-6354 POWER	

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CHLORINE BUILDING

ENGINEER MJG

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
P-63-006	63E12	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: EF-6355 TO: MCC-CL 3 #12 >> EF-6355 POWER	
P-63-007	63E12	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: EF-6356 TO: MCC-CL 3 #12 >> EF-6356 POWER	
P-63-008	63E05	0.75"	3	#8	XHHW-2	1	#10	XHHW-2	FR: UPS-CL TO: MCC-CL 3 #8 >> UPS (MAIN) POWER	
P-63-009	63E05	2.5"	3	250	XHHW-2	1	#4	XHHW-2	FR: PP-CL TO: MCC-CL 3 250 >> PP-CL POWER	
P-63-010	63E05	2"	3	#4/0	XHHW-2	1	#4	XHHW-2	FR: XFMR-CL TO: MCC-CL 3 #4/0 >> XFMR-CL POWER	
P-63-011	63E09	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: CHLORINE BRIDGE CRANE TO: BRIDGE CRANE DISCONNECT 3 #12 >> CHLORINE BRIDGE CRANE POWER	
P-63-012	63E09	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: BRIDGE CRANE DISCONNECT TO: MCC-CL 3 #12 >> BRIDGE CRANE DISCONNECT POWER	
P-63-013	63E09	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: OHD-6311 TO: DISC-6311 3 #12 >> OHD-6311 POWER	
P-63-014	63E09	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-6311 TO: PP-CL 3 #12 >> DISC-6311 POWER	
P-63-015	63E10	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: OHD-6312 TO: DISC-6312 3 #12 >> OHD-6312 POWER	
P-63-016	63E10	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-6312 TO: PP-CL 3 #12 >> DISC-6312 POWER	
S-63-001	63E03	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: WIT-6301 TO: RTU-CL 1 2/CS-#16 >> WIT-6301 SIGNAL 2 #14 >> WIT-6301 (24VDC) POWER	
S-63-002	63E03	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: WIT-6302 TO: RTU-CL 1 2/CS-#16 >> WIT-6302 SIGNAL 2 #14 >> WIT-6302 (24VDC) POWER	
S-63-003	63E03	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: WIT-6303 TO: RTU-CL 1 2/CS-#16 >> WIT-6303 SIGNAL 2 #14 >> WIT-6303 (24VDC) POWER	
S-63-004	63E03	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: WIT-6304 TO: RTU-CL 1 2/CS-#16 >> WIT-6304 SIGNAL 2 #14 >> WIT-6304 (24VDC) POWER	
S-63-005	63E03	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: WIT-6305 TO: RTU-CL 1 2/CS-#16 >> WIT-6305 SIGNAL 2 #14 >> WIT-6305 (24VDC) POWER	
S-63-006	63E03	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: WIT-6306 TO: RTU-CL 1 2/CS-#16 >> WIT-6306 SIGNAL 2 #14 >> WIT-6306 (24VDC) POWER	
S-63-007	63E03	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: WIT-6307 TO: RTU-CL 1 2/CS-#16 >> WIT-6307 SIGNAL 2 #14 >> WIT-6307 (24VDC) POWER	
S-63-008	63E03	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: WIT-6308 TO: RTU-CL 1 2/CS-#16 >> WIT-6308 SIGNAL 2 #14 >> WIT-6308 (24VDC) POWER	

CONDUIT SCHEDULE AREA 63

JVWTP FILTER AND CHEMICAL FEED UPGRADES

CHLORINE BUILDING

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
S-63-009	63E03	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: WIT-6309 TO: RTU-CL 1 2/CS-#16 >> WIT-6309 SIGNAL 2 #14 >> WIT-6309 (24VDC) POWER	
S-63-010	63E03	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: WIT-6310 TO: RTU-CL 1 2/CS-#16 >> WIT-6310 SIGNAL 2 #14 >> WIT-6310 (24VDC) POWER	
S-63-011	63E04	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: WIT-6311 TO: RTU-CL 1 2/CS-#16 >> WIT-6311 SIGNAL 2 #14 >> WIT-6311 (24VDC) POWER	
S-63-012	63E04	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: WIT-6312 TO: RTU-CL 1 2/CS-#16 >> WIT-6312 SIGNAL 2 #14 >> WIT-6312 (24VDC) POWER	
S-63-013	63E04	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: WIT-6313 TO: RTU-CL 1 2/CS-#16 >> WIT-6313 SIGNAL 2 #14 >> WIT-6313 (24VDC) POWER	
S-63-014	63E04	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: WIT-6314 TO: RTU-CL 1 2/CS-#16 >> WIT-6314 SIGNAL 2 #14 >> WIT-6314 (24VDC) POWER	
S-63-015	63E04	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: WIT-6315 TO: RTU-CL 1 2/CS-#16 >> WIT-6315 SIGNAL 2 #14 >> WIT-6315 (24VDC) POWER	
S-63-016	63E04	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: WIT-6316 TO: RTU-CL 1 2/CS-#16 >> WIT-6316 SIGNAL 2 #14 >> WIT-6316 (24VDC) POWER	
S-63-017	63E04	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: WIT-6317 TO: RTU-CL 1 2/CS-#16 >> WIT-6317 SIGNAL 2 #14 >> WIT-6317 (24VDC) POWER	
S-63-018	63E04	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: WIT-6318 TO: RTU-CL 1 2/CS-#16 >> WIT-6318 SIGNAL 2 #14 >> WIT-6318 (24VDC) POWER	
S-63-019	63E04	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: WIT-6319 TO: RTU-CL 1 2/CS-#16 >> WIT-6319 SIGNAL 2 #14 >> WIT-6319 (24VDC) POWER	
S-63-020	63E04	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: WIT-6320 TO: RTU-CL 1 2/CS-#16 >> WIT-6320 SIGNAL 2 #14 >> WIT-6320 (24VDC) POWER	
S-63-021	63E06	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-6311 TO: LCP-6361 (RTU-CLIP) 1 2/CS-#16 >> AIT-6311 SIGNAL 2 #14 >> AIT-6311 (24VDC) POWER	
S-63-022	63E03	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-6312 TO: LCP-6361 (RTU-CLIP) 1 2/CS-#16 >> AIT-6312 SIGNAL 2 #14 >> AIT-6312 (24VDC) POWER	
S-63-023	63E03	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-6313 TO: LCP-6361 (RTU-CLIP) 1 2/CS-#16 >> AIT-6313 SIGNAL 2 #14 >> AIT-6313 (24VDC) POWER	
S-63-024	63E03	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-6314 TO: LCP-6361 (RTU-CLIP) 1 2/CS-#16 >> AIT-6314 SIGNAL 2 #14 >> AIT-6314 (24VDC) POWER	

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CHLORINE BUILDING

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
S-63-025	63E04	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-6315 TO: LCP-6361 (RTU-CLIP) 1 2/CS-#16 >> AIT-6315 SIGNAL 2 #14 >> AIT-6315 (24VDC) POWER	
S-63-026	63E04	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-6316 TO: LCP-6361 (RTU-CLIP) 1 2/CS-#16 >> AIT-6316 SIGNAL 2 #14 >> AIT-6316 (24VDC) POWER	
S-63-027	63E04	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-6317 TO: LCP-6361 (RTU-CLIP) 1 2/CS-#16 >> AIT-6317 SIGNAL 2 #14 >> AIT-6317 (24VDC) POWER	
S-63-028	63E07	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-6318 TO: LCP-6361 (RTU-CLIP) 1 2/CS-#16 >> AIT-6318 SIGNAL 2 #14 >> AIT-6318 (24VDC) POWER	
S-63-031	63E09	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-6321 TO: LCP-6361 (RTU-CLIP) 1 2/CS-#16 >> AIT-6321 SIGNAL 2 #14 >> AIT-6321 (24VDC) POWER	
S-63-032	63E10	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-6322 TO: LCP-6361 (RTU-CLIP) 1 2/CS-#16 >> AIT-6322 SIGNAL 2 #14 >> AIT-6322 (24VDC) POWER	
S-63-033	63E09	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-6323 TO: LCP-6361 (RTU-CLIP) 1 2/CS-#16 >> AIT-6323 SIGNAL 2 #14 >> AIT-6323 (24VDC) POWER	
S-63-034	63E10	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-6324 TO: LCP-6361 (RTU-CLIP) 1 2/CS-#16 >> AIT-6324 SIGNAL 2 #14 >> AIT-6324 (24VDC) POWER	
S-63-035	63E08	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-6391 TO: LCP-6361 (RTU-CLIP) 1 2/CS-#16 >> AIT-6391 SIGNAL 2 #14 >> AIT-6391 (24VDC) POWER	
S-63-036	63E08	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-6392 TO: LCP-6361 (RTU-CLIP) 1 2/CS-#16 >> AIT-6392 SIGNAL 2 #14 >> AIT-6392 (24VDC) POWER	
S-63-037	63E02	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-6331 TO: LCP-6361 (RTU-CLIP) 1 2/CS-#16 >> AIT-6331 SIGNAL 2 #14 >> AIT-6331 (24VDC) POWER	
S-63-038	63E08	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: PDIT-6391 TO: RTU-CL 1 2/CS-#16 >> PDIT-6391 SIGNAL	
S-63-039	63E08	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: PDIT-6392 TO: RTU-CL 1 2/CS-#16 >> PDIT-6392 SIGNAL	
S-63-042	63E04	0.75"	2 1	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-6342 TO: LCP-6361 (RTU-CLIP) 1 2/CS-#16 >> AIT-6342 SIGNAL 2 #14 >> AIT-6342 (24VDC) POWER	
S-63-051	63E02	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: VCP-6331 TO: RTU-CL 1 2/CS-#16 >> VCP-6331 SIGNAL	
S-63-052	63E02	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: VCP-6332 TO: RTU-CL 1 2/CS-#16 >> VCP-6332 SIGNAL	
S-63-053	63E02	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: VCP-6333 TO: RTU-CL 1 2/CS-#16 >> VCP-6333 SIGNAL	
S-63-054	63E02	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: VCP-6334 TO: RTU-CL 1 2/CS-#16 >> VCP-6334 SIGNAL	

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NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
S-63-055	63E02	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: VCP-6335 TO: RTU-CL 1 2/CS-#16 >> VCP-6335 SIGNAL	
S-63-056	63E02	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: VCP-6336 TO: RTU-CL 1 2/CS-#16 >> VCP-6336 SIGNAL	
S-63-058	63E05	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: TE-6359 TO: TIT-6359 1 2/CS-#16 >> TE-6359 SIGNAL	
S-63-059	63E05	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: TIT-6359 TO: RTU-CL 1 2/CS-#16 >> TIT-6359 SIGNAL	
S-63-060	63E07	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: TE-6357 TO: TIT-6357 1 2/CS-#16 >> TE-6357 SIGNAL	
S-63-061	63E07	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: TIT-6357 TO: RTU-CL 1 2/CS-#16 >> TIT-6357 SIGNAL	
S-63-062	63E10	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: TE-6358 TO: TIT-6358 1 2/CS-#16 >> TE-6358 SIGNAL	
S-63-063	63E10	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: TIT-6358 TO: RTU-CL 1 2/CS-#16 >> TIT-6358 SIGNAL	
S-63-064	63E02	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: TE-6360 TO: TIT-6360 1 2/CS-#16 >> TE-6360 SIGNAL	
S-63-065	63E02	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: TIT-6360 TO: RTU-CL 1 2/CS-#16 >> TIT-6360 SIGNAL	

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 16990G

CONDUIT SCHEDULE
AREA 65

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. */C#Y: Multiconductor cable (* indicates number of conductors, Y indicates conductor size and insulation).
   4. CAT6: Category 6 Ethernet cable.
   5. MFR: Manufacturer or vendor furnished cable.
   6. PULL: Pull Rope.
   7. VFD: Shielded VFD cable with integral ground.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

CONDUIT SCHEDULE AREA 65

FILTER AND CHEMICAL FEED UPGRADES

CAUSTIC SODA BUILDING

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
C-65-001	65E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSH-6517 TO: RTU-CS 2 #14 >> FSH-6517 CONTROL	
C-65-005	65E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSH-6516 TO: RTU-CS 2 #14 >> FSH-6516 HIGH FLOW CONTROL	
C-65-007	65E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: TSHL-6560 TO: LCP-6560 2 #14 >> TSHL-6560 CONTROL	
C-65-008	65E03	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: FSL-6560 TO: RTU-CS 4 #14 >> FSL-6560 LOW FLOW CONTROL	
C-65-009	65E02	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: XS-6560 TO: LCP-6560 4 #14 >> XS-6560 CONTROL	
C-65-010	65E06	1"	14	#14	XHHW-2	1	#14	XHHW-2	FR: MAU-6560 TO: RTU-CS 14 #14 >> MAU-6560 CONTROL	
C-65-015	65E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: TSHL-6551 TO: AHU-6551 2 #14 >> TSHL-6551 CONTROL	
C-65-016	65E02	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AHU-6551 TO: CU-6551 1 MFR >> AHU-6551 CONTROL	
C-65-017	65E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: TSHL-6552 TO: AHU-6552 2 #14 >> TSHL-6552 CONTROL	
C-65-018	65E02	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: AHU-6552 TO: CU-6552 1 MFR >> AHU-6552 CONTROL	
C-65-019	65E02	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: PPU-6553 TO: RTU-CS 2 #14 >> PPU-6553 SMOKE SHUT DOWN 2 #14 >> PPU-6553 FAILED 2 #14 >> PPU-6553 RUNNING 2 #14 >> PPU-6553 DIRTY FILTER 2 #14 >> PPU-6553 LOW TEMP 2 #14 >> PPU-6553 START	
C-65-021	65E04	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6572 TO: RTU-CS 4 #14 >> PISH-6572 HIGH PRESSURE CONTROL	
C-65-022	65E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: SV-6584 TO: RTU-CS 2 #14 >> SV-6584 OPEN CONTROL	
C-65-023	65E02	2"	78	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-CS TO: RTU-CS 2 #14 >> MCC-CS SPD FAIL 8 #14 >> FVNR-6554 CONTROL 8 #14 >> FVNR-6555 CONTROL 8 #14 >> FVNR-6556 CONTROL 14 #14 >> VFD-6572 CONTROL 14 #14 >> VFD-6582 CONTROL 10 #14 >> FVNR-6511 CONTROL 10 #14 >> FVNR-6521 CONTROL 2 #14 >> SSM-6501 2 #14 >> SPD-6501	
C-65-024	65E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6541 TO: RTU-CS 2 #14 >> PISH-6541 HIGH PRESSURE CONTROL	
C-65-025	65E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6562 TO: RTU-CS 2 #14 >> PISH-6562 HIGH PRESSURE CONTROL	
C-65-026	65E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6511 TO: MCC-CS 2 #14 >> PISH-6511 HIGH PRESSURE CONTROL	
C-65-027	65E05	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6521 TO: MCC-CS 4 #14 >> PISH-6521 HIGH PRESSURE CONTROL	

CONDUIT SCHEDULE AREA 65

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
C-65-029	65E03	1"	14	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-6560 TO: RTU-CS 14 #14 >> LCP-6560 CONTROL	
C-65-031	65E06	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: RTU-CS TO: LCP-6555 2 #14 >> LCP-6555 AUTO CONTROL	
C-65-032	65E04 65E06	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: XS-6556 TO: MCC-CS 4 #14 >> XS-6556 SMOKE DETECTOR CONTROL	
C-65-035	65E04	1"	14	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-6541 TO: RTU-CS 14 #14 >> PMP-6541 CONTROL	
C-65-036	65E04	1"	14	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-6562 TO: RTU-CS 14 #14 >> PMP-6562 CONTROL	
C-65-039	65E06	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-6554 TO: MCC-CS 7 #14 >> LCP-6554 FVNR-6554 CONTROL	
C-65-040	65E06	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-6555 TO: MCC-CS 7 #14 >> LCP-6555 FVNR-6555 CONTROL	
C-65-042	65E06	0.75"	7	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-6556 TO: MCC-CS 7 #14 >> LCP-6556 FVNR-6556 CONTROL	
C-65-044	65E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6582 TO: MCC-CS 2 #14 >> PISH-6582 VFD-6582 CONTROL	
C-65-045	65E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6582 TO: RTU-CS 2 #14 >> PISH-6582N HIGH PRESS CONTROL	
C-65-047	65E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6521 TO: MCC-CS 2 #14 >> PISH-6521 FVNR-6521 CONTROL	
C-65-049	65E05	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: TIT-6557 TO: TE-6557 1 MFR >> TIT-6557 CONTROL	
C-65-050	65E03	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: TIT-6568 TO: TE-6568 1 MFR >> TIT-6568 CONTROL	
C-65-051	65E02	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: TIT-6559 TO: TE-6559 1 MFR >> TIT-6559 MFR CONTROL	
C-65-510	65E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSH-6510 TO: RTU-CS 2 #14 >> FSH-6510 CONTROL	
C-65-534	65E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LSH-6534 TO: RTU-CS 2 #14 >> LSH-6534 CONTROL	
C-65-554	65E05	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: XS-6554 TO: MCC-CS VIA FVNR-6554 4 #14 >> XS-6554 CONTROL	
C-65-555	65E05	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: XS-6555 TO: MCC-CS VIA FVNR-6555 4 #14 >> XS-6555 CONTROL	
C-65-584	65E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSH-6584 TO: RTU-CS 2 #14 >> FSH-6584 CONTROL	
C-65-611	65E10	1"	1	PULL	ROPE				FR: DOOR 65-D101-01 SECURITY J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
C-65-621	65E10	1"	1	PULL	ROPE				FR: DOOR 65-D103-01 SECURITY J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
C-65-631	65E10	1"	1	PULL	ROPE				FR: DOOR 65-D102-01 SECURITY J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
C-65-650	65E04	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-6500 TO: RTU-CS 6 #14 >> LCP-6500 CONTROL	
L-65-007	65E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: RTU-CS TO: PNL-UPS-CS 3 #12 >> RTU-CS POWER	
L-65-010	65E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PISH-6582 TO: MCC-CS 3 #12 >> PISH-6582 POWER	
L-65-011	65E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PNL-CS TO: RTU-CS 3 #12 >> RTU-CS POWER	
L-65-012	65E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PNL-CS TO: SECURITY PANEL 3 #12 >> RTU-CS POWER	
L-65-015	65E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: WIT-6531 TO: RTU-CS 2 #12 >> WIT-3631 POWER	
L-65-016	65E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: PISH-6541 TO: RTU-CS 2 #12 >> PISH-6541 POWER	
L-65-017	65E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6562 TO: RTU-CS 2 #14 >> PISH-6562 HIGH PRESSURE CONTROL	
L-65-019	65E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: PMP-6541 TO: PNL-CS 2 #12 >> PMP-6541 POWER	
L-65-020	65E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: PMP-6562 TO: PNL-CS 2 #12 >> PMP-6562 POWER	
L-65-021	65E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: FIT-6583 TO: RTU-CS 2 #12 >> FIT-6583 POWER	
L-65-022	65E05	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: LSH-6514 TO: RTU-CS 2 #12 >> LSH-6514 POWER	
L-65-023	65E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: FIT-6563 TO: RTU-CS 2 #12 >> FIT-6563 POWER	
L-65-501	65E05	0.75"	2	#10	XHHW-2	1	#10	XHHW-2	FR: HTU-6501 TO: PNL-CS 2 #10 >> HTU-6501 POWER	
L-65-502	65E05	0.75"	2	#10	XHHW-2	1	#10	XHHW-2	FR: HTU-6502 TO: PNL-CS 2 #10 >> HTU-6502 POWER	
L-65-503	65E05	0.75"	2	#10	XHHW-2	1	#10	XHHW-2	FR: HTU-6503 TO: PNL-CS 2 #10 >> HTU-6503 POWER	
L-65-030	65E02	1"	3	#6	XHHW-2	1	#10	XHHW-2	FR: PNL-UPS-CS TO: UPS-CS 3 #6 >> PNL-UPS-CS POWER	
L-65-031	65E02	1"	3	#6	XHHW-2	1	#10	XHHW-2	FR: UPS-CS TO: UPS BYPASS DISC 3 #6 >> UPS-CS (BYPASS) POWER	
L-65-032	65E02	1"	3	#6	XHHW-2	1	#10	XHHW-2	FR: UPS BYPASS DISC TO: PNL-CS 3 #6 >> UPS BYPASS DISC POWER	
L-65-501	65E05	0.75"	2	#10	XHHW-2	1	#10	XHHW-2	FR: HTU-6501 TO: PNL-CS 2 #10 >> HTU-6501 CONTROLLER POWER	

CONDUIT SCHEDULE AREA 65

FILTER AND CHEMICAL FEED UPGRADES

CAUSTIC SODA BUILDING

ENGINEER CK

REVISION

DATE 2/11/25

CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
L-65-502	65E05	0.75"	2	#10	XHHW-2	1	#10	XHHW-2	FR: HTU-6502 TO: PNL-CS 2 #10 >> HTU-6502 CONTROLLER POWER	
L-65-503	65E05	0.75"	2	#10	XHHW-2	1	#10	XHHW-2	FR: HTU-6503 TO: PNL-CS 2 #10 >> HTU-6503 CONTROLLER POWER	
L-65-510	65E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: HTU-6510 TO: PNL-CS 2 #12 >> HTU-6510 POWER	
L-65-511	65E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: HTU-6511 TO: PNL-CS 2 #12 >> HTU-6511 POWER	
L-65-531	65E04	0.75"	2	#10	XHHW-2	1	#10	XHHW-2	FR: HTU-6531 TO: PNL-CS 2 #10 >> HTU-6531 CONTROLLER POWER	
L-65-534	65E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: LSH-6534 TO: RTU-CS 2 #12 LSH-6534 POWER	
L-65-561	65E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: GUH-6561 TO: PNL-CS 3 #12 >> GUH-561 POWER	
L-65-562	65E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: GUH-6562 TO: PNL-CS 3 #12 >> GUH-6562 POWER	
L-65-563	65E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: GUH-6563 TO: PNL-CS 3 #12 >> GUH-563 POWER	
L-65-564	65E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: GUH-6564 TO: PNL-CS 3 #12 >> GUH-564 POWER	
L-65-650	65E04	0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR: LCP-6500 TO: RTU-CS 3 #10 >> LCP-6500 POWER	
N-65-001	65E02	0.75"	1		CAT6	1	#14	XHHW-2	FR: MCC-CS TO: RTU-CS 1 CAT6 >> MCC-CS POWER MONITOR NETWORK	
N-65-611	65E10	1"	1	PULL	ROPE				FR: SECURITY CAMERA J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
N-65-621	65E10	1"	1	PULL	ROPE				FR: SECURITY CAMERA J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
N-65-631	65E10	1"	1	PULL	ROPE				FR: WIRELESS NETWORK J-BOX TO: RTU-CS 1 PULL >> SPARE	
N-65-641	65E10	1"	1	PULL	ROPE				FR: WIRELESS NETWORK J-BOX TO: RTU-CS 1 PULL >> SPARE	
N-65-651	65E10	1"	1	PULL	ROPE				FR: WIRELESS NETWORK J-BOX TO: RTU-CS 1 PULL >> SPARE	
P-65-001	65E06	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-6554 TO: EF-6554 3 #12 >> EF-6554 POWER	P-65-002
P-65-002	65E06	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-6554 TO: MCC-CS 3 #12 >> EF-6554 POWER	P-65-001
P-65-004	65E06	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: EF-6555 TO: DISC-6555 3 #12 >> EF-6555 POWER	P-65-024
P-65-005	65E06	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: SF-6556 TO: DISC-6556 3 #12 >> SF-6556 POWER	P-65-006

CONDUIT SCHEDULE AREA 65

FILTER AND CHEMICAL FEED UPGRADES

CAUSTIC SODA BUILDING

ENGINEER CK

REVISION

DATE 2/11/25

CONDUIT			CONDUCTORS			GROUND						
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE		DESCRIPTION		CONNECTING SEGMENTS
P-65-006	65E06	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR:	DISC-6556		
									TO:	MCC-CS		
									3	#12	>> SF-6556 POWER	P-65-005
P-65-007	65E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR:	PPU-6553		P-65-008
									TO:	DISC-6553		
									3	#12	>> PPU-6553 POWER	
P-65-008	65E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR:	DISC-6553		
									TO:	MCC-CS		
									3	#12	>> PPU-6553 POWER	P-65-007
P-65-013	65E03	0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR:	LCP-6560		
									TO:	PP-CS		
									3	#10	>> LCP-6560 POWER	
P-65-016	65E04	1.5"	1	3/C-#12:VFD	VFD			INTEGRAL	FR:	PMP-6572		
			4	#14	XHHW-2				TO:	MCC-CS		
									1	3/C-#12:VFD	>> PMP-6572 POWER	
									2	#14	>> PMP-6572 MWH CONTROL	
									2	#14	>> PMP-6572 TSH CONTROL	
P-65-018	65E04	1.5"	1	3/C-#12:VFD	VFD			INTEGRAL	FR:	PMP-6582		
			4	#14	XHHW-2				TO:	MCC-CS		
									1	3/C-#12:VFD	>> PMP-6582 POWER	
									2	#14	>> PMP-6582 MWH CONTROL	
									2	#14	>> PMP-6582 TSH CONTROL	
P-65-020	65E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR:	PMP-6511		
			4	#14	XHHW-2				TO:	LCP-6511		
									3	#12	>> PMP-6511 POWER	
									2	#14	>> PMP-6511 MWH CONTROL	
									2	#14	>> PMP-6511 TSH CONTROL	
P-65-021	65E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR:	PMP-6521		
			4	#14	XHHW-2				TO:	LCP-6521		
									3	#12	>> PMP-6521 POWER	
									2	#14	>> PMP-6521 MWH CONTROL	
									2	#14	>> PMP-6521 TSH CONTROL	
P-65-024	65E06	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR:	DISC-6555		
									TO:	MCC-CS		
									3	#12	>> EF-6555 POWER	P-65-004
P-65-025	65E06	0.75"	2	#10	XHHW-2	1	#10	XHHW-2	FR:	HP-6551		P-65-026
									TO:	DISC-6551		
									2	#10	>> HP-6551 POWER	
P-65-026	65E06	0.75"	2	#10	XHHW-2	1	#10	XHHW-2	FR:	DISC-6551		
									TO:	PNL-CS		
									2	#10	>> HP-6551 POWER	P-65-025
P-65-027	65E06	0.75"	2	#10	XHHW-2	1	#10	XHHW-2	FR:	HP-6552		P-65-028
									TO:	DISC-6552		
									2	#10	>> HP-6552 POWER	
P-65-028	65E06	0.75"	2	#10	XHHW-2	1	#10	XHHW-2	FR:	DISC-6552		
									TO:	PNL-CS		
									2	#10	>> HP-6552 POWER	P-65-027
P-65-030	65E02	2"	3	#4/0	XHHW-2	1	#4	XHHW-2	FR:	XFMR-CS		
									TO:	MCC-CS		
									3	#4/0	>> XFMR-CS POWER	
P-65-031	65E02	3"	4	250	XHHW-2	1	#2	XHHW-2	FR:	PNL-CS		
									TO:	XFMR-CS		
									4	250	>> PNL-CS POWER	
P-65-040	65E02	0.75"	3	#8	XHHW-2	1	#10	XHHW-2	FR:	UPS-CS		
									TO:	MCC-CS		
									3	#8	>> UPS-CS (MAIN) POWER	
P-65-045	65E02	1.5"	3	#2	XHHW-2	1	#8	XHHW-2	FR:	PP-CS		
									TO:	MCC-CS		
									3	#2	>> PP-CS POWER	
P-65-600	65E06	0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR:	MAU-6560		
									TO:	PP-CS		
									3	#10	>> MAU-6560 POWER	
S-65-001	65E05	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR:	LSH-6514		
									TO:	RTU-CS		
									1	2/CS-#16	>> LSH-6514 SIGNAL	

CONDUIT SCHEDULE AREA 65

FILTER AND CHEMICAL FEED UPGRADES

CAUSTIC SODA BUILDING

ENGINEER	CK
REVISION	
DATE	2/11/25

CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
S-65-002	65E05	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-6501 TO: RTU-CS 1 2/CS-#16 >> LIT-6501 SIGNAL	
S-65-003	65E05	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-6502 TO: RTU-CS 1 2/CS-#16 >> LIT-6502 SIGNAL	
S-65-004	65E05	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-6503 TO: RTU-CS 1 2/CS-#16 >> LIT-6503 SIGNAL	
S-65-005	65E04	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-6531 TO: RTU-CS 1 2/CS-#16 >> LIT-6531 SIGNAL	
S-65-006	65E04	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: WIT-3631 TO: RTU-CS 1 2/CS-#16 >> WIT-3631 SIGNAL	
S-65-007	65E05	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: TIT-6557 TO: RTU-CL 1 2/CS-#16 >> TIT-6557 SIGNAL	
S-65-008	65E03	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: TIT-6568 TO: RTU-CL 1 2/CS-#16 >> TIT-6568 SIGNAL	
S-65-009	65E02	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: TIT-6559 TO: RTU-CS 1 2/CS-#16 >> TIT-6559 SIGNAL	
S-65-010	65E04	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: FIT-6563 TO: RTU-CS 1 2/CS-#16 >> FIT-6563 SIGNAL	
S-65-011	65E04	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: FIT-6583 TO: RTU-CS 1 2/CS-#16 >> FIT-6583 FLOW SIGNAL	
S-65-020	65E04	1"	4	2/CS-#16		1	#14	XHHW-2	FR: PMP-6541 TO: RTU-CS 4 2/CS-#16 >> PMP-6541 SIGNAL	
S-65-025	65E04	1"	4	2/CS-#16		1	#14	XHHW-2	FR: PMP-6562 TO: RTU-CS 4 2/CS-#16 >> PMP-6562 SIGNAL	
S-65-048	65E04	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: WE-6531 TO: WIT-6531 1 MFR >> WIT-6531 CONTROL	
S-65-650	65E04	1"	3	2/CS-#16		1	#14	XHHW-2	FR: LCP-6500 TO: RTU-CS 3 2/CS-#16 >> LCP-6500 SIGNAL	

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 16990H

CONDUIT SCHEDULE
AREA 68

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. */C#Y: Multiconductor cable (* indicates number of conductors, Y indicates conductor size and insulation).
   4. VFD: Shielded VFD cable with integral ground.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

CONDUIT SCHEDULE AREA 68

FILTER AND CHEMICAL FEED UPGRADES

PAC AREA

ENGINEER	**SKB**
REVISION	
DATE	2/11/25

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-68-125	68E02	1.5"	44	#14	XHHW-2	1	#14	XHHW-2	FR: PAC SILO 1 CONTROL J-BOX TO: VCP-6800 2 #14 >> LIT-6801 POWER 2 #14 >> PDAH-6802 CONTROL 2 #14 >> LSH-6801 CONTROL 2 #14 >> LSL-6801 CONTROL 2 #14 >> LSH-6803 CONTROL 2 #14 >> LSHL-6803 CONTROL 3 #14 >> PISL-6802 CONTROL 3 #14 >> PISL-6804 CONTROL 3 #14 >> PISL-6825 CONTROL 3 #14 >> PISL-6811 CONTROL 3 #14 >> PISL-6812 CONTROL 2 #14 >> LSH-6810 CONTROL 3 #14 >> PISL-6814 CONTROL 12 #14 >> SPARE	
C-68-128	68E02	2"	20 40	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: PAC SILO 1 CONTROL J-BOX TO: VCP-6800 16 #14 >> VCP-6801 CONTROL 2 #12 >> SV1-6801 CONTROL 2 #12 >> SV2-6801 CONTROL 2 #12 >> SV3-6801 CONTROL 2 #12 >> SV4-6801 CONTROL 2 #12 >> SV-6802 CONTROL 2 #12 >> SV1-6804 CONTROL 2 #12 >> SV2-6804 CONTROL 2 #12 >> SV-6811 CONTROL 2 #12 >> SV-6813A CONTROL 2 #12 >> SV-6813B CONTROL 24 #14 >> SPARE	
C-68-325	68E02	1.5"	44	#14	XHHW-2	1	#14	XHHW-2	FR: PAC SILO 2 CONTROL J-BOX TO: VCP-6830 2 #14 >> LIT-6831 POWER 2 #14 >> PDAH-6832 CONTROL 2 #14 >> LSH-6831 CONTROL 2 #14 >> LSL-6831 CONTROL 2 #14 >> LSH-6833 CONTROL 2 #14 >> LSHL-6833 CONTROL 3 #14 >> PISL-6832 CONTROL 3 #14 >> PISL-6834 CONTROL 3 #14 >> PISL-6845 CONTROL 3 #14 >> PISL-6841 CONTROL 3 #14 >> PISL-6842 CONTROL 2 #14 >> LSH-6840 CONTROL 3 #14 >> PISL-6844 CONTROL 12 #14 >> SPARE	
C-68-328	68E02	2"	20 40	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: PAC SILO 2 CONTROL J-BOX TO: VCP-6830 16 #14 >> VCP-6831 CONTROL 2 #12 >> SV1-6831 CONTROL 2 #12 >> SV2-6831 CONTROL 2 #12 >> SV3-6831 CONTROL 2 #12 >> SV4-6831 CONTROL 2 #12 >> SV-6832 CONTROL 2 #12 >> SV1-6834 CONTROL 2 #12 >> SV2-6834 CONTROL 2 #12 >> SV-6841 CONTROL 2 #12 >> SV-6843A CONTROL 2 #12 >> SV-6843B CONTROL 24 #14 >> SPARE	
L-68-125	68E02	1"	8	#10	XHHW-2	1	#10	XHHW-2	FR: PAC SILO 1 120V J-BOX TO: PPSC-PAC 2 #10 >> SILO 1 RECEPTACLES 2 #10 >> SILO 1 LIGHTS 4 #10 >> SPARE	
L-68-325	68E02	1"	8	#10	XHHW-2	1	#10	XHHW-2	FR: PAC SILO 2 120V J-BOX TO: PPSC-PAC 2 #10 >> SILO 2 RECEPTACLES 2 #10 >> SILO 2 LIGHTS 4 #10 >> SPARE	
P-68-124	68E02	1.5"	1	3/C-#12:VFD	VFD			INTEGRAL	FR: PAC SILO 1 480V J-BOX TO: VCP2-6802 1 3/C-#12:VFD >> FDR-6803 POWER	

CONDUIT SCHEDULE AREA 68

FILTER AND CHEMICAL FEED UPGRADES

PAC AREA

ENGINEER	**SKB**
REVISION	
DATE	2/11/25

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P-68-125	68E02	1.5"	6 6 6	#10 #12 #14	XHHW-2 XHHW-2 XHHW-2	1	#10	XHHW-2	FR: PAC SILO 1 480V J-BOX TO: VCP2-6802 2 #12 >> MWH-6803 POWER 2 #14 >> TSH-6803 CONTROL 3 #10 >> FDR-6810 POWER 2 #12 >> MWH-6810 POWER 2 #14 >> TSH-6810 CONTROL 3 #10 >> BLO-6802 POWER 2 #12 >> MWH-6802 POWER 2 #14 >> TSH-6802 CONTROL	
P-68-128	68E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PAC SILO 1 480V J-BOX TO: PP-PAC 3 #12 >> PAC SILO 1 HEATER	
P-68-324	68E02	1.5"	1	3/C-#12:VFD	VFD			INTEGRAL	FR: PAC SILO 2 480V J-BOX TO: VCP2-6832 1 3/C-#12:VFD >> FDR-6833 POWER	
P-68-325	68E02	1.5"	6 6 6	#10 #12 #14	XHHW-2 XHHW-2 XHHW-2	1	#10	XHHW-2	FR: PAC SILO 2 480V J-BOX TO: VCP2-6832 2 #12 >> MWH-6833 POWER 2 #14 >> TSH-6833 CONTROL 3 #10 >> FDR-6840 POWER 2 #12 >> MWH-6840 POWER 2 #14 >> TSH-6840 CONTROL 3 #10 >> BLO-6832 POWER 2 #12 >> MWH-6832 POWER 2 #14 >> TSH-6832 CONTROL	
P-68-328	68E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PAC SILO 2 480V J-BOX TO: PP-PAC 3 #12 >> PAC SILO 2 HEATER	
S-68-125	68E02	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: PAC SILO 1 SIGNAL J-BOX TO: VCP-6800 1 2/CS-#16 >> VCP-6801 SIGNAL 1 2/CS-#16 >> LIT-6801 SIGNAL	
S-68-325	68E02	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: PAC SILO 2 SIGNAL J-BOX TO: VCP-6830 1 2/CS-#16 >> VCP-6831 SIGNAL 1 2/CS-#16 >> LIT-6831 SIGNAL	

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 16990J

CONDUIT SCHEDULE
AREA 69

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. */C#Y: Multiconductor cable (* indicates number of conductors, Y indicates conductor size and insulation).
   4. CAT6: Category 6 Ethernet cable.
   5. MFR: Manufacturer or vendor furnished cable.
   6. PULL: Pull Rope.
   7. RS-485 RS-485 cable.
   8. VFD: Shielded VFD cable with integral ground.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

CONDUIT SCHEDULE AREA 69

FILTER AND CHEMICAL FEED UPGRADES

PEA DRY FEED AREA

ENGINEER	**CK**
REVISION	**0**
DATE	2/11/25

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-69-004	69E02	2.5"	82	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6901 TO: RTU-PEA 2 #14 >> LSL-6901 CONTROL 2 #14 >> LSH-6901 CONTROL 10 #14 >> FV-6902 CONTROL 10 #14 >> FV-6903 CONTROL 10 #14 >> FV-6904 CONTROL 4 #14 >> MIX-6905 COTROL 2 #14 >> LSHH-6905 CONTROL 2 #14 >> BLO-6911 CONTROL 2 #14 >> LSL-6911 CONTROL 2 #14 >> LSH-6911 CONTROL 10 #14 >> FV-6912 CONTROL 10 #14 >> FV-6913 CONTROL 10 #14 >> FV-6914 CONTROL 4 #14 >> MIX-6915 CONTROL 2 #14 >> LSHH-6915 CONTROL	
C-69-011	69E02	1.5"	36	#14	XHHW-2	1	#14	XHHW-2	FR: JB-6911 TO: VCP-6911 2 #14 >> BLO-6911 CONTROL 2 #14 >> LSL-6911 CONTRL 2 #14 >> LSH-6911 CONTROL 10 #14 >> FV-6912 CONTROL 10 #14 >> FV-6913 CONTROL 10 #14 >> FV-6914 CONTROL	
C-69-016	69E03	1"	14	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6916 TO: RTU-PEA 14 #14 >> PMP-6916 CONTROL	
C-69-018	69E03	0.75"	1	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-6918 TO: RTU-PEA 1 #14 >> FIT-6918 24 VDC POWER	
C-69-019	69E03	0.75"	1	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-6919 TO: RTU-PEA 1 #14 >> FIT-6919 24 VDC POWER	
C-69-021	69E03	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-6921 TO: MCC-PEA VIA VFD-6921 2 #14 >> MWH-6921 CONTROL 2 #14 >> TSH-6921 CONTROL	
C-69-026	69E03	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-6926 TO: MCC-PEA VIA VFD-6926 2 #14 >> MWH-6926 CONTROL 2 #14 >> TSH-6926 CONTROL	
C-69-027	69E03	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: SV-6927 TO: RTU-PEA 2 #14 >> SV-6927 CONTROL 2 #14 >> SV-6927 24 VDC POWER	
C-69-028	69E03	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: SV-6928 TO: RTU-PEA 2 #14 >> SV-6928 CONTROL 2 #14 >> SV-6928 24 VDC POWER	
C-69-029	69E03	0.75"	1	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-6929 TO: RTU-PEA 1 #14 >> FIT-6929 24 VDC POWER	
C-69-035	69E03	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: SV-6935 TO: RTU-PEA 2 #14 >> SV-6935 OPEN CONTROL 2 #14 >> SV-6935 24 VDC POWER 14	
C-69-037	69E03	0.75"	2 1	#14	XHHW-2 CAT6	1	#14	XHHW-2	FR: FIT-6937 TO: RTU-PEA 2 #14 >> FIT-6937 24 VDC POWER 1 CAT6 >> FIT-6937 NETWORK	
C-69-038	69E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-6938 TO: RTU-PEA 2 #14 >> FIT-6938 24VDC POWER	
C-69-041		0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: SV-6941 TO: RTU-PEA 2 #14 >> SV-6941 CONTROL 2 #14 >> SV-6941 24 VDC POWER	
C-69-048	69E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-6948 TO: RTU-PEA 2 #14 >> FIT-6948 24VDC POWER	

CONDUIT SCHEDULE AREA 69

FILTER AND CHEMICAL FEED UPGRADES

PEA DRY FEED AREA

ENGINEER	**CK**
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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-69-049	69E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-6949 TO: RTU-PEA 2 #14 >> FIT-6949 24VDC POWER	
C-69-054	69E03	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: SV-6934 TO: RTU-PEA 2 #14 >> SV-6934 CONTROL 2 #14 >> SV-6934 24 VDC POWER	
C-69-055	69E03	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: SV-6940 TO: RTU-PEA 2 #14 >> SV-6940 CONTROL 2 #14 >> SV-6940 24 VDC POWER	
C-69-056	69E03	1"	14	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6956 TO: RTU-PEA 14 #14 >> PMP-6956 CONTROL	
C-69-057		0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: SV-6957 TO: RTU-PEA 2 #14 >> SV-6957 CONTROL 2 #14 >> SV-6957 24 VDC POWER	
C-69-058		0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-6958 TO: RTU-PEA 2 #14 >> FIT-6958 CONTROL	
C-69-101	69E02	1.5"	36	#14	XHHW-2	1	#14	XHHW-2	FR: JB-6901 TO: VCP-6901 2 #14 >> BLO-6901 CONTROL 2 #14 >> LSL-6901 CONTRL 2 #14 >> LSH-6901 CONTROL 10 #14 >> FV-6902 CONTROL 10 #14 >> FV-6903 CONTROL 10 #14 >> FV-6904 CONTROL	
C-69-105	69E03	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: JB-6905 TO: VCP-6901 4 #14 >> MIX-6905 CONTROL 2 #14 >> LSHH-6905 CONTROL 2 #14 >> PDIT-6905 CONTROL 4 #14 >> SPARE	
C-69-111	69E03	1"	14	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6911 TO: RTU-PEA 14 #14 >> PMP-6911 CONTROL	
C-69-115	69E03	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: JB-6915 TO: VCP-6901 4 #14 >> MIX-6915 CONTROL 2 #14 >> LSHH-6915 CONTROL 2 #14 >> PDIT-6915 CONTROL 4 #14 >> SPARE	
C-69-116	69E03	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6916 TO: RTU-PEA 2 #14 >> PISH-6916 CONTROL 2 #14 >> PISH-6916 24 VDC POWER	
C-69-121	69E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6921 TO: MCC-PEA VIA VFD-6921 2 #14 >> PISH-6921 CONTROL	
C-69-126	69E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6926 TO: MCC-PEA VIA VFD-6926 2 #14 >> PISH-6926 CONTROL	
C-69-128	69E03	0.75"	1	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-6928 TO: RTU-PEA 1 #14 >> FIT-6928 24 VDC POWER	
C-69-131	69E03	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-6931 TO: MCC-PEA VIA VFD-6931 2 #14 >> MWH-6931 2 #14 >> TSH-6931	
C-69-136	69E03	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-6936 TO: MCC-PEA VIA VFD-6936 2 #14 >> MWH-6936 2 #14 >> TSH-6936	

CONDUIT SCHEDULE AREA 69

FILTER AND CHEMICAL FEED UPGRADES

PEA DRY FEED AREA

ENGINEER	**CK**
REVISION	**0**
DATE	2/11/25

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-69-141	69E03	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-6941 TO: MCC-PEA VIA VFD-6941 2 #14 >> MWH-6941 2 #14 >> TSH-6941	
C-69-146	69E03	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-6946 TO: MCC-PEA VIA VFD-6946 2 #14 >> MWH-6946 2 #14 >> TSH-6946	
C-69-151	69E03	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-6951 TO: MCC-PEA VIA VFD-6951 2 #14 >> MWH-6951 2 #14 >> TSH-6951	
C-69-156	69E03	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6956 TO: RTU-PEA 2 #14 >> PISH-6956 CONTROL 2 #14 >> PISH-6956 24 VDC POWER	
C-69-211	69E03	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6911 TO: RTU-PEA 2 #14 >> PISH-6911 CONTROL 2 #14 >> PISH-6911 24 VDC POWER	
C-69-221	69E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6921 TO: RTU-PEA 2 #14 >> PISH-6921 CONTROL	
C-69-226	69E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6926 TO: RTU-PEA 2 #14 >> PISH-6926 CONTROL	
C-69-231	69E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6931 TO: RTU-PEA 2 #14 >> PISH-6931 CONTROL	
C-69-236	69E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6936 TO: RTU-PEA 2 #14 >> PISH-6936 CONTROL	
C-69-241	69E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6941 TO: RTU-PEA 2 #14 >> PISH-6941 CONTROL	
C-69-246	69E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6946 TO: RTU-PEA 2 #14 >> PISH-6946 CONTROL	
C-69-251	69E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6951 TO: RTU-PEA 2 #14 >> PISH-6951 CONTROL	
C-69-331	69E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6931 TO: MCC-PEA VIA VFD-6931 2 #14 >> PISH-6931 CONTROL	
C-69-336	69E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6936 TO: MCC-PEA VIA VFD-6936 2 #14 >> PISH-6936 CONTROL	
C-69-341	69E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6941 TO: MCC-PEA VIA VFD-6941 2 #14 >> PISH-6941 CONTROL	
C-69-346	69E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6946 TO: MCC-PEA VIA VFD-6946 2 #14 >> PISH-6946 CONTROL	
C-69-351	69E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-6951 TO: MCC-PEA VIA VFD-6951 2 #14 >> PISH-6951 CONTROL	
C-69-405	69E03	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: WE-6905 TO: WIT-6905 1 MFR >> WE-6905 CONTROL	
C-69-415	69E03	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: WE-6915 TO: WIT-6915 1 MFR >> 23-6915 CONTROL	

CONDUIT SCHEDULE AREA 69

FILTER AND CHEMICAL FEED UPGRADES

PEA DRY FEED AREA

ENGINEER	**CK**
REVISION	**0**
DATE	2/11/25

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-69-505	69E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: WIT-6905 TO: RTU-PEA 2 #14 >> WIT-6905 24 VDC POWER	
C-69-515	69E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: WIT-6915 TO: RTU-PEA 2 #14 >> WIT-6915 24 VDC POWER	
C-69-611	69E04	1"	1	PULL	ROPE				FR: DOOR SECURITY J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
C-69-621	69E04	1"	1	PULL	ROPE				FR: DOOR 69-D101-03 SECURITY J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
C-69-710	69E02	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-7100 TO: RTU-PEA 6 #14 >> LCP-7100 CONTROL	
C-69-901	69E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSH-6901 TO: RTU-PEA 2 #14 >> FSH-6901 CONTROL	
C-69-903	69E03	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6903 TO: VCP-6901 6 #14 >> FV-6903 CONTROL	
C-69-904	69E03	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6904 TO: VCP-6901 6 #14 >> FV-6904 CONTROL	
C-69-905	69E03	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-6905 TO: JB-6905 4 #14 >> MIX-6905	
C-69-906	69E03	0.75"	3	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6906 TO: VCP-6901 3 #14 >> FV-6906 CONTROL	
C-69-907	69E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LSH-6907 TO: RTU-PEA 2 #14 >> LSH-6907 CONTROL	
C-69-913	69E03	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6913 TO: VCP-6901 6 #14 >> FV-6913 CONTROL	
C-69-914	69E03	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6914 TO: VCP-6901 6 #14 >> FV-6914 CONTROL	
C-69-915	69E03	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-6915 TO: JB-6915 4 #14 >> MIX-6915	
C-69-916	69E03	0.75"	3	#14	XHHW-2	1	#14	XHHW-2	FR: FV-6916 TO: VCP-6901 3 #14 >> FV-6916 CONTROL	
L-69-011	69E03	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: PMP-6911 TO: VCP-6911 2 #12 >> PMP-6911 POWER	
L-69-016	69E03	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6916 TO: PNL-PEA 2 #12 >> PMP-6916 POWER	
L-69-021	69E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PISH-6921 TO: MCC-PEA VIA VFD-6921 3 #12 >> PISH-6921 POWER	
L-69-026	69E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PISH-6926 TO: MCC-PEA VIA VFD-6926 3 #12 >> PISH-6926 POWER	
L-69-031	69E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PISH-6931 TO: MCC-PEA VIA VFD-6931 3 #12 >> PISH-6931 POWER	
L-69-036	69E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PISH-6936 TO: MCC-PEA VIA VFD-6936 3 #12 >> PISH-6936 POWER	

CONDUIT SCHEDULE AREA 69

FILTER AND CHEMICAL FEED UPGRADES

PEA DRY FEED AREA

ENGINEER	**CK**
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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
L-69-041	69E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PISH-6941 TO: MCC-PEA VIA VFD-6941 3 #12 >> PISH-6941 POWER	
L-69-046	69E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PISH-6946 TO: MCC-PEA VIA VFD-6946 3 #12 >> PISH-6946 POWER	
L-69-051	69E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PISH-6951 TO: MCC-PEA VIA VFD-6951 3 #12 >> PISH-6951 POWER	
L-69-056	69E03	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6956 TO: PNL-PEA 2 #12 >> PMP-6956 POWER	
L-69-061	69E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MD-6961 TO: MCC-PEA 3 #12 >> MD-6961 POWER	
L-69-062	69E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MD-6962 TO: MCC-PEA 3 #12 >> MD-6962 POWER	
L-69-161	69E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: SUH-6961 TO: PNL-PEA 3 #12 >> SUH-6961 POWER	
L-69-162	69E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: SUH-6962 TO: PNL-PEA 3 #12 >> SUH-6962 POWER	
L-69-710	69E02	0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR: LCP-7100 TO: RTU-PEA 3 #10 >> LCP-7100 POWER	
L-69-903	69E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: FV-6903 TO: VCP-6901 3 #12 >> FV-6903 POWER	
L-69-904	69E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: FV-6904 TO: VCP-6901 3 #12 >> FV-6904 POWER	
L-69-907	69E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: LSH-6907 TO: RTU-PEA 3 #12 >> LSH-6907 POWER	
L-69-913	69E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: FV-6913 TO: VCP-6901 3 #12 >> FV-6913 POWER	
L-69-914	69E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: FV-6914 TO: VCP-6901 3 #12 >> FV-6914 POWER	
N-69-018	69E03	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-6918 TO: RTU-PEA 1 RS-485 >> FIT-6918 NETWORK	
N-69-019	69E03	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-6919 TO: RTU-PEA 1 RS-485 >> FIT-6919 NETWORK	
N-69-028	69E03	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-6928 TO: RTU-PEA 1 RS-485 >> FIT-6928 NETWORK	
N-69-029	69E03	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-6929 TO: RTU-PEA 1 RS-485 >> FIT-6929 NETWORK	
N-69-037	69E03	2"	1		RS-485	1	#14	XHHW-2	FR: FIT-6937 TO: RTU-PEA 1 RS-485 >> FIT-6937 NETWORK	
N-69-038	69E03	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-6938 TO: RTU-PEA 1 RS-485 >> FIT-6938 NETWORK	
N-69-048	69E03	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-6948 TO: RTU-PEA 1 RS-485 >> FIT-6948 NETWORK	

CONDUIT SCHEDULE AREA 69

FILTER AND CHEMICAL FEED UPGRADES

PEA DRY FEED AREA

ENGINEER	**CK**
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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
N-69-049	69E03	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-6949 TO: RTU-PEA 1 RS-485 >> FIT-6949 NETWORK	
N-69-058		0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-6958 TO: RTU-PEA 1 RS-485 >> FIT-6958 NETWORK	
N-69-611	69E04	1"	1	PULL	ROPE				FR: SECURITY CAMERA J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
N-69-621	69E04	1"	1	PULL	ROPE				FR: SECURITY CAMERA J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
N-69-631	69E04	1"	1	PULL	ROPE				FR: SECURITY CAMERA J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
N-69-641	69E04	1"	1	PULL	ROPE				FR: SECURITY CAMERA J-BOX TO: SECURITY PANEL 1 PULL >> SPARE	
P-69-001	69E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6901 TO: PP-PEA 3 #12 >> VCP-6901 POWER	
P-69-006	69E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: JB-6901 TO: DISC-6906 3 #12 >> HOI-6906 POWER	P-69-007
P-69-007	69E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-6906 TO: PP-PEA 3 #12 >> HOI-6906 POWER	P-69-006
P-69-016	69E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: JB-6911 TO: DISC-6916 3 #12 >> HOI-6916 POWER	P-69-017
P-69-017	69E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-6906 TO: PP-PEA 3 #12 >> HOI-6916 POWER	P-69-016
P-69-021	69E03	1.5"	1	3/C-#12:VFD	VFD			INTEGRAL	FR: PMP-6921 TO: MCC-PEA VIA VFD-6921 1 3/C-#12:VFD >> PMP-6921 POWER	
P-69-026	69E03	1.5"	1	3/C-#12:VFD	VFD			INTEGRAL	FR: PMP-6926 TO: MCC-PEA VIA VFD-6926 1 3/C-#12:VFD >> PMP-6926 POWER	
P-69-031	69E03	1.5"	1	3/C-#12:VFD	VFD			INTEGRAL	FR: PMP-6931 TO: MCC-PEA VIA VFD-6931 1 3/C-#12:VFD >> PMP-6931 POWER	
P-69-036	69E03	1.5"	1	3/C-#12:VFD	VFD			INTEGRAL	FR: PMP-6936 TO: MCC-PEA VIA VFD-6936 1 3/C-#12:VFD >> PMP-6936 POWER	
P-69-041	69E03	1.5"	1	3/C-#12:VFD	VFD			INTEGRAL	FR: PMP-6941 TO: MCC-PEA VIA VFD-6941 1 3/C-#12:VFD >> PMP-6941 POWER	
P-69-046	69E03	1.5"	1	3/C-#12:VFD	VFD			INTEGRAL	FR: PMP-6946 TO: MCC-PEA VIA VFD-6946 1 3/C-#12:VFD >> PMP-6946 POWER	
P-69-051	69E03	1.5"	1	3/C-#12:VFD	VFD			INTEGRAL	FR: PMP-6951 TO: MCC-PEA VIA VFD-6951 1 3/C-#12:VFD >> PMP-6951 POWER	
P-69-061	69E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: EF-6961 TO: MCC-PEA 3 #12 >> EF-6961 POWER	
P-69-062	69E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: EF-6962 TO: MCC-PEA 3 #12 >> EF-6962 POWER	
P-69-105	69E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: JB-6915 TO: VCP-6901 3 #12 >> MIX-6905 POWER	

CONDUIT SCHEDULE AREA 69

FILTER AND CHEMICAL FEED UPGRADES

PEA DRY FEED AREA

ENGINEER	**CK**
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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P-69-115	69E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: JB-6915 TO: VCP-6901 3 #12 >> MIX-6915 POWER	
P-69-905	69E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-6905 TO: VCP-6901 3 #12 >> MIX-6905 POWER	
P-69-915	69E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-6915 TO: VCP-6901 3 #12 >> MIX-6915 POWER	
S-69-001	69E02	1"	4	2/CS-#16		1	#14	XHHW-2	FR: VCP-6901 TO: RTU-PEA 1 2/CS-#16 >> PIT-6906 SIGNAL 1 2/CS-#16 >> PDIT-6905 SIGNAL 1 2/CS-#16 >> PIT-6914 SIGNAL 1 2/CS-#16 >> PDIT-6915 SIGNAL	
S-69-011	69E02	1"	4	2/CS-#16		1	#14	XHHW-2	FR: JB-6911 TO: VCP-6901 2 2/CS-#16 >> SPARE 2 2/CS-#16 >> PIT-6914 SIGNAL	
S-69-015		0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: WIT-6915 TO: RTU-PEA 1 2/CS-#16 >> WIT-6915 SIGNAL	
S-69-101	69E02	1"	4	2/CS-#16		1	#14	XHHW-2	FR: JB-6901 TO: VCP-6901 2 2/CS-#16 >> SPARE 2 2/CS-#16 >> PIT-6906 SIGNAL	
S-69-105	69E03	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: JB-6905 TO: VCP-6901 2 2/CS-#16 >> SPARE	
S-69-115	69E03	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: JB-6915 TO: VCP-6901 2 2/CS-#16 >> SPARE	
S-69-505	69E03	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: WIT-6905 TO: RTU-PEA 1 2/CS-#16 >> WIT-6905 SIGNAL	
S-69-515	69E03	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: WIT-6915 TO: RTU-PEA 1 2/CS-#16 >> WIT-6915 SIGNAL	
S-69-606	69E03	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: LIT-6906 TO: VCP-6901 2 2/CS-#16 >> LIT-6901 SIGNAL	
S-69-710	69E02	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: LCP-7100 TO: RTU-PEA 2 2/CS-#16 >> LCP-7100 SIGNAL	

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 16990K

CONDUIT SCHEDULE
AREA 71

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. MFR: Manufacturer or vendor furnished cable.
   4. RS-485 RS-485 cable.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

CONDUIT SCHEDULE AREA 71

FILTER AND CHEMICAL FEED UPGRADES

PEC AREA

ENGINEER	**CK**
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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-71-001	71E01	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-7100 TO: RTU-PEA 6 #14 >> LCP-7100 CONTROL	
C-71-002	71E02	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-7107 TO: RTU-PEA 10 #14 >> PMP-7107 CONTROL	
C-71-003	71E02	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-7106 TO: RTU-PEA 10 #14 >> PMP-7106 CONTROL	
C-71-004	71E01	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-7103 TO: RTU-PEA 8 #14 >> PMP-7103 CONTROL	
C-71-005	71E01	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-7104 TO: RTU-PEA 8 #14 >> PMP-7104 CONTROL	
C-71-006	71E02	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: LSH-7104 TO: RTU-PEA 2 #14 >> LSH-7104 CONTROL 2 #14 >> LSH-710424 VDC POWER	
C-71-007	71E02	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE-7105 TO: LIT-7105 1 MFR >> LE-7105 CONTROL	
C-71-008	71E02	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: WE-7105 TO: WIT-7105 1 MFR >> WE-7105 CONTROL	
C-71-009	71E01	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FSH-7116 TO: RTU-PEA 2 #14 >> FSH-7116 CONTROL	
C-71-010	71E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-PEA TO: RTU-PEA 2 #14 >> MCC-PEA CONTROL	
C-71-011	71E02	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: WE-6211 TO: WIT-6211 1 MFR >> WE-6211 CONTROL	
C-71-103	71E01	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-7103 TO: RTU-PEA 2 #14 >> PISH-7103 CONTROL	
C-71-104	71E01	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-7104 TO: RTU-PEA 2 #14 >> PISH-7104 CONTROL	
C-71-106	71E02	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-7106 TO: RTU-PEA 2 #14 >> PISH-7106 CONTROL 2 #14 >> PISH-7106 24VDC POWER	
C-71-107	71E02	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-7107 TO: RTU-PEA 2 #14 >> PISH-7107 CONTROL 2 #14 >> PISH-7107 24VDC POWER	
C-71-108	71E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-7108 TO: RTU-PEA 2 #14 >> FIT-7108 24VDC CONTROL	
C-71-111	71E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: WIT-6211 TO: RTU-PEA 2 #14 >> WIT-6211 24VDC POWER	
C-71-113	71E01	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-7103 TO: FVNR-7103 2 #14 >> PISH-7103 CONTROL	
C-71-114	71E01	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PISH-7104 TO: FVNR-7104 2 #14 >> PISH-7104 CONTROL	
C-71-203	71E01	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: LE-7103 TO: RTU-PEA 2 #14 >> LE-7103 CONTROL	

CONDUIT SCHEDULE AREA 71

FILTER AND CHEMICAL FEED UPGRADES

PEC AREA

ENGINEER	**CK**
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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-71-204	71E02	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6204 TO: RTU-PEA 10 #14 >> PMP-6204 CONTROL	
C-71-205	71E02	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6205 TO: RTU-PEA 10 #14 >> PMP-6205 CONTROL	
C-71-211	71E02	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6211 TO: RTU-PEA 10 #14 >> PMP-6211 CONTROL	
C-71-214	71E02	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: LSH-6214 TO: RTU-PEA 2 #14 >> LSH-6214 CONTROL 2 #14 >> LSH-6214 24VDC POWER	214
C-71-215	71E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-6215 TO: RTU-PEA 2 #14 >> FIT-6215 24VDC POWER	
C-71-216	71E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: FIT-6216 TO: RTU-PEA 2 #14 >> FIT-6216 24VDC POWER	
C-71-221	71E02	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-6221 TO: RTU-PEA 10 #14 >> PMP-6221 CONTROL	
L-71-001	71E01	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: LCP-7100 TO: RTU-PEA 2 #12 >> LCP-7100 POWER	
L-71-002	71E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-7107 TO: PNL-PEA 2 #12 >> PMP-7107 POWER	
L-71-003	71E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-7106 TO: PNL-PEA 2 #12 >> PMP-7106 POWER	
L-71-004	71E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: RTU-PEA TO: UPS-S 2 #12 12 RTU-PEA POWER	
L-71-005	71E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: RTU-PEA TO: PNL-PEA 3 #12 >> RTU-PEA POWER	
L-71-103	71E01	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PISH-7103 TO: FVNR-7103 3 #12 >> PISH-7103 POWER	
L-71-104	71E01	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PISH-7104 TO: FVNR-7104 3 #12 >> PISH-7104 POWER	
L-71-203	71E01	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: LE-7103 TO: RTU-PEA 3 #12 >> LE-7103 POWER	
L-71-204	71E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6204 TO: PNL-PEA 2 #12 >> PMP-6204 POWER	
L-71-205	71E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6205 TO: PNL-PEA 2 #12 >> PMP-6205 POWER	
L-71-211	71E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6211 TO: PNL-PEA 2 #12 >> PMP-6211 POWER	
L-71-221	71E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-6221 TO: PNL-PEA 2 #12 >> PMP-6221 POWER	
N-71-001	71E02	0.75"	1		RS-485	1	#14	XHHW-2	FR: MCC-PEA TO: RTU-PEA 1 RS-485 >> MCC-PEA NETWORK	

CONDUIT SCHEDULE AREA 71

FILTER AND CHEMICAL FEED UPGRADES

PEC AREA

ENGINEER	**CK**
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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
N-71-108	71E02	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-7108 TO: RTU-PEA 1 RS-485 >> FIT-7108 NETWORK	
N-71-215	71E02	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-6215 TO: RTU-PEA 1 RS-485 >> FIT-6215 NETWORK	
N-71-216	71E02	0.75"	1		RS-485	1	#14	XHHW-2	FR: FIT-6216 TO: RTU-PEA 1 RS-485 >> FIT-6216 NETWORK	
P-71-001	71E01	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PMP-7103 TO: MCC-PEA VIA FVNR-7103 3 #12 >> PMP-7103 POWER	
P-71-002	71E01	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PMP-7104 TO: MCC-PEA VIA FVNR-7104 3 #12 >> PMP-7104 POWER	
P-71-003	71E02	1.5"	3	#2	XHHW-2	1	#8	XHHW-2	FR: PP-PEA TO: MCC-PEA 3 #2 >> PP-PEA POWER	
P-71-004	71E02	1.5"	3	#1/0	XHHW-2	1	#6	XHHW-2	FR: PNL-PEA TO: XFMR-PEA 3 #1/0 >> PNL-PEA POWER	
P-71-006	71E02	1.5"	3	#1/0	XHHW-2	1	#6	XHHW-2	FR: XFMR-PEA TO: MCC-PEA 3 #1/0 >> XFMR-PEA POWER	
P-71-007	71E02	2"	3	#4/0	XHHW-2	1	#4	XHHW-2	FR: MCC-PEA TO: MCC-B1 3 #4/0 >> MCC-PEA POWER	
S-71-001	71E01	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-7101 TO: RTU-PEA 1 2/CS-#16 >> LIT-7101 SIGNAL	
S-71-002	71E01	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-7102 TO: RTU-PEA 1 2/CS-#16 >> LIT-7102 SIGNAL	
S-71-003	71E01	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: LCP-7100 TO: RTU-PEA 2 2/CS-#16 >> LCP-7100 SIGNAL	
S-71-004	71E02	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: VCP-7107 TO: RTU-PEA 2 2/CS-#16 >> PMP-7107 SIGNAL	
S-71-005	71E02	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: VCP-7106 TO: RTU-PEA 2 2/CS-#16 >> PMP-7106 SIGNAL	
S-71-006	71E02	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-7105 TO: RTU-PEA 1 2/CS-#16 >> LIT-7105 SIGNAL	
S-71-007	71E02	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: WIT-7105 TO: RTU-PEA 1 2/CS-#16 >> WIT-7105 SIGNAL	
S-71-011	71E02	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LIT-6211 TO: RTU-PEA 1 2/CS-#16 >> LIT-6211 SIGNAL	
S-71-111	71E02	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: WIT-6211 TO: RTU-PEA 1 2/CS-#16 >> WIT-6211 SIGNAL	
S-71-204	71E02	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: VCP-6204 TO: RTU-PEA 2 2/CS-#16 >> PMP-6204 SIGNAL	
S-71-205	71E02	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: VCP-6205 TO: RTU-PEA 2 2/CS-#16 >> PMP-6205 SIGNAL	
S-71-211	71E02	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: VCP-6211 TO: RTU-PEA 2 2/CS-#16 >> PMP-6211 SIGNAL	

CONDUIT SCHEDULE AREA 71

FILTER AND CHEMICAL FEED UPGRADES

PEC AREA

ENGINEER	**CK**
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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
S-71-221	71E02	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: VCP-6221 TO: RTU-PEA 2 2/CS-#16 >> PMP-6221 SIGNAL	

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 17050

COMMON WORK RESULTS FOR PROCESS CONTROL AND INSTRUMENTATION SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Process control and instrumentation systems requirements for common components including installation, including, but not limited to, the following:
      a. Hardware.
      b. Software.
      c. Programming.
      d. Testing.
      e. Commissioning.
   2. Loop drawings:
      a. Provide complete loop drawings for all systems, including packaged equipment furnished as part of a vendor furnished package, and pre-purchased equipment.
      b. The form, minimum level of detail, and format for the loop drawings must match that of the sample loop drawings included in the Contract Documents.
      c. Owner and Engineer are not responsible for providing detailed loop diagrams for Contractor furnished equipment.
   3. Instrumentation and Control Specifications requirements apply to all Instrumentation and Control Work specified in Technical Sections, including packaged mechanical systems, LCPs, VCPs, etc.

B. Project Responsibilities:
   1. Programming: Steve Anderson from APCO Inc. will do the RTU, local operator interfaces, and HMI. Refer to Section 01110 - Summary of Work.
   2. Control Panels:
      a. The Contractor purchases an enclosure with back panels and turns them over to the Owner. The contractor installs vents and fans on the enclosures and provides cutouts on the enclosure doors for any pilot devices and HMI/LOI screens. The contractor is to coordinate with the owner regarding the exact dimensions of the screens for the cutouts.
      b. Back Panel: The Owners will provide, install, and wire all components onto the back panel. The Owner will also install the back panels and terminate all field wires in the RTUs and CLIP panel.
      c. The Contractor will pull all field wires and clearly label for the Owner to terminate.
      d. Contractor is not responsible for loop drawings for Owner provided panels.

C. Contract Drawings:
    1. Schematic diagrams:
        a. Use schematic diagrams in conjunction with the descriptive operating sequence in the Technical Sections to furnish a coordinated and fully functional control system.
        b. Schematic diagrams show control function only.
            1) Incorporate other necessary functions for proper operation and system protection.
        c. Controls are indicated on the Drawings as de-energized.
        d. Add relays, where required, to provide necessary contacts for the control system or, where needed, to function as interposing relays for control voltage coordination, equipment coordination, or control system voltage drop considerations.
        e. Mount devices shown on motor controller schematic diagrams in the controller compartment enclosure, unless otherwise noted or indicated on the Drawings.

1.02 REFERENCES

A. Abbreviations:
    1. ACB: Automatic current balance.
    2. ATS: Automatic Transfer Switch.
    3. CCS: The PCS central computer system (CCS) consisting of computers and software. The personal computer-based hardware and software system that includes the operator interface, data storage, data retrieval, archiving, alarming, historian, reports, trending, and other higher level control system software and functions.
    4. DPDT: Double-pole, double-throw.
    5. ECP: Electronic circuit protector.
    6. ES: Ethernet Switch.
    7. FAT: Factory acceptance test also known as Source Test.
    8. HART: Highway addressable remote transducer.
    9. HMI: Human-machine-interface is a software application that presents information to an operator or user about the state of a process and accepts and implements the operator's control instructions. Typically, information is displayed in a graphical format.
    10. HOA: Hand-Off-Auto control function that is totally PLC based. In the Hand mode, equipment is started or stopped, valves are opened or closed through operator direction under the control of the PLC software. In the Auto mode, equipment is started or stopped, and valves are opened or closed through a control algorithm within the PLC software. In the Off mode, the equipment is prohibited from responding from the PLC control.
    11. I/O: Input/Output.
    12. ICSC: Instrumentation and control system contractor: Subcontractor who specializes in the design, construction, fabrication, software development, installation, testing, and commissioning of industrial instrumentation and control systems.
    13. IJB: Instrument junction boxes: A panel designed with cord sets to easily remove, replace, or relocate instrument signals.
    14. IP: Internet protocol or ingress protection.

15. LAN: Local area network: A control or communications network that is limited to the physical boundaries of the facility.
16. LCP: Local control panel: Operator interface panel that may contain an HMI, pilot type control devices, operator interface devices, control relays, etc. and does not contain a PLC or RIO.
17. LOI: Local Operator Interface is an operator interface device consisting of an alphanumeric or graphic display with operator input functionality. The LOI is typically a flat panel type of display mounted on the front of an enclosure with either a touch screen or tactile button interface.
18. LOR: Local-Off-Remote control function. In the Remote mode, equipment is started or stopped, and valves are opened or closed through the PLC based upon the selection of the HOA. In the Local mode, equipment is started or stopped, valves are opened or closed based upon hardwired control circuits completely independent of the PLC with minimum interlocks and permissive conditions. In the Off mode, the equipment is prohibited from responding to any control commands.
19. NJB: Network junction box. An enclosure that contains multiple access points to various networks within the facility. Networks could be Ethernet, Ethernet/IP, Fieldbus, RIO, etc.
20. P&ID: Process and instrumentation diagram.
21. PC: Personal computer.
22. PCIS: Process control and instrumentation system: Includes the entire instrumentation system, the entire control system, and all of the Work specified in the Instrumentation and Control Specifications and depicted on the Instrumentation Drawings. This includes all the PCS and instruments and networking components as well as the various servers, workstations, thin clients, etc.
23. PCM: Process control module: An enclosure containing any of the following devices: PLC, RTU, or RIO.
24. PCS: Process Control System: A general name for the computerized system that gathers and processes data from equipment and sensors and applies operational controls to the process equipment. It includes the PLCs and/or RIOs, LOIs, HMIs, both LCPs, VCPs and all data management systems accessible to staff.
25. PJB: Power junction box: An enclosure with terminal blocks that distribute power to multiple instruments.
26. PLC: Programmable logic controller.
27. PS: Power supply.
28. RIO: Remote I/O device for the PLC consisting of remote I/O racks or remote I/O blocks.
29. RTU: Remote telemetry unit: A controller typically consisting of a PLC, and a means for remote communications. The remote communications devices typically are radios, modems, etc.
30. SCADA: Supervisory control and data acquisition system: A general name for the computerized system that gathers and processes data from sensors and equipment located outside of the facility, such as wells, lift stations, metering stations, etc.
31. SELV: Safety extra-low voltage.
32. SFP: Small form-factor pluggable.
33. SPDT: Single-pole, double-throw.
34. SPST: Single-pole, single-throw.

35. UPS: Uninterruptible power supply.
36. VCP: Vendor control panel: Control panels that are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, LOI, HMI, etc.
37. WAN: Wide area network: A control or communications network that extends beyond the physical boundaries of the facility.

B. Standards:
1. American Petroleum Institute (API):
   a. RP 550 - Manual on Installation of Refinery Instruments and Control Systems; Part II-Process Stream Analyzers; Section 5-Oxygen Analyzers.
   b. RP 551 - Process Measurement Instrumentation.
2. International Organization for Standardization (ISO):
   a. 9001 - Quality Management Systems - Requirements.
3. International Society of Automation (ISA):
   a. 5.1 - Instrumentation Symbols and Identification.
   b. 5.4 - Instrument Loop Diagrams.
   c. 20 Instrument Forms Plus Pro-Combo-Enterprise Version (Microsoft SQL Server Express Database Software based).
4. National Electrical Manufacturers Association (NEMA).
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. 508 - Standard of Safety for Industrial Control Equipment.
   b. 508A - Standard of Safety for Industrial Control Panels.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
1. 2-Wire transmitter (loop powered): A transmitter that derives its operating power supply from the signal transmission circuit and requires no separate power supply connections. As used in this Section, 2-wire transmitter refers to a transmitter that provides a signal such as 4 to 20 mA 24 VDC regulation of a signal in a series circuit with an external 24 VDC driving potential:
   a. Fieldbus communications signal or both.
2. Control circuit: Any circuit operating at 120 volts alternating current (VAC) or direct current (VDC) or less, whose principal purpose is the conveyance of information (including performing logic) and not the conveyance of energy for the operation of an electrically powered device.
3. Digital bus: A communication network, such as PROFIBUS, Foundation Fieldbus, or DeviceNet, allowing instruments and devices to transmit data, control functions, and diagnostic information.
4. Instrument: A measurement device that includes a sensor for taking the measurement and one or both of the following:
   a. A local display.
   b. A device for communicating the measurement to a remote location such as a PLC or DCS.
5. Modifications: Changing, extending, interfacing to, removing, or altering an existing circuit.

6. Panel: An instrument support system that may be a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems.
7. Power circuit: Any circuit operating at 90 volts (AC or DC) or more, whose principal purpose is the conveyance of energy for the operation of an electrically powered device.
8. Powered transmitters: A transmitter that requires a separate power source (120 VAC, 240 VAC, etc.) in order for the transmitter to develop its signal. As used in this Section, the produced signal may be a 4 to 20 mA 24 VDC signal, a digital bus communications signal, or both.
9. Programmer: Responsible for PLC programming and SCADA/HMI software configuration.
10. RS-485: RS-485 is also known as TIA-485 or EIA-485, is a standard defining the electrical characteristics of drivers and receivers for use in serial communications system. Electrical signaling is balanced, and multipoint systems are supported, can be used with data rates up to 10 Mbit/s or at lower speeds distances up to 1,000 meters (4,000 feet).
11. Signal circuit: Any circuit operating at less than 50 VAC or VDC, which conveys analog information or digital communications information.

1.04 DELEGATED DESIGN

A. The requirements for Delegated Design are specified in the Technical Sections.

1.05 SUBMITTALS

A. General:
   1. Adhere to the wiring numbering scheme as specified in Section 16075 - Identification for Electrical Systems throughout the Project:
      a. Uniquely number each wire.
      b. Wire numbers must appear on Equipment Drawings.
   2. Some items of Work are represented schematically and are designated for the most part by numbers, as derived from criteria in ISA-5.1:
      a. Employ the nomenclature and numbers designated in this Section and indicated on the Drawings exclusively throughout Shop Drawings, datasheets, and similar Submittals.
      b. Replace any other symbols, designations, and nomenclature unique to a manufacturer's, Supplier's, or Subcontractor's standard methods with those identified in this Section and indicated on the Drawings.

B. Specific Submittal requirements:
   1. Control Panel Drawings for panels not provided by the Owner:
      a. General Requirements:
         1) Submit panel, enclosure, console, furniture, and cabinet layout drawings for all items provided.
         2) Use equipment and instrument tags as depicted on the P&IDs for all Submittals.
         3) Nameplates and Wire Labeling:
            a) Nameplate legend including text, letter size, materials, and colors.

b) As specified in Section 16075 - Identification for Electrical Systems or as indicated on the Drawings.

4) Structural Requirements:
   a) Anchoring method and leveling criteria, including manufacturer's recommendations for the Project site seismic criteria.
   b) Weight.
5) Clearly show modifications to existing circuits:
   a) Show existing unmodified wiring to clearly depict the functionality and electrical characteristics of the complete modified circuits.

b. Required for materials and equipment listed in this and other Technical Sections.

c. Front, side, rear, internal, external elevations, and top and bottom views, showing all dimensions and all to scale.
   1) Locations of conduit entrances and access plates.
   2) Component layout and identification.
   3) Complete and detailed bills of materials:
      a) Including quantity, description, manufacturer, and part number for each assembly or component for each control panel.
      b) Include all items within an enclosure.
   4) Requirements for physical separation between control system components and 120 VAC, 480 VAC, and medium-voltage power cables.
   5) Complete grounding requirements for each system component including any requirements for PLCs, process LANs, and Control System equipment.
   6) PLC rack and card layout:
      a) Provide a count of current I/O allocation.
      b) Future I/O allocation.
      c) Quantity of spares provided.
   7) NEMA rating.
   8) Material and finish.

2. Schematics and Wiring Diagrams:
   a. General Requirements:
      1) Submit panel wiring diagrams for every panel that contains wiring.
      2) Use equipment and instrument tags as depicted on the P&IDs for all Submittals.
      3) Nameplates and Wire Labeling:
         a) As specified in Section 16075 - Identification for Electrical Systems or as indicated on the Drawings.
      4) Clearly show modifications to existing circuits:
         a) Show existing unmodified wiring to clearly depict the functionality and electrical characteristics of the complete modified circuits.
   b. Include the following information:
      1) Name of panel.
      2) Wiring sizes and types.
      3) Terminal strip numbers.
      4) Terminal identification for device and field connections.
      5) Wire tags and labels.

6) Functional name and manufacturer's designation for items to which wiring are connected.
7) Set points for relays and control or alarm contact settings.

c. Incorporate equipment manufacturer's Shop Drawing information into the schematic diagrams in order to document the entire control system.

3. Loop drawings:
   a. General Requirements:
      1) Submit loop drawings for every analog, discrete, Fieldbus signal, vendor-supplied equipment package, and control panel.
         a) Includes monitoring, alarm, interlocks, and control devices.
      2) Use equipment and instrument tags for all Submittals as depicted on the P&IDs.
      3) Show and identify each component of each loop or system using requirements and symbols from ISA-5.4.
      4) Provide Drawings for every instrumentation loop system:
         a) Furnish a separate Drawing sheet for each system or loop diagram.
      5) Nameplates and Wire Labeling:
         a) As specified in Section 16075 - Identification for Electrical Systems or as indicated on the Drawings.
      6) Clearly show modifications to existing circuits:
         a) Show existing unmodified wiring to clearly depict the functionality and electrical characteristics of the complete modified circuits.
      7) Provide loop drawings in the format indicated in the Contract Drawings.
   b. Provide a complete index in the front of each bound volume:
      1) Index the loop drawings by systems or process areas.
   c. In addition to the ISA-5.4 requirements, show the following details:
      1) Functional name of each loop.
      2) Reference name, drawing, and loop diagram numbers for any signal continuing off the sheet.
      3) Show all terminal numbers, regardless of the equipment provider.
      4) MCC panel, circuit, and breaker numbers for power feeds to the loops and instrumentation.
      5) Terminal assignments associated with every manhole, pull-box, junction box, conduit, and panel through which the loop circuits pass.
      6) Show vendor control panel, instrument panel, conduit, junction box, equipment and PCS terminations, termination identification, wire numbers and colors, power circuits, and ground identifications.
      7) Cables required for communication requirements.
4. PLC I/O List:
   a. A complete listing of the PCS system point I/O database:
      1) Include for each data point relevant parameters such as range, contact orientation, limits, incremental limits, I/O hardware address, and PLC assignment.
      2) Organize on a site-by-site basis and separate by point type.
      3) In addition to the active I/O points, list the implemented spare I/O points and the available I/O points remaining on each card, as well as other defined future points specified or shown.

4) Upon completion of the Work, update I/O lists to indicate the final as-built configuration of the systems:
    a) Organize as-built I/O list on a site-by-site basis, separated by equipment and point type.

5. Control Descriptions:
    a. For each control loop, provide programming logic in the form of a written functional description of the operation of the equipment, signals, and controls based on the requirements as specified in Section 17100 - Control Strategies, Section 17101 - Specific Control Strategies, and as shown on the P&IDs:
        1) Functional descriptions shall be modified to reflect the actual programming to be implemented in the PLCs.
        2) Include each function depicted or described in the Contract Documents.
        3) Include within the Control Description content:
            a) Specific requirements.
            b) Common requirements that pertain in general to all loops.
            c) Listing ranges, setpoints, timers, values, counter values, etc.
            d) Manual keyboard entries.
            e) Entry codes.
            f) System responses.
            g) Modes:
                (1) Startup.
                (2) Routine and regular operation.
                (3) Regulation and control.
                (4) Shutdown under specified modes of operation.
                (5) Emergency operating shutdown.
6. Instrument Datasheets:
    a. The datasheets provided with the instrument specifications are preliminary and are not complete but are provided to assist with the completion of final instrument datasheets. Additional datasheets may be required.
    b. Furnish fully completed datasheets for each instrument and component according to ISA-20 Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
    c. Format: Provide datasheets in Microsoft Word or Microsoft Excel.
        1) Features and options that are furnished.
    d. Provide completed datasheet as specified in the Technical Sections and for each control system component.
7. Instrument Installation Drawings:
    a. Provide instrument installation, mounting, and anchoring details for components and assemblies, including access requirements and conduit connection or entry details.
    b. Each installation shall be identified by the equipment or instrument by tag number.
    c. Provide certification by the instrument manufacturer that the proposed installation is in accordance with the instrument manufacturer’s recommendations and is fully warrantable.
    d. Provide, at a minimum, the following contents for each detail:
        1) Necessary sections and elevation views required to define instrument location by referencing tank, building, or equipment names and

numbers, and geographical qualities such as north, south, east, west, basement, first floor, etc.
2) Ambient temperature and humidity where the instrument is to be installed.
3) Corrosive qualities of the environment where the instrument is to be installed.
4) Hazardous rating of the environment where the instrument is to be installed.
5) Process line pipe or tank size, service, and material.
6) Process tap elevation and location.
7) Upstream and downstream straight pipe lengths between instrument installation and pipe fittings and valves.
8) Routing of tubing and identification of supports.
9) Mounting brackets, stands, anchoring devices, and sunshades.
10) Conduit entry size, number, location, and delineation between power and signal.
11) NEMA ratings of enclosures and components.
12) Clearances required for instrument servicing.
13) List itemizing manufacturer makes, model numbers, quantities, lengths required, and materials of each item required to support the implementation of the detail.

8. Product data:
   a. Provide a technical brochure or bulletin (“cutsheet”) for each instrument or equipment on the project labeled with equipment and instrument tags as depicted on the P&IDs.
      1) Submit with the corresponding datasheets.
      2) Organization: Index product data in the Submittal by systems or loops.
   b. Engineering data:
      1) Test data and performance curves, when applicable.
   c. Manufacturer’s technical reference manuals.
9. Commissioning Submittals:
   a. As specified in Section 01756 - Commissioning.
   b. Manufacturer representative qualifications.
   c. Manufacturer certificates.
   d. Test plans.
   e. Test reports.
   f. Owner Training Submittals.
   g. Operation and maintenance manuals.
      1) Organize the operation and maintenance manuals for each process in the following manner:
         a) Section A - Process and Instrumentation Diagrams.
         b) Section B - Control Panel Drawings.
         c) Section D - Schematics and Wiring Diagrams.
         d) Section E - Loop Drawings.
         e) Section F - Network Diagrams.
         f) Section G - PLC I/O List.
         g) Section H - Control Descriptions.
         h) Section I - Instrument Datasheets.
         i) Section J - Instrument Installation Drawings.
         j) Section K - Product Data.
         k) Section L - Sizing Calculations.

l) Section M - Test Results.
m) Section N - Operational Manual.
n) Section O - Spare Parts List.

1.06 QUALITY ASSURANCE

A. Manufacture instruments at facilities certified to the quality standards of ISO 9001.

B. Provide equipment listed by and bearing the label of UL or of an independent testing laboratory acceptable to the Engineer and the Authority Having Jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Upon receipt of instruments in the field:
   1. Outside of the package: Prominently display tag number identification.
   2. On each instrument: Provide a nameplate as specified in this Section.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

B. Area classifications:
   1. Furnish enclosures that match the area classifications as specified in Section 16050 - Common Work Results for Electrical.

1.09 ADMINISTRATIVE REQUIREMENTS

A. Project PCIS overview conference:
   1. Contractor leads the meeting.
   2. Timing:
      a. Prior to start of ICSC and Programmer Work.
   3. Attendees:
      a. Engineer, Owner, ICSC, and Programmer.
      b. Contractor.
      c. Electrical subcontractor.
      d. Manufacturers furnishing major pieces of equipment must attend, including, but not limited to:
         1) Vendor control panels.
         2) Chemical feed systems.
         3) Motor control centers.
         4) Switchgear.
         5) Variable frequency drives.
         6) Lighting.
         7) Engine generators.
   4. Agenda:
      a. Meeting purpose:
         1) Review the entire project, equipment, control philosophy, schedules, and Submittal requirements.
      b. Review entire project.
      c. Review equipment lists.
      d. Review control philosophy.

e. Review schedules.
f. Review Submittal requirements.
g. Safety and security.
h. Action items.
i. Next meeting.

B. System configuration meetings: Meet on at least the following occasions:
1. Preliminary meeting:
a. Contractor leads the meeting.
b. Timing:
1) Before configuration work is begun.
c. Attendees:
1) Engineer, Owner, ICSC, and Programmer.
d. Agenda:
1) Meeting purpose:
a) Review the system configuration, the HMI system database, control schemes, displays, report formats, etc.
2) Review the ICSC provided examples of displays, display symbols, reports, etc., to show the capabilities of the system software.
3) Safety and security.
4) Action items.
5) Next meeting.
2. Development review meeting:
a. Contractor leads the meeting.
b. Timing:
1) After the initial database is entered and typical screens and reports have been entered.
c. Attendees:
1) Engineer, Owner, ICSC, and Programmer.
d. Agenda:
1) Meeting purpose:
a) Review the system configuration, the HMI system database, control schemes, displays, report formats, etc.
2) Review the system configuration.
3) Review the HMI system database.
4) Review the control schemes.
5) Review the displays.
6) Review the report formats.
7) Safety and security.
8) Action items.
9) Next meeting.
3. Pre-submittal review meeting:
a. Contractor leads the meeting.
b. Timing:
1) Before producing any Submittals.
c. Attendees:
1) Engineer, Owner, Programmer, and ICSC.
d. Agenda:
1) Meeting purpose:
a) Review the system configuration, the HMI system database, control schemes, displays, report formats, etc.

b) Review an informal hardcopy of developed HMI screens for review by the Engineer.
2) Review the system configuration.
3) Review the HMI system database.
4) Review the control schemes.
5) Review the displays.
6) Review the report formats.
7) Review an informal hardcopy of developed HMI screens.
8) Review the Submittal schedule.
9) Safety and security.
10) Action items.
11) Next meeting.

4. Final review meeting:
   a. Contractor leads the meeting.
   b. Timing:
      1) After initial completion of configuration work.
      2) Prior to the Source Test.
   c. Attendees:
      1) Engineer, Owner, Programmer, and ICSC.
   d. Agenda:
      1) Meeting purpose:
         a) Review the system configuration, the HMI system database, control schemes, displays, report formats, etc.
      2) Review the system configuration.
      3) Review the HMI system database.
      4) Review the control schemes.
      5) Review the displays.
      6) Review the report formats.
      7) Safety and security.
      8) Action items.
      9) Next meeting.
   e. Make final format revisions after this review.
5. Additional requirements as specified in the following:
   a. Section 17100 - Control Strategies.
   b. Section 17101 - Specific Control Strategies.
   c. Section 17720 - Control Systems: Programmable Logic Controllers.

C. Control logic meetings: Meet on at least the following occasions:
   1. Preliminary meeting:
      a. Contractor leads the meeting.
      b. Timing:
         1) Before configuration work is begun on any PLCs programmed by the Contractor (including those provided through Subcontractors and Suppliers).
      c. Attendees:
         1) Owner, Engineer, Programmer, and ICSC.
         2) Individuals responsible for programming PLCs and other programmable devices supplied by the Contractor may attend by telephone conference call.

d. Agenda:
    1) Meeting purpose:
        a) Discuss overall control logic.
    2) Review list of each PLC and other programmable devices that will interface to the rest of the control system, including make, model, and a description of the interface.
    3) Review contact information for each individual responsible for programming each said PLC and other programmable device.
    4) Review schedule of Submittals that will contain HMI/LOI interface information.
    5) Safety and security.
    6) Action items.
    7) Next meeting.

2. Development review meeting:
    a. Contractor leads the meeting.
    b. Timing:
        1) After approximately one-half of the HMI/LOI interface Submittals have been submitted.
    c. Attendees:
        1) Owner, Engineer, Programmer, and ICSC.
        2) Individuals responsible for programming PLCs and other programmable devices supplied by the Contractor may attend by telephone conference call.
    d. Agenda:
        1) Meeting purpose:
            a) Discuss progress on control logic.
        2) Discuss HMI/LOI interface Submittals to date.
        3) Discuss HMI/LOI interface future Submittals and their requirements.
        4) Discuss half of the screens “drafted” but not submitted.
        5) Review list of each PLC and other programmable devices that will interface to the rest of the control system, including make, model, and a description of the interface.
        6) Review contact information for each individual responsible for programming each said PLC and other programmable device.
        7) Review schedule of Submittals that will contain HMI/LOI interface information.
        8) Safety and security.
        9) Action items:
            a) Document Vendor Control Panel programming requirements.
        10) Next meeting.

3. Pre-submittal review meeting:
    a. Contractor leads the meeting.
    b. Timing:
        1) Before producing any Submittals.
    c. Attendees:
        1) Engineer, Owner, Programmer, and ICSC.
    d. Agenda:
        1) Meeting purpose:
            a) Coordinate Submittals.
        2) Review the system configuration, the HMI system database, control schemes, displays, report formats, etc.

3) Review an informal hardcopy of developed HMI screens for review by the Engineer to determine that requirements are being sufficiently met.
4) Review the Submittal schedule.
5) Safety and security.
6) Action items.
7) Next meeting.

4. Vendor control panel programming meetings:
   a. Contractor leads the meeting.
   b. Timing:
      1) Prior to start of vendor control panel programming Work.
   c. Attendees:
      1) Owner, Engineer, Programmer, and ICSC.
      2) Individuals responsible for programming PLCs and other programmable devices supplied by the Contractor may attend by telephone conference call.
      3) Each equipment supplier who is providing equipment with a PLC and/or LOI.
   d. Agenda:
      1) Meeting purpose:
         a) Coordinate control logic requirements for specific equipment.
      2) Review minimum Vendor Control Panel programming requirements:
         a) PLC to PLC global data mapping.
         b) PLCs to HMI tags mapping.
         c) Communication methods.
      3) Review advanced Vendor Control Panel programming requirements, as applicable:
         a) Tag naming conventions.
         b) LOI screen colors and navigation.
         c) Interlock and permissive definitions.
         d) Alarms: Clearing, formats, colors, and status.
         e) Standard code blocks for common control functionality.
      4) Safety and security.
      5) Action items.
      6) Next meeting.
5. Final review meeting:
   a. Contractor leads the meeting.
   b. Timing:
      1) After HMI/LOI interface Submittals have been submitted.
   c. Attendees:
      1) Owner, Engineer, Programmer, and ICSC.
      2) Individuals responsible for programming PLCs and other programmable devices supplied by the Contractor may attend by telephone conference call.
   d. Agenda:
      1) Meeting purpose:
         a) Discuss HMI/LOI interface Submittals and requirements.
      2) Review minimum programming requirements:
         a) PLC to PLC global data mapping.
         b) PLCs to HMI tags mapping.
         c) Communication methods.

3) Review advanced requirements, as applicable:
    a) Tag naming conventions.
    b) LOI screen colors and navigation.
    c) Interlock and permissive definitions.
    d) Alarms: Clearing, formats, colors, and status.
    e) Standard code blocks for common control functionality.
4) Safety and security.
5) Action items.
6) Next meeting.

6. Additional requirements as specified in the following:
    a. Section 17100 - Control Strategies.
    b. Section 17101 - Specific Control Strategies.
    c. Section 17720 - Control Systems: Programmable Logic Controllers.

PART 2 PRODUCTS

2.01 GENERAL

A. Furnish meters, instruments, and other components that are the most recent field proven models marketed by their manufacturers at the time of Submittal of the Shop Drawings unless otherwise specified to match existing equipment.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Non-conditioned spaces:
    1. Provide additional temperature conditioning equipment to maintain equipment in non-conditioned spaces subject to these ambient temperatures, with a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature, as determined by the equipment manufacturer’s guidelines.

B. Outdoor installations:
    1. Provide electrical, instrumentation and control equipment suitable for operation in the ambient conditions where the equipment is located.
    2. Provide heating, cooling, and dehumidifying devices incorporated into and included with electrical equipment, instrumentation and control panels to maintain the enclosures within the rated environmental operating ranges as specified in the Sections for the equipment.

C. This facility includes potable water:
    1. Utilize NSF/ANSI/CAN 61 certification where available for instrumentation and instrumentation accessories.
    2. If there are no certified NSF/ANSI/CAN 61 alternatives:
        a. Provide a statement that there is no available certified alternative.
        b. Utilize instruments certified FDA food compliant or USP compliant that can be substantiated as being appropriate for contact with potable water.
        c. Components of the instrument or instrument accessory in direct contact with water has an acknowledged and demonstrable history of use in the state for drinking water applications.

d. Components of the instrument or instrument accessory in direct contact with water shall conform with NSF/ANSI/CAN 372 requirements.

D. Unless otherwise specified, furnish individual instruments that have a minimum accuracy of within 0.5 percent of full scale and a minimum repeatability of within 0.25 percent of full scale.

E. Furnish current version of software unless specifically noted in the Contract Documents.
   1. Use of an older version to maintain functionality of an existing system is acceptable with written permission from the Engineer.
   2. Equipment or software with limited support or end of life with the vendor is not acceptable.

F. Discrete circuit configuration:
   1. Configure discrete control circuits to fail safe, on loss of continuity or loss of power.
   2. Alarm contacts: Fail to the alarm condition.
   3. Control contacts fail to the inoperative condition unless otherwise indicated on the Drawings.

G. Grounding:
   1. Analog signal cables shields shall only be grounded at a single point in the loop. Unless otherwise noted, ground signal cable shields at control panel.
   2. For communication and data line signal cable shields and drain wires should be grounded at both ends of the cable.
   3. Insulate the shielding and exposed drain wire for each signal cable with heat-shrink tubing.
   4. Terminate the signal cable shield on a dedicated grounding terminal block.
   5. Provide isolating amplifiers within control panels for field equipment possessing a grounded input or output, except when the panel circuit is galvanically isolated.

H. Instrument air:
   1. Where indicated on the Drawings, provide dry, filtered control air at 30 pounds per square inch gauge nominal pressure piped to field instruments and instrument panels requiring air:
      a. Provide each field instrument with an integral, non-adjustable filter/regulator assembly to provide regulated air.
      b. Provide each instrument panel requiring air with an adjustable filter/regulator assembly with gauge and an air manifold to provide air to pneumatic instruments.
      c. Filter air to 5-micron maximum particle size.
      d. Provide low pressure switch to alarm on insufficient air supply.

I. Terminal blocks:
   1. Schematics do not reflect the actual conductor routing. Add intermediate terminal in enclosures and equipment as needed based on the actual conductor routing.

J. Signal transmission:
   1. Analog signals:
      a. Furnish analog measurements and control signals that vary in direct linear proportion to the measured variable, unless otherwise indicated.
      b. Furnish electrical analog signals outside control panels that are 4 to 20 mA 24 VDC, except as indicated.
      c. Electrically or optically isolate analog signals from other signals.
      d. Furnish regulated analog signals that are not affected by changes in supply voltage or load resistance within the unit's rating.
      e. Maintain the total 4 to 20 mA loop impedance to 10 percent below the published value at the loop operating voltage.
      f. Where necessary, reduce loop impedance by providing current-to-current (I/I) isolation amplifiers for signal re-transmission.
   2. Discrete input signals:
      a. The desire is to have all discrete signal to be 24vdc where possible.
   3. Discrete output signals:
      a. Provide external terminal block mounted fuse with blown fuse indication for discrete outputs.
      b. Provide interposing relays for discrete outputs for voltage and/or current compatibilities.
      c. Provide control relays as required for the functionality of the control circuit.
   4. Signal performance and design criteria:
      a. Stability:
         1) After controls have taken corrective action, oscillation of the final control element shall not exceed 2 cycles per minute or a magnitude of motion of 0.5 percent of full travel.
      b. Response:
         1) Any change in setpoint or controlled variable shall produce a corrective change in position of the final control element and stabilized within 30 seconds.
      c. Agreement:
         1) Setpoint indication of controlled variable and measured indication of controlled variable shall agree within 3 percent of full scale over a 6:1 operating range.
      d. Repeatability:
         1) For any repeated magnitude of control signal, from either an increasing or decreasing direction, the final control element shall take a repeated position within 0.5 percent of full travel regardless of force required to position the final element.
      e. Sensitivity:
         1) Controls shall respond to a setpoint deviations and measured variable deviations within 1.0 percent of full scale.
      f. Performance:
         1) Instruments and control devices shall perform in accordance with the manufacturers' specifications.

2.03 MANUFACTURERS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 ACCESSORIES

A. Provide flow conditioning devices or other required accessories as needed to meet the accuracy requirements in the Contract Documents.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. PCIS configurations are diagrammatic:
   1. Locations of equipment are approximate unless dimensioned.
   2. Where Project conditions require, make reasonable changes in locations and arrangements.

B. Field instruments installation:
   1. Install field instruments as specified in the Contract Documents, API RP 550 and RP 551, and the manufacturer's instructions.
   2. Mount field instruments so that they can be easily read, readily approached, and easily serviced, and so they do not restrict access to mechanical equipment:
      a. Mount field instruments on a pipe stand or local panel, if they are not directly mounted, unless otherwise indicated on the Drawings.
      b. Provide sun shields for field electronic instruments, panels, and enclosures located outdoors. Sun shields shall include standoffs to allow air gap between shield and equipment.
      c. Orient LED, LCD, or other readout screens north to minimize sun glare and reduce potential of sun damage.
   3. Make connections from rigid conduit systems to field instruments with PVC coated flexible conduit:
      a. Type of flexible conduit required for the area classification:
         1) Area classification as specified in Section 16050 - Common Work Results for Electrical.
      b. Maximum length of 18 inches.
   4. Connect field instruments with cable as specified in the Electrical Specifications, except when the manufacturer requires the use of special cable, or otherwise specified in this Section:
      a. Special cable applications shall be in accordance with the NEC.
   5. Verify the correctness of each installation:
      a. Polarity of electric power and signal connections.
   6. Ensure process connections are free of leaks.

C. Process sensing lines and air tubing:
   1. Install individual tubes parallel and/or perpendicular to and near the surfaces from which they are supported.
   2. Provide supports for rigid tubing at intervals of not more than 3 feet.

3. Slope horizontal runs of instrument tubing at a minimum of 1/16-inch per foot to allow for draining of any condensate.
4. Bends:
    a. Make bends for parallel lines symmetrical.
    b. Make bends without deforming or thinning the walls of the tubing.
5. Square-cut and clean ends of tubing before being inserted in the fittings.
6. Provide bulkhead fittings at panels requiring pipe and/or tubing entries.
7. Use stainless steel tubing for piping hard piped from the air header, unless otherwise indicated on the Drawings or not compatible with the fluids or atmosphere in the area:
    a. Use flexible connections only on moving equipment and under the constraint that the length shall be less than 1.5 times maximum travel of the equipment.

D. Cable and conductor termination:
1. Terminate cables and conductors on terminal blocks.
2. Terminal block enclosures:
    a. Suitable for the area classification as specified in Section 16050 - Common Work Results for Electrical.

E. Surge protection:
1. Provide outdoor field instrument loops with voltage surge protection units installed on the instruments and the panel.
2. Individually fuse each 4 to 20 mA DC loop with a 1/2-amp fuse between power supplies and receiver surge protectors.
3. Provide voltage surge protection for 4 wire transmitters and analyzers:
    a. Protect both power source and signal loop.

3.04 RE-INSTALLATION

A. Existing instrumentation:
1. Clean, recondition and re-calibrate each existing instrument to be reused, removed, or reinstalled using an authorized service facility of the instrument manufacturer.
2. Provide certification of this Work before reinstallation of each instrument.

3.05 COMMISSIONING

A. As specified in Section 01756 - Commissioning and Technical Sections.

B. Functional Testing:
1. Assist with troubleshooting and correcting instrumentation and control issues.

3.06 FIELD QUALITY CONTROL (NOT USED)

3.07 ADJUSTING

A. Control valves:
1. Stroke control valves, cylinders, drives and connecting linkages from the control system as well as local control devices and adjust to verify proper

control action, hand switch action, limit switch settings, torque settings, remote control actions, and remote feedback of valve status and position.

2. Check control valve actions and positioner settings with the valves in place to ensure that no changes have occurred since the bench calibration.

B. Make revisions necessary to the control system software, as directed by the Engineer.

1. It is understood that the Contractor knows and agrees that changes will be required in the control system software during commissioning.

3.08 CLEANING

A. Oxygen service devices including piping, valves, and appurtenances shall be cleaned for oxygen service and certified by a qualified inspector prior to placing into service.

B. Vacuum clean control panels and enclosures before process start-up and again after final completion of the project.

C. Clean panel surfaces.

D. Return to new condition any scratches and/or defects.

E. Wipe instrument faces and enclosures clean.

F. Leave wiring in panels, manholes, boxes, and other locations in a neat, clean, and organized manner:

1. Neatly coil and label spare wiring lengths.
2. Shorten, re-terminate, and re-label excessive spare wire and cable lengths, as determined by the Engineer.

END OF SECTION

SECTION 17100

CONTROL STRATEGIES

TABLE OF CONTENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Contractor-developed loop description submittal requirements.
   2. General programming requirements.
   3. Common control functions:
      a. General control and monitoring functions to be provided throughout the PCS system.
         1) These requirements apply to all systems and supplement the specific loop descriptions in Section 17101 - Specific Control Strategies and information indicated on the Drawings.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Clamp: Imposed upper and lower limits on setpoints to eliminate entries outside the allowable control parameters.
   2. Hardwired control: Control circuitry that does not utilize software to initiate functionality.
   3. Hardwired interlocks: A safety or protective feature that will interrupt operation of the equipment in all operating modes with no required operator intervention.
   4. Historize: To store data collected by a Supervisory Control and Data Acquisition system or Distributed Control system in a Historical Server or Historian for later use in trends and reports.
   5. Software interlocks: A safety or protective feature that will interrupt operation of the equipment when the PLC has control.
   6. Slew rate: Rate of change in respect to time.
   7. Watchdog timer: Timers imposed to test components such as discrete I/O to verify the health of the card.

1.04 SUBMITTALS

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.05 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PROGRAMMING REQUIREMENTS

A. General:
   1. Use variable names or aliases derived from tag and loop identification on the P&IDs for all process values.
      a. Submit names for Owner approval.
      b. Unless otherwise noted, utilize floating-point format for all PLC algorithms and calculations.
      c. Provide PLC logic to convert raw input values into engineering units in a floating-point format.
   2. Store all adjustable parameters in the PLC and configure so that an operator with sufficient security access can change the parameters from the LOI or HMI. Update and display the current value at all locations, regardless of where the last change was made.
   3. Reusable PLC code blocks:
      a. Develop and use new standard user defined function blocks (UDFBs) and user defined types (UDTs) where appropriate. One instance of each standard code block shall reside in each PLC and shall be referenced in main routines and subroutines.
      b. New code blocks that the Contractor would like to use as a standard shall be submitted to the Owner for review and approval.
      c. Provide complete library of standard code blocks used in the project to the Owner as part of O&M documentation.
   4. Documentation:
      a. Control logic shall be completely annotated including rungs, instructions, and tags.
      b. Each routine shall have a title and a detailed description of the control strategy represented by the control logic. Where parameters are passed to the routine, all parameters shall be defined in the routine description.
      c. Analog tag descriptions representing process variables shall include the engineering unit range of the analog variable.
      d. Digital tag descriptions shall include the On and Off state labels.
      e. Complete, grammatically correct sentences and terminology, consistent with water treatment processes, shall be utilized in the development of rung and routine descriptions.
      f. Equations developed in the process logic shall be fully documented in the rung or routine description. A description of each constant and variable utilized in the equation shall be defined including engineering units.
   5. Program slew rates for setpoints as needed to limit the effect of updated setpoints on the process:
      a. Provide for control setpoints and manual speed and position selections.
      b. Store new setpoints in 1 register, and gradually ramp the actual setpoint register at the slew rate until it reaches the new value.
      c. Provide operator access to change slew rates from the HMI.
   6. Saved setpoints:
      a. Provide an operator selection to save all setpoint values.
      b. Where possible, use a DFB or AOI to provide an operator selection to restore all setpoints to the initial start-up value.

c. Provide an operator selection to restore all setpoints to the last saved value.

7. Store a copy of adjustable parameters and accumulated and integrated totals in PCS:
   a. Upon re-loading of the PLC program, re-load these values to the PLC from PCS or processor memory card.
   b. PLCs provide a minimum 2-week data storage to provide for data accumulation and later communication to the Historian in the event of a network interruption.
8. Calculated values:
   a. Program calculations such that division by zero errors cannot occur.
   b. Prevent calculations from generating values that exceed the limits of the equipment or data type structures (integers) internal to the PLC.
   c. Configure counting functions (start counts and operation counts) to allow a minimum of 10,000 counts, and to roll-over to zero at an even decimal interval (1 followed by 4 or more zeros).
   d. Configure integrating functions to accurately accumulate the maximum rate from the instrument/equipment (totalizers, run time meters) for 30 years. Utilize manufacturer AOI/DFBs etc., where possible.
9. Timers:
   a. Provide programmable settling and proving timers in control sequences as required for starting and stopping of equipment to allow the process to settle to a steady state before proceeding with any additional control functions.
      1) Settling timers may be overridden by setting the timer to 0 seconds.
10. Control Panel status:
   a. Design the PLC system to function as a stand-alone unit that performs all of the control functions described in this Section completely independent from the functions of the PCS system PC-based operator interfaces:
      1) Failure of the PCS system shall not impact data acquisition, control, scaling, alarm checking, or communication functions of the PLC.
   b. Furnish a minimum of 1 screen that depicts the status of enclosures containing PLCs, communication equipment, UPS or I/O in the control system, including, but not limited to, the following:
      1) PLC cabinet over-temperatures from high temperature switch.
      2) Intrusion status on enclosures equipped with intrusion switches.
      3) AC power failure:
         a) Monitor ahead of UPS.
      4) DC power supply failure:
         a) For redundant power supplies, alarm when either power supply or the diode bridge fails.
      5) UPS failure signal.
      6) UPS Low Battery signal.
      7) Digital bus network Coupler and or Gateway failure signal.
      8) Ethernet Switch failure signal.
11. PLC system communication status:
   a. Furnish a minimum of 1 screen to display communication errors and status within the PCS:
      1) Communication between PCS and PLCs, PLC to PLC, PLC to RIO and PLC and or PCS to VCP.
      2) 4-20 mA HART interface cards.

3) Digital bus network status:
a) Profibus scanners.
4) Modbus Gateway modules.
5) Display status of each node, and summary of failures over the past 60 minutes.

b. Generate a communications alarm if any communication fault is detected or there is no response from a node for more than a user specified time.

c. In the event of communications loss:
1) Continue normal operation at each PLC.
2) Where control parameters are received over a communications link:
a) If a link fails where process elements use the remote value for closed-loop control, hold operating status, speed and position, of the process elements at their last state before the communication alarm, unless other I/O local to that PLC indicates shutdown or over-ride conditions:
(1) Ensure that the operator can control the process using PCI\S HAND mode at the local LOI.
b) If a link fails where process elements use the remote value to determine setpoints, continue to operate using the last value received:
(1) Provide a manual over-ride entry at the local LOI to allow an operator to enter a different value for any such remote signal.
(2) Generate an alarm whenever an over-ride value is in use.

B. Common control functions:
1. Incorporate common control functions into control loops and devices and into the control programming, whether or not specifically shown in the specific control descriptions or elsewhere in the Contract Documents.
2. Alarms:
a. Generate alarms within the PLC logic.
b. Indicate alarms at the LOI and HMI. Enable acknowledgement from either the HMI or the LOI.
c. Generate high, high-high, low, and low-low level alarms where indicated:
1) Provide an alarm reset deadband for each analog value to prevent excessive repeated alarms.
2) Provide logic and timers to inhibit analog alarms based on process events. For example, inhibit low flow alarms when a pump is stopped, or has not been running long enough to establish flow.
d. Flash alarm and fail conditions and their respective indicators on the PCS graphic screens and local indicating lights until the condition is acknowledged by the operator, even if the alarm condition is no longer present.
e. Once the alarm is acknowledged by an operator, display alarm conditions in a steady state (not flashing) while the alarm condition is still present:
1) Flash with a cycle rate of 1/2 second on and 1/2 second off.
f. Once the alarm has been cleared and the operator has acknowledged the alarm or fail condition, turn the graphic alarm indicator off.
g. For alarms that do not have inherent timers, provide an operator-adjustable proving timer to limit nuisance alarms, continuously adjustable from

zero seconds to 100 minutes. Initial setting of proving timers shall be zero seconds:
1) PLC shall start the timer when it first detects an alarm condition and shall only activate the alarm after the timer has expired.
2) If the alarm condition clears while the timer is running, the timer shall reset, and the alarm shall not be activated.

h. Use interlocks and proving timers to prevent alarms from operating due to power loss, except for loss of power alarms.
i. Furnish an alarm silence pushbutton at each PCM, LOI, or LCP with an audible alarm to signal the PLC to turn off the audible alarm until the next alarm occurs.
j. Lamp test: Furnish lamp test pushbuttons at each control panel with more than 10 pilot lights that illuminates all pilot lights on the panel:
1) May sequence through blocks of lights.
2) Minimum on time for each lamp during lamp test 15 seconds.
k. Horns and beacons:
1) Activate PCM horn and beacon on critical alarms and on other alarms as defined by the Facility Alarm Philosophy.
2) Deactivate PCM horn and beacon when PCM reset pushbutton is activated.
3) Silence PCM horn when PCM silence pushbutton is activated.
l. Dual analog instruments:
1) For applications where 2 or more analog instruments are measuring the same process variable:
a) Generate an operator adjustable percent deviation alarm.
b) Allow operator to take each instrument out of service when an instrument is out of service.

3. Where a reset is shown for counts, totals and times maintained in the PLC:
a. Provide a reset selection on the HMI screen that displays the value.
b. Provide a preset function on the HMI to allow an operator-entered value to become the current accumulated total.
c. Limit access to the reset and preset functions to operators with suitable security level.
d. Log the value before reset, operator, time, and date of reset in the PCS archive.
e. Log the value before preset, preset value, operator, time, and date of preset in the PCS archive.
4. Count starts for each piece of equipment (off to on transitions of running status) in the PLC:
a. Display total starts on PCS screens and provide a reset function.
b. Calculate number of starts for each day:
1) Display current day and previous day starts on PCS displays.
2) Do not reset daily start count when overall count is reset.
3) Archive starts for each day through PCS.
c. Calculate the number of starts per hour. Alarm when the number of starts per hour exceeds the manufacturer limit.
5. Where run time accumulation is indicated on the Drawings, or required in this Section, integrate accumulated run time to the nearest 0.1 hour whenever the running status input indicates that the equipment is running:
a. Display total run time in hours on PCS screens.

b. Where indicated, calculate total run time for each day:
    1) Display current day and previous day run time on the HMI to the nearest 0.1 hour.
    2) Do not reset daily run time when overall time is reset.
    3) Archive run time for each day through PCS.

6. For all monitored analog values:
    a. Convert values to engineering units in floating-point format within the PLC.
    b. Maintain trends in PCS.
        1) Display minima and maxima on the HMI, and archive through PCS.
    c. Flows and weights:
        1) Totalize flows in the PLC logic:
            a) Where totalized flows are input to a discrete input, count input pulses and multiply by the volume per pulse.
            b) Where no totalizer input is shown, integrate the analog input over time.
            c) Display totals on the HMI and LOI.
            d) Archive totals to the historical database through PCS.
    d. Generate an alarm whenever an over-ride value is in use.
    e. Calculate hourly, daily, and monthly averages:
        1) Calculations shall be performed by the PLC.
        2) Display averages on the HMI, and archive through PCS.
        3) Display minima and maxima on the HMI, and archive through PCS.
    f. Calculate minimum and maximum values each day, and month:
        1) Calculations may be performed by the PLC or PCS.
        2) Display minima and maxima on the HMI, and archive through PCS.
7. Analog data processing:
    a. Engineering units conversion:
        1) Use engineering units for all analog point values. Convert analog inputs to engineering units.
    b. Analog magnitude checking:
        1) Provide upper and lower limits to prevent operator-entered values (setpoints, etc.) from falling outside acceptable limits.
8. Tank and vessel levels:
    a. Display as both a level (typically in feet) and a volume (typically in gallons):
        1) Some individual displays may be only level or volume, when agreed to by the Owner and Engineer during screen review meetings.
    b. Monitor rate of change of volume on tanks and vessels:
        1) Establish the maximum withdraw rate at which the volume should decrease (all pumps or feeders operating at maximum output). Generate an alarm whenever the volume decreases faster than this rate.
        2) Establish the maximum fill rate at which the volume should increase when filling.
            a) Generate an alarm whenever the volume increases faster than this rate.
            b) Verify tank and vessel level is fluctuating to verify the validity of the IO register.
            c) If it is determined the register is not active or failed in a manner that leaves a stagnant value generate an alarm.

9. I/O filtering and processing:
    a. Analog input filtering:
        1) For each analog input provide an adjustable first order filter, for the purpose of smoothing out spikes and other noise for analog transmitter input signals. By default, configure analog inputs with no filtering affect.
        2) Monitor analog input signal quality:
            a) Over range: Input value is above the normal range (typically over 21 mA).
            b) Under range: Input value is below the normal range (typically under 3 mA, indicating a probable broken connection).
            c) Generate alarms for over or under range inputs.
            d) Do not use over or under range values for control or calculation purposes:
                (1) Where a second instrument is provided to monitor the same condition (a redundant instrument, or additional instruments furnished for averaging or different operating modes), and has a valid signal, use that input for control.
        3) Digital input filtering (proving timer):
            a) Provide an adjustable time delay function (0 to 10 seconds) on discrete input for the purpose of de-bouncing.
            b) By default, discrete inputs shall be configured with de-bounce timers set to zero seconds.
10. Instrument scaling (HMI/LOI):
    a. Provide 1 or more maintenance screens to display ranges and trigger points for all field instruments:
        1) For analog instruments, use input scaling values in the PLC to determine minimum and maximum calibration points.
        2) For discrete instruments, display calibrated pick-up and drop-out values.
11. PCS HAND-OFF-AUTO:
    a. Where indicated, provide HAND-OFF-AUTO and START-STOP selections in the PCS, accessed from an LOI or HMI for operators with sufficient security, to provide the following operating modes:
        1) PCS AUTO: Normal, automatic control mode of the strategy which allows full PLC control in response to process conditions and programmed sequences.
        2) PCS HAND: Enables PCS Manual control where control decisions are made by an operator through the PCS START-STOP, OPEN/CLOSE, or other selections as indicated.
        3) PCS OFF: Automated PCS control is disabled, and PLC calls for all associated equipment to stop and valves to close or go to their identified safe state.
        4) Program the PLC so that switching a strategy between AUTO and HAND (either direction) occurs with a smooth transition.
            a) Keep running or position status unchanged when control is switched to HAND until a change is requested using the operator selections (START, STOP, OPEN, CLOSE).
            b) Keep running and position status unchanged when control is switched to AUTO until the control logic determines a change is required.

12. Display the current status of all operator selections (PCS HAND/AUTO, PCS START/STOP, etc.) on LOI and HMI.
13. Interlocks:
    a. Implement software interlocks where indicated to place equipment in a safe condition in response to impending hazardous process conditions. Apply software interlocks when equipment is operating in PCS AUTO or PCS HAND.
14. Permissives:
    a. Implement software permissives where indicated to prevent equipment from starting in an unsafe condition.
    b. Apply software permissives when equipment is operating in PCS AUTO or PCS HAND.
15. Process control algorithms:
    a. Jog and hold:
        1) When the error between the process variable and the setpoint is beyond a setpoint deadband:
            a) Jog valve or ramp speed in the required direction for a preset "Jog Time" or until the process variable reaches or passes the setpoint.
            b) Hold speed or position through a setpoint "Hold Time."
            c) Continue alternating jog and hold until the error exceeds the deadband.
        2) Provide operator access to Jog Time and Hold Time setpoints from the HMI.
    b. PID algorithms:
        1) Provide a PID faceplate with the following displays and functions for each PID control algorithm:
            a) Display Output, CV.
            b) Display Setpoint, SP.
            c) Display Process Variable, PV.
            d) Allow for operator selection of Automatic or Manual control of the output.
            e) Under Manual control of output allow the operator to enter the desired output value.
            f) Allow for input of the 3 Proportional, Integral, and Derivative tuning parameters.
            g) Configure PID loops to prevent reset windup when controlled equipment is operating in Manual (local or PCS), or when the equipment has reached a physical limit.
            h) When controlled equipment is being operated in remote PCS HAND, configure the PID function to track the process variable to provide a smooth transfer between Manual and Automatic modes.
            i) Provide selectable slew rates with adjustable setpoints to allow the PID algorithm to slowly ramp to its final value to minimize system disturbance.
16. Equipment alternating and sequencing:
    a. Distribute number of starts and run time equally between identical equipment.

17. Motor control:
    a. Monitor the device's LOCAL-OFF-REMOTE (LOR) switch (the hard-wired switch at the MCC, drive or equipment) to determine when the PLC has control of the associated equipment:
        1) Display current REMOTE status on the PCS screens.
    b. Monitor the device's running status from the starter auxiliary or run status input:
        1) Display the current status (running or stopped) on the PCS screens.
        2) Use status to calculate total run time and daily run time, and to count total starts and daily starts.
        3) Provide time stamp for each start.
        4) For motors 200 horsepower and greater, provide software to prevent exceeding the manufacturer's recommended maximum starts per hour.
    c. When equipment control has been given to the PLC as reported by the LOCAL-OFF-REMOTE switch, allow selection of PCS AUTO or PCS HAND control modes based upon operator selection using the PCS screens.
    d. Starting, stopping and running when the device LOR is in LOCAL:
        1) With the LOR switch in the LOCAL position, the motor is controlled by the START and STOP pushbuttons.
        2) With the LOR switch in the OFF position, the motor is prohibited from running.
        3) With the LOR switch in the REMOTE position, the motor is controlled remotely.
    e. Starting, stopping and running when the device LOR is in REMOTE:
        1) When the motor is expected to be running (PLC has issued a START or RUN due to process conditions or operator selection), LOR is in REMOTE, and the device is not reported to be running, start an operator adjustable "Control Activation" timer:
            a) Provide "Control Activation" timers for each piece of controlled equipment:
                (1) If the LOR and required running status do not change, and the PLC does not receive running status within the "Control Activation" time period:
                    (a) De-activate the output.
                    (b) Place the device in a "Failed" state.
                    (c) Generate a "Failed to Respond" alarm.
        2) When the motor is not expected to be running (PLC has issued a STOP or removed the RUN output), LOR is in REMOTE, and the device is reported to be running, start the "Control Activation" timer:
            a) If the LOR and required stopped status do not change, and the PLC does not lose the running status within the "Control Activation" time period:
                (1) Keep the RUN output off or the STOP output on.
                (2) Place the device in a "Failed" state.
                (3) Generate a "Failed to Respond" alarm.

3) Re-establish PLC control of a device in a “Failed” state only after one of the following:
    a) An operator turns the device’s LOR switch out of REMOTE, and back to REMOTE (i.e., REMOTE input to the PLC cycles off and back on).
    b) An operator acknowledges the fault from the PCS.

f. Where motor winding high temperature switches or RTD temperature elements are shown, generate an alarm when high temperature is sensed (contact opens or temperature above the high alarm setpoint), but do not stop the motor unless otherwise indicated.

g. Motor equipped with current detection shall shut down and report a “failed” status on detection of high current.

h. Control 2-speed motors similar to other motors, except as listed below:
    1) Motor states are RUN-FAST, RUN-SLOW, and STOP.
    2) Start 2-speed motors in the RUN-SLOW state. If or when the high speed is required (RUN-FAST operator selection or process conditions), transition to RUN-FAST after a designated time.
    3) When transitioning from RUN-FAST to RUN-SLOW, remove the RUN-FAST output or issue a STOP, then wait for a “Fast to Slow” time delay before energizing the RUN-SLOW or START-SLOW output.

i. Speed control:
    1) Modulate speed on VFD-driven motors using jog and hold, or PID control algorithms to maintain process conditions as described in the specific loop descriptions.
    2) Operate speed control within a pre-defined range:
        a) Minimum speed as determined by equipment manufacturer. The higher of:
            (1) Minimum motor speed to maintain adequate cooling for the type of load driven (constant or variable torque).
            (2) Minimum equipment speed, such as minimum speed to deliver flow or to deliver minimum flow for equipment cooling or lubrication.
        b) Maximum speed 100 percent (60 hertz) or as identified by equipment manufacturer.
        c) Scale analog signals used to control speed at 0 to 100 percent of the operable speed range for the equipment.
    3) Where multiple equipment may operate together to maintain the same process condition, alternatively referred to as “Lead/Lag”:
        a) Start the first equipment at a preset starting speed.
        b) When 1 or more equipment is running and the speed control algorithm reaches a preset “Start Next” speed value (initially 95 percent of speed range) through a preset time delay:
            (1) Start the next available equipment at the preset starting speed.
            (2) Ramp up the started equipment and ramp down the previously running equipment to the mid operating speed (adjustable in the PLC). Determine preset values for each condition based on equipment and system characteristics to provide approximately the same total flow or process condition with the new load running at the mid speed (for example if 1 pump is running and the second pump will be

added, then the total flow of both pumps running at mid operating speed should be approximately the same as flow of 1 pump at Start Next speed).

(3) Once both equipment reach the mid operating speed, resume the speed control algorithm for those equipment.

(4) Operate equipment at the same speed following the output of the speed control algorithm.

c) When 2 or more pieces of equipment are running, monitor for a "Stop Next" condition:

(1) Where flow rate is monitored, use a preset "Stop Next" flow rate for each possible number and combination of equipment:

(a) Determine initial "Stop Next" speed based on the flow that can be provided with 1 fewer piece of equipment running at a speed slightly below the "Start Next" speed.

(2) When the "Stop Next" condition exists through a preset time delay:

(a) Ramp speed of running equipment except for the equipment to be stopped up to a preset value based on the number of items running. Determine preset values for each condition based on equipment and system characteristics to provide approximately the same total flow or process condition with 1 fewer load running (typically slightly below the preset "Start Next" speed) while ramping speed of equipment to be stopped down to the preset minimum speed.

(b) Operate remaining equipment at the same speed following the output of the speed control algorithm. Stop the load once it reaches minimum speed.

18. Gate and valve control:

a. Monitor the device's LOCAL-STOP-REMOTE (LSR) switch(es) (the integral switch in the actuator or hard-wired switch at the local control station):

1) Display current REMOTE status on PCS screens.

b. Start an "Open Activation" timer whenever the device is expected to be open (PLC has issued an OPEN command in PCS AUTO, or OPEN was selected in PCS HAND):

1) Initially set "Open Activation" time to twice the normal opening time.

2) If the LSR position and open command do not change, and the PLC does not receive fully open status feedback within the "Open Activation" time period:

a) De-activate the open output.

b) Place the device in a "Failed" state.

c) Generate a "Failed to Open" alarm.

c. Start a "Close Activation" timer whenever the device is expected to be closed (PLC has issued a CLOSE command in PCS AUTO, or CLOSE was selected in PCS HAND):

1) Initially set "Close Activation" time to twice the normal closing time.

2) If the LSR position and close command do not change, and the PLC does not receive fully closed status feedback within the “Close Activation” time period:
    a) De-activate the close output.
    b) Place the device in a “Failed” state.
    c) Generate a “Failed to Close” alarm.

d. Limit the number of open/close /commands so that it does not exceed the manufacturer requirements.

e. For modulating valves (valves controlled from either a 4 to 20 mA signal or digital communications command) with position feedback, start a “Position Error” timer whenever the position feedback differs from the required position command by more than a setpoint error when the LSR is in REMOTE:
    1) For analog modulating devices, error is determined by position feedback differing from position command by more than the setpoint error.
    2) For discrete modulating devices, error is determined by feedback not changing in the correct direction, or changing at less than a setpoint rate, when the OPEN or CLOSE PLC output is active.
    3) Initially set the “Position Error” time to 60 seconds.
    4) If the LSR position does not change, and position error stays outside of the setpoint error through the “Position Error” time period:
        a) Place the device in a “Failed” state.
        b) Generate a “Position Fail” alarm.

f. Provide separate time delay settings for each function and for each device.

g. If the valve position inputs indicate an invalid state (i.e., valve open and closed at the same time), place the device in a “Failed” state and generate an “Invalid State” alarm.

h. Re-establish PLC control of a device in a “Failed” state after one of the following:
    1) An operator turns the device’s LSR switch out of REMOTE and back to REMOTE (i.e., REMOTE input to the PLC cycles off and back on).

i. For all alarm conditions, control other devices (as stopping pumps, etc.) as stated in the individual loop descriptions to make the system safe.

j. For discrete modulating valves (valves positioned to intermediate positions to control process values through discrete OPEN and CLOSE outputs), count the number of actuations (OPEN or CLOSE commands) per hour in the PLC:
    1) Display count on the HMI.

19. Chemical systems (LOI/HMI):
    a. Provide the following chemical system screens:
        1) Where 1 LOI manages more than 1 chemical system, a main menu screen will allow the operator to access the individual chemical system screens using software keys.
        2) One or more screens for each individual chemical system controlled at that location, containing:
            a) All status displays (running, failed, etc.).
            b) Selections (lead/lag, which process flow to pace to, etc.).
            c) Setpoint entry and display.
            d) Calculated feed requirement (result of flow pacing calculation) in engineering units (typically milligrams of chemical per minute).

e) Output signal to feeder in percent of full span.
f) Actual chemical flow rate from flowmeter (where shown).
g) Process flow rate(s) used to pace each chemical on the individual chemical screens (PROC FLOW):
(1) Where different process flows can be selected for flow pacing, display and identify the selected source.

b. Chemical system calculations: Perform calculations as indicated on the Drawings and in the individual loop descriptions. Use the following assumptions, unless otherwise noted:
1) Where chemical flow feedback is not used, assume feeder output is linear in response to control signal.
2) Zero signal (typically 4 mA) produces zero flow.
3) Perform flow-pacing calculations using as indicated on the Drawings or described in the individual loop descriptions.

c. Provide the setpoints indicated on the Drawings and in the individual loop descriptions. Typical setpoints include:
1) Q_C: Chemical pump flow rate measured from calibration column at maximum feeder output (typically in gallons of solution per hour).
2) D: Desired chemical concentration in the process stream in engineering units (typically milligrams of chemical per liter of process fluid).
3) Q_f: Process flow measurement upstream of dosage point (typically in million gallons per day of process fluid).
4) ρ: Density of the chemical solution to be fed (typically in pounds per gallon). Used to calculate the concentration of the chemical in the solution.
5) C: Concentration of the chemical in the solution to be fed (typically in decimal format. For example, 0.25 for 25 percent chemical solution).

d. Provide the selections indicated on the Drawings and in the individual loop descriptions. Typical selections include:
1) OPEN/CLOSED LOOP:
a) Selection of method of controlling chemical flow-paced feed rate.
b) OPEN LOOP: Signal to feeder is based on feeder calibration (Q_C) to deliver calculated chemical solution feed rate. Chemical solution flowmeter is not used for control.
c) CLOSED LOOP: Chemical feed rate is directly controlled using the calculated chemical solution feed rate as the setpoint, and the flow rate from the chemical solution flowmeter as the process variable.
2) TRIM FACTOR: Refer to the equations below.

e. Chemical control algorithms:
1) Flow pacing algorithm:
a) Operator selects a desired dose and the control system adjusts the chemical feed rate to dose based on process flow, chemical concentration, and feeder calibration.
b) Calculation is as follows (units may vary from those shown in the calculation below):

Use the following equation to calculate the chemical pump flow rate:

$$Q_C = \frac{D \cdot Q_f \cdot 8.33}{C \cdot p \cdot 24}$$

Where:
Q_C = Chemical Pump Flow Rate (gal/hr)
D = Dose setpoint (mg/L)
Q_f = Process Flow Measurement (MGD)
8.34 = Conversion Factor [(lbs • L)/(MG • day • mg)]
C = Chemical Concentration (ratio in decimal format. For example, use 0.25 for 25 percent chemical solution)
p = Chemical Density (lbs/gal)
24 = Conversion Factor (days to hours)

Use the following equation to calculate the chemical pump speed control setpoint:

$$S = \frac{Q_C}{Q_{max}}$$

Where:
S = Chemical Pump Speed Control Setpoint (0 to 100 percent)
Q_C = Flow Setpoint From Equation Above (gal/hr)
Q_{max} = Maximum Pump Flow Setpoint Based on Calibration Column Test (gal/hr).

2) Flow pacing with closed loop algorithm:
   a) Operator selects a desired dose and the control system adjusts the speed of the chemical feeder through a speed control signal to match the measured chemical feed rate to a flow rate setpoint.
   b) This flow rate setpoint shall be derived from the process flow and operator setpoints for dosage and concentration.
   c) Calculation is as follows (units may vary from those shown in the calculation below):

   Use the following equation to calculate the chemical pump flow rate:

$$Q_C = \frac{D \cdot Q_f \cdot 8.33}{C \cdot p \cdot 24}$$

   Where:
   Q_C = Chemical Pump Flow Rate (gal/hr)
   D = Dose setpoint (mg/L)
   Q_f = Process Flow Measurement (MGD)
   8.34 = Conversion Factor [(lbs • L)/(MG • day • mg)]
   C = Chemical Concentration *(ratio in decimal format. For example, use 0.25 for 25 percent chemical solution)*
   p = Chemical Density (lbs/gal)
   24 = Conversion Factor (days to hours)

3) The speed (control variable) of the chemical feed pump shall be determined by the output of a PID controller.
   a) Setpoint of the PID controller shall be the result of the equation in the paragraph above.
   b) Process variable (feedback) shall be the chemical feed flow as measured by a flow meter on the discharge of the chemical feed pump.
4) Flow pacing with analyzer trim algorithm:
   a) Operator selects a desired dose and desired analyzer setpoint band and the control system adjusts the chemical feed rate to

dose based on process flow, chemical concentration, process analyzer output, and feeder calibration.

b) Calculation is as follows (units may vary from those shown in the calculation below):

Use the following equation to calculate the chemical pump flow rate pre-trim:

$$Q_{CPT} = \frac{D \cdot Q_f \cdot 8.3334}{C \cdot p \cdot 24}$$

Where,
Q_{CPT} = Chemical Pump Flow Rate Pre-Trim (gal/hr)
D = Dose setpoint (mg/L)
Q_f = Process Flow Measurement (MGD)
8.34 = Conversion Factor [(lbs • L)/(MG • day • mg)]
C = Chemical Concentration (ratio in decimal format. For example, use 0.25 for 25 percent chemical solution)
p = Chemical Density (lbs/gal)
24 = Conversion Factor (days to hours)

Use the following equation to calculate the trim factor:

$$TF = Q_{CPT} \cdot 0.1 \cdot \left(\frac{AI - \frac{1}{2}(QAH + QAL)}{-\frac{1}{2}(QAH - QAL)} \right)$$

Where:
TF = Trim Factor (gal/hr)
Q_{CPT} = Chemical Pump Flow Rate Pre-Trim (gal/hr)
AI = Analyzer Output to be Used For Trim Calculation
QAH = Analyzer Band High Value
QAL = Analyzer Band Low Value

Use the following equation to calculate the chemical pump flow rate with trim:

$$Q_{CWT} = Q_{CPT} + TF$$

Where:
Q_{CWT} = Chemical Pump Flow Rate with Trim (gal/hr)
Q_{CPT} = Chemical Pump Flow Rate Pre-Trim (gal/hr)
TF = Trim Factor (gal/hr)

Use the following equation to calculate the chemical pump speed control setpoint:

$$S = \frac{Q_{CWT}}{Q_{max}}$$

Where:
S = Chemical Pump Speed Control Setpoint (0 to 100 percent)
Q_{CWT} = Flow Setpoint from Equation Above (gal/hr)
Q_{max} = Maximum Pump Flow Setpoint Based on Calibration Column Test (gal/hr).

5) Flow pacing with closed loop and analyzer trim algorithm:

a) Operator selects a desired dose and desired analyzer setpoint band and the control system adjusts the speed of the chemical feeder through a speed control signal to match the measured chemical feed rate to a flow rate setpoint.

b) An additional control algorithm is used in the calculation to fine-tune the feed based on an analytical measurement as measured by the process analyzer.

Use the following equation to calculate the chemical pump flow rate pre-trim:

$$Q_{CPT} = \frac{D \cdot Q_f \cdot 8.34}{C \cdot p \cdot 24}$$

Where:
Q_{CPT} = Chemical Pump Flow Rate Pre-Trim (gal/hr)
D = Dose setpoint (mg/L)
Q_f = Process Flow Measurement (MGD)
8.34 = Conversion Factor [(lbs • L)/(MG • day • mg)]
C = Chemical Concentration (ratio in decimal format. For example, use 0.25 for 25 percent chemical solution)
p = Chemical Density (lbs/gal)
24 = Conversion Factor (days to hours)

Use the following equation to calculate the trim factor:

$$TF = Q_{CPT} \cdot 0.1 \cdot \left(\frac{AI - \frac{1}{2}(QAH + QAL)}{-\frac{1}{2}(QAH - QAL)} \right)$$

Where:
TF = Trim Factor (gal/hr)
Q_{CPT} = Chemical Pump Flow Rate Pre-Trim (gal/hr)
AI = Analyzer Output to be Used For Trim Calculation
QAH = Analyzer Band High Value
QAL = Analyzer Band Low Value

Use the following equation to calculate the chemical pump flow rate with trim:

$$Q_{CWT} = Q_{CPT} + TF$$

Where:
Q_{CWT} = Chemical Pump Flow Rate with Trim (gal/hr)
Q_{CPT} = Chemical Pump Flow Rate Pre-Trim (gal/hr)
TF = Trim Factor (gal/hr)

6) The speed (control variable) of the chemical feed pump shall be determined by the output of a PID controller.
   a) Setpoint of the PID controller shall be the result of the equation in the paragraph above.
   b) Process variable (feedback) shall be the chemical feed flow as measured by a flow meter on the discharge of the chemical feed pump.

20. Breaker status:
    a. Display the following data to the extent it is available from the specified device:
       1) Open.
       2) Closed.
       3) Tripped.
       4) Ground fault.
       5) Settings.
       6) Racked out.

21. Power data:
    a. Retrieve data from:
        1) Power Quality Meters (PQMs) at 480 V.
        2) Main Breaker Protective Relays on 12.47 kV Switchgear.
        3) Generator Master Control Panel.
        4) Digital bus networks, as indicated.
        5) Where available, use EtherNet IP communications.
    b. Display the following data (to the extent it is available) from the specified device.
        1) Current XXXX.X A:
            a) A-Phase.
            b) B-Phase.
            c) C-Phase.
        2) Volts: XXXX.X V:
            a) A-Phase.
            b) B-Phase.
            c) C-Phase.
        3) Reactive power: XXXX.X kVAR.
        4) Real power: XXXX.X kW.
        5) Apparent power: XXXX.X kVA.
        6) Power factor: 0.XX.
        7) Energy: XXXXXXX kW*hr.
        8) Demand peak: XXXX amp.
        9) Demand peak: XXXX kW.
    c. For engine/generator system monitoring, also display percent of rated output.
22. Power Supply and Distribution displays Power Quality Meters display:
    a. In addition to the Power Data listed above, display the following (where available) from PQMs, Protective Relays, and Generator Master Control Panel:
        1) Frequency: Hertz.
        2) THD (current and voltage): Up to 31st harmonic.
    b. Calculate, indicate, historize, and trend data in a 12.47 kV Meter Table that lists measurements from the following Protection Relays:
        1) Protection Relay on 52-G1.
        2) Protection Relay on 52-G2.
        3) Protection Relay on 52-M1.
        4) Protection Relay on 52-M2.
        5) Protection Relay on 52-M3.
        6) Display calculated values for “Load At 12.47 kV”, which sums the current, kW, and kW-hr values for all 5 Protection Relays.
        7) Display calculated values for “Load At 480 V”, which sums the current, kW, and kW-hr values for all PQM meters.
        8) Display calculated values for “Transformer and Line Losses”, which subtracts “Load at 480 V” from “Load At 12.47 kV” for current, kW, and kW-hr values for all PQM meters.
    c. Display the data in a 480 V Meter Table that lists measurements from all power quality meters on the plant.

23. Digital bus starters, RVSS and VFDs equipped with EtherNet IP communications:
    a. Communicate and display all values listed in the equipment specifications, indicated on the Drawings, or listed below.
    b. Communicate start and stop commands and receive running feedback over the fieldbus network.
    c. Provide data entry screen for the cost of electricity in dollars per (kw*hr), which will be used in calculations for display.
    d. Monitor the following additional values, and display on the HMI:
        1) Motor current, phase A, B, and C.
        2) Over current alarm.
        3) Under current alarm.
        4) Running status.
        5) Phase loss.
        6) Stall.
        7) Number of starts.
        8) History of past 5 trips.
    e. Calculate, indicate, historize, and trend, the following additional values:
        1) Full Load Amps (static value; Engineer will provide).
        2) Average Motor Operating Current.
        3) Run Time (Hours).
        4) Operating Hours (Hours/Year).
        5) Average Load Factor (equals Average Motor Current Operating Current/Full Load Amps) - *display as a percentage.*
        6) Annual Energy Use (kW*hr).
        7) Annual Operating Cost (dollars).
        8) Percent of Site Electric Use (equals Annual Energy Use/Sum of Annual Energy (kW*hr) values for all PQM meters).
    f. For variable frequency drives:
        1) Speed command.
        2) Speed feedback.
    g. For RVSS, variable frequency drives, and where otherwise shown or available, monitor the following over the digital bus network:
        1) Line voltage.
        2) Power.
        3) Power factor.
        4) Over voltage alarm.
        5) Under voltage alarm.
        6) Over current alarm.
        7) Under current alarm.
        8) Indicate, historize, trend, and alarm data as indicated in the Digital I/O Tables on the Drawings.
24. Calculate, indicate, historize, and trend plant-wide calculated values for kW by the following groups.
    a. Calculated values (summed from starter data for all equipment within the groups identified below):
        1) Demand peak: XXXX amp.
        2) Demand peak: XXXX kW.
        3) Electric Power Consumption, by Process Group (kW): XXXX kW.

4) Electric Power Consumption, by Process Group (percent): XX.XX percent (equals Electric Power Consumption, by Process Group (kW)/Sum of Electric Power Consumption on all 480 V Meters).
5) Electric Energy Consumption, by Process Group (kW*hr): XXXX kW*hr.
6) Electric Energy Consumption, by Process Group (percent): XX.XX percent (equals Electric Energy Consumption, by Process Group (kW)/Sum of Electric Energy Consumption on all 480 V Meters).

b. Display a Process Energy Consumption Table that lists the calculated values for each of the identified groups.
c. Display a Process Energy Pie Graph that portions wedges according to the values calculated in Electric Energy Consumption, by process group (5). Label wedges, (with numeric percentage), for groups to cover at least 90 percent of the Pie Graph. Remainder wedge of pie graph area can be labelled as “Other” (with numeric percentage).

25. Instruments equipped with digital bus communications:
    a. Communicate and display all values listed in the equipment specifications, indicated on the Drawings, or listed below:
        1) Instrument diagnostics.
        2) Communications health.
        3) Process variable.
        4) Alarm summary.
        5) All totalizers (if applicable).
        6) Indicate, historize, trend, and alarm data as indicated in the Digital I/O Tables on the Drawings.
26. Calculate, indicate, historize, and trend calculated values for additional, process-specific measurements. Algorithms will be provided by the Engineer.
    a. Influent:
        1) Influent flows (diurnally) vs. time (mgd vs. hours for 2 weeks, running).
        2) Influent flows (daily vs. time (mgd vs. day of the week for 1 week, running).
        3) Influent flows (diurnally) vs. time (mgd vs. month of the year for the last 3 years, running).
    b. Aeration basins:
        1) BOD loading rate vs. time.
        2) MLSS in Aeration Basins vs. time.
        3) Solids retention time (total and aerobic) vs. time.
        4) Aerobic solids retention time and WW temperature vs. time.
        5) Aerobic solids retention time and WAS load vs. time.
        6) Aerobic solids retention time and MLSS vs. time.
        7) Sludge volume index vs. time.
        8) Effluent ammonia and nitrate, phosphorus vs. time.
    c. Secondary clarifiers:
        1) Surface overflow rate vs. time.
        2) Solids loading rate vs. time.
        3) Effluent TSS vs. time.
        4) Solids blanket depth vs. time.
        5) RAS flows and percent of influent vs. time.
    d. Effluent.
    e. Solids treatment.

f. Plant-wide process measurements:
    1) Surface overflow rate vs. time.
    2) Solids loading rate vs. time.
    3) Effluent TSS vs. time.
    4) Solids blanket depths vs. time.
    5) RAS flows and percent of influent vs. time.

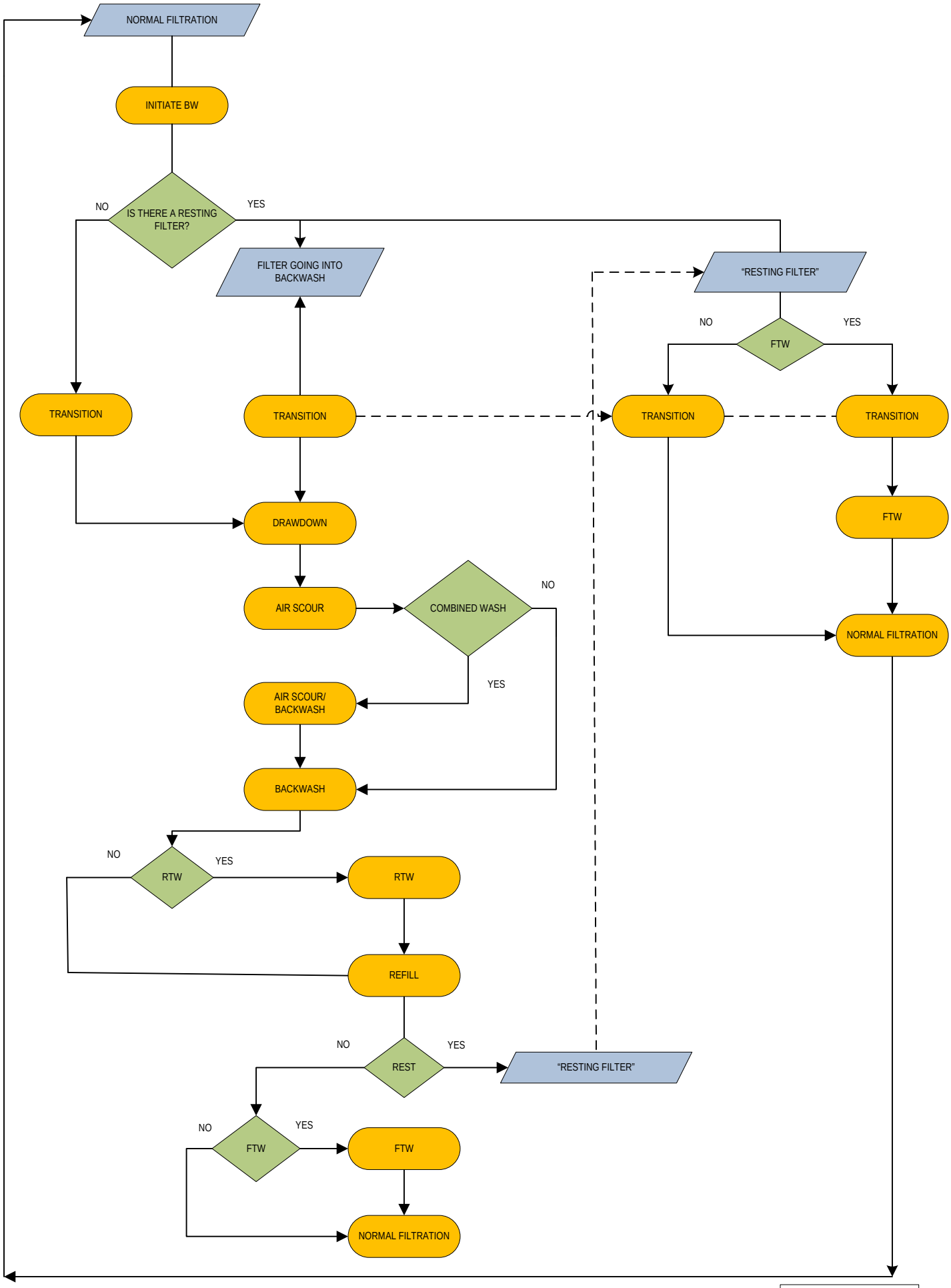
27. Valves and gate operators equipped with digital bus communications:
    a. Communicate and display all controls and data listed in the equipment specification, as indicated on the Drawings, or listed below:
        1) Open, close, or direct position commands.
        2) Fully open and closed status.
        3) Position.
        4) High torque, overload and other applicable alarms.
        5) Indicate, historize, trend, and alarm data as indicated in the Digital I/O Tables on the Drawings.
    b. Establish initial torque curves using the manufacturer's software for performance tracking and wear.
28. Power failure:
    a. Retain all operating setpoints during power failure.
    b. Restore plant operation to the state it was before the power loss:
        1) Store the operating state of all major equipment and systems in the PLC and retain the last state during a power loss.
    c. Provide an operator selection to permit the plant to re-start. Once re-start is selected:
        1) Allow plant loads to re-start and allow loads to sequence on and ramp up following normal control logic. Where loads were operating in PCS HAND, restore their operation to the state before the power loss.
        2) Use the logic described above for preventing concurrent starts to provide necessary delays between each start.
    d. Operating on generator power:
        1) Include running and starting kW and kVA requirements for each major equipment and system in registers in the PLC:
            a) Where running load can vary due to speed, valve position, etc., use the normal starting value plus 25 percent of the difference between the maximum and minimum values.
        2) Inhibit starting of loads from process control logic and from operator selection (in PCS HAND) that will exceed generator capability.
        3) Generate the following alarms:
            a) Generator near capacity: When measured kW or kVA reaches 90 percent of the rating of running generators.
            b) Generator at capacity: When measured kW or kVA reaches 95 percent of the rating of running generators.
            c) Unable to start: When an operator selects a load exceeding the generator's starting or running capacity.
            d) Insufficient capacity: When the control system needs to start a load but is inhibited due to generator capacity.
        4) Whenever the generator at capacity alarm is active, inhibit the starting of any loads, the increase in the speed of all control loops, and other changes that would increase the electrical load.

5) Display the following power system data on the HMI and LOI in numerical and graphical formats:
   a) Available power.
   b) Current power demand.
   c) Capacity of the generator.
   d) Current power demand load as a percentage of capacity.
   e) Generator frequency.

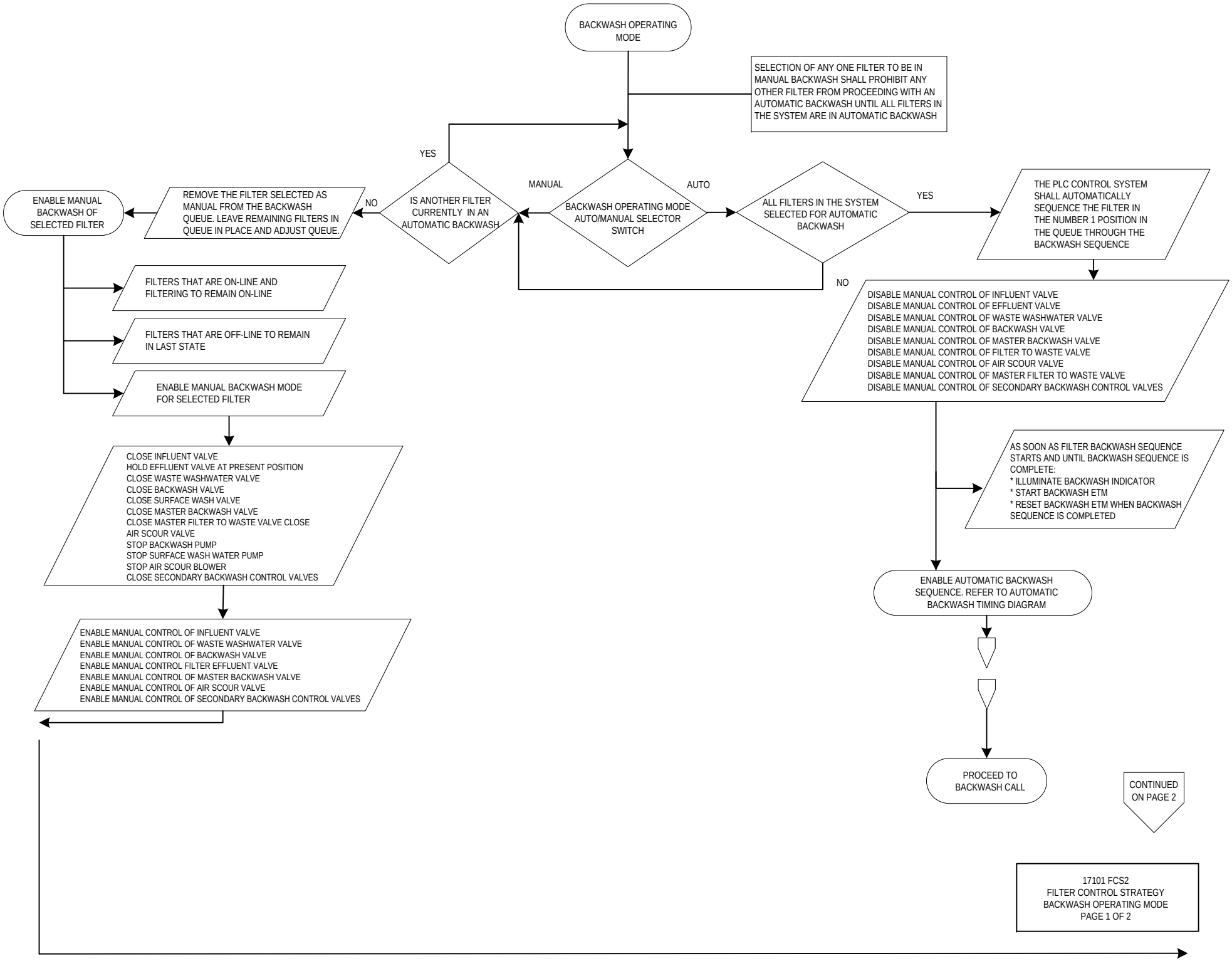
3.02 COMMISSIONING

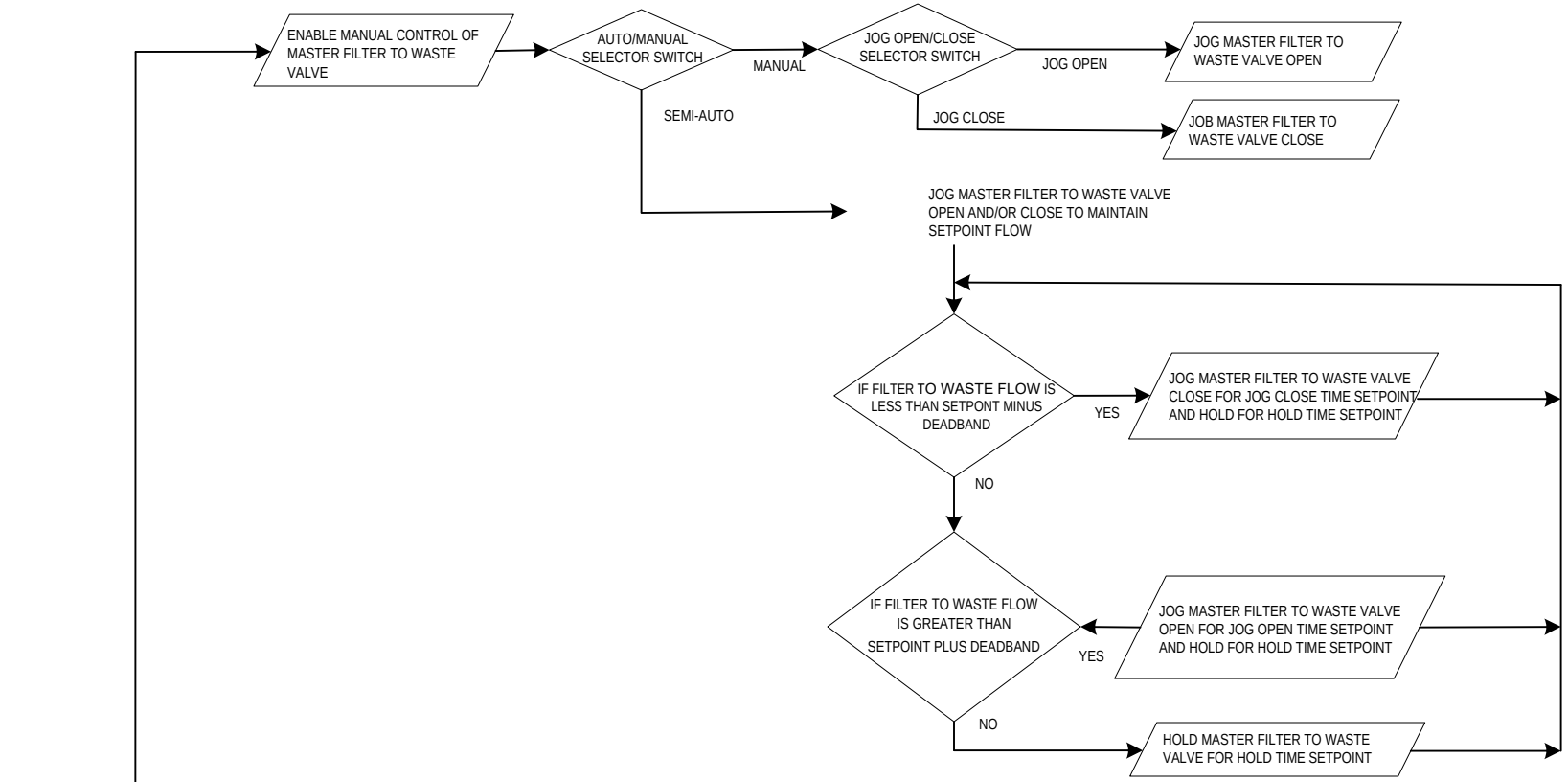
A. As specified in Section 01756 - Commissioning.

END OF SECTION



17101 FCS1
BACKWASH SEQUENCE
OVERVIEW FLOW CHART


BACKWASH OPERATING MODE
SELECTION OF ANY ONE FILTER TO BE IN MANUAL BACKWASH SHALL PROHIBIT ANY OTHER FILTER FROM PROCEEDING WITH AN AUTOMATIC BACKWASH UNTIL ALL FILTERS IN THE SYSTEM ARE IN AUTOMATIC BACKWASH
BACKWASH OPERATING MODE AUTO/MANUAL SELECTOR SWITCH
MANUAL
AUTO
ALL FILTERS IN THE SYSTEM SELECTED FOR AUTOMATIC BACKWASH
YES
THE PLC CONTROL SYSTEM SHALL AUTOMATICALLY SEQUENCE THE FILTER IN THE NUMBER 1 POSITION IN THE QUEUE THROUGH THE BACKWASH SEQUENCE
NO
IS ANOTHER FILTER CURRENTLY IN AN AUTOMATIC BACKWASH
YES
REMOVE THE FILTER SELECTED AS MANUAL FROM THE BACKWASH QUEUE. LEAVE REMAINING FILTERS IN QUEUE IN PLACE AND ADJUST QUEUE.
NO
ENABLE MANUAL BACKWASH OF SELECTED FILTER
FILTERS THAT ARE ON-LINE AND FILTERING TO REMAIN ON-LINE
FILTERS THAT ARE OFF-LINE TO REMAIN IN LAST STATE
ENABLE MANUAL BACKWASH MODE FOR SELECTED FILTER
CLOSE INFLUENT VALVE
HOLD EFFLUENT VALVE AT PRESENT POSITION
CLOSE WASTE WASHWATER VALVE
CLOSE BACKWASH VALVE
CLOSE SURFACE WASH VALVE
CLOSE MASTER BACKWASH VALVE
CLOSE MASTER FILTER TO WASTE VALVE CLOSE
AIR SCOUR VALVE
STOP BACKWASH PUMP
STOP SURFACE WASH WATER PUMP
STOP AIR SCOUR BLOWER
CLOSE SECONDARY BACKWASH CONTROL VALVES
ENABLE MANUAL CONTROL OF INFLUENT VALVE
ENABLE MANUAL CONTROL OF WASTE WASHWATER VALVE
ENABLE MANUAL CONTROL OF BACKWASH VALVE
ENABLE MANUAL CONTROL FILTER EFFLUENT VALVE
ENABLE MANUAL CONTROL OF MASTER BACKWASH VALVE
ENABLE MANUAL CONTROL OF AIR SCOUR VALVE
ENABLE MANUAL CONTROL OF SECONDARY BACKWASH CONTROL VALVES
DISABLE MANUAL CONTROL OF INFLUENT VALVE
DISABLE MANUAL CONTROL OF EFFLUENT VALVE
DISABLE MANUAL CONTROL OF WASTE WASHWATER VALVE
DISABLE MANUAL CONTROL OF BACKWASH VALVE
DISABLE MANUAL CONTROL OF MASTER BACKWASH VALVE
DISABLE MANUAL CONTROL OF FILTER TO WASTE VALVE
DISABLE MANUAL CONTROL OF AIR SCOUR VALVE
DISABLE MANUAL CONTROL OF MASTER FILTER TO WASTE VALVE
DISABLE MANUAL CONTROL OF SECONDARY BACKWASH CONTROL VALVES
AS SOON AS FILTER BACKWASH SEQUENCE STARTS AND UNTIL BACKWASH SEQUENCE IS COMPLETE:
* ILLUMINATE BACKWASH INDICATOR
* START BACKWASH ETM
* RESET BACKWASH ETM WHEN BACKWASH SEQUENCE IS COMPLETED
ENABLE AUTOMATIC BACKWASH SEQUENCE. REFER TO AUTOMATIC BACKWASH TIMING DIAGRAM
PROCEED TO BACKWASH CALL
CONTINUED ON PAGE 2
17101 FCS2
FILTER CONTROL STRATEGY
BACKWASH OPERATING MODE
PAGE 1 OF 2



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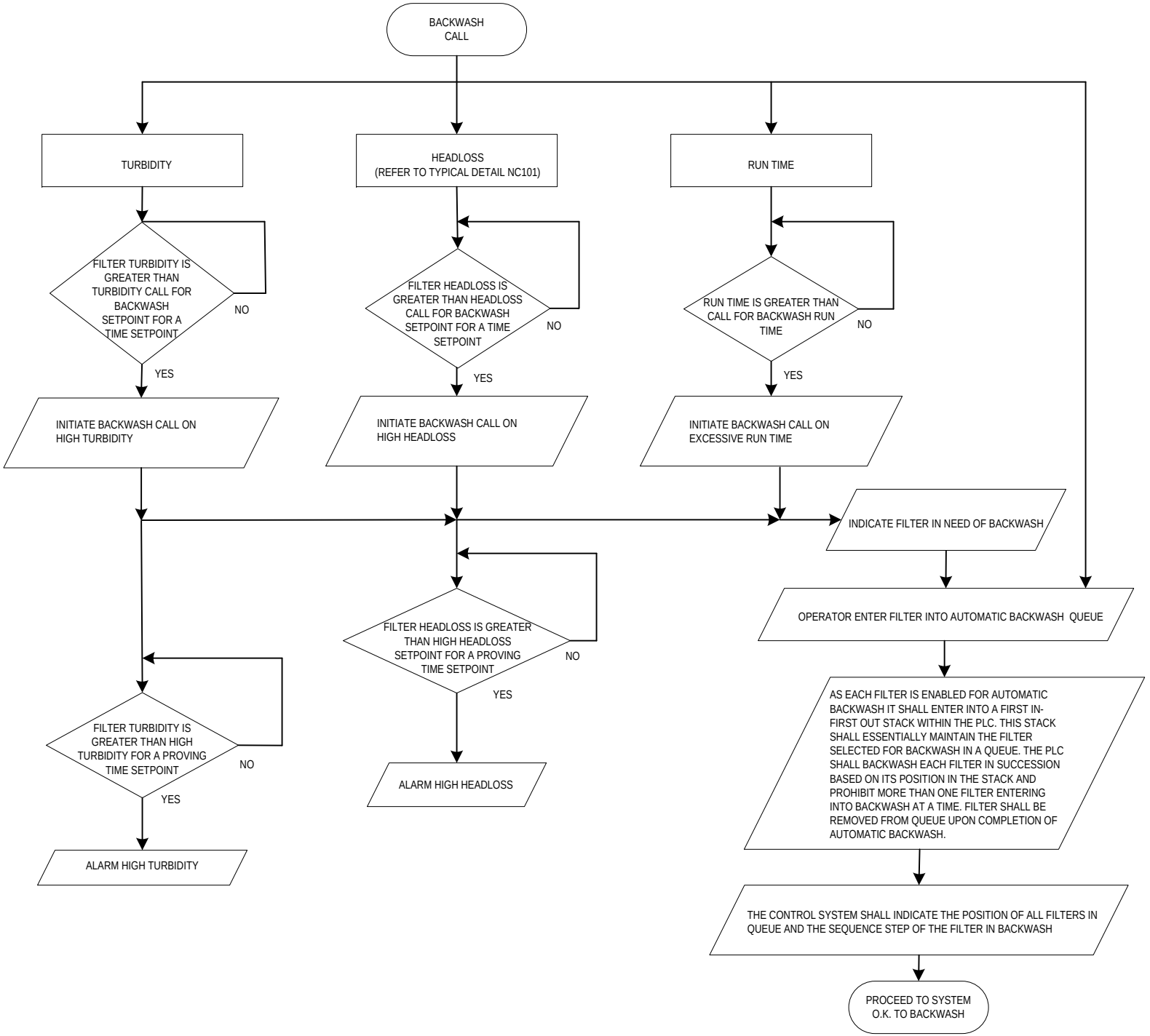
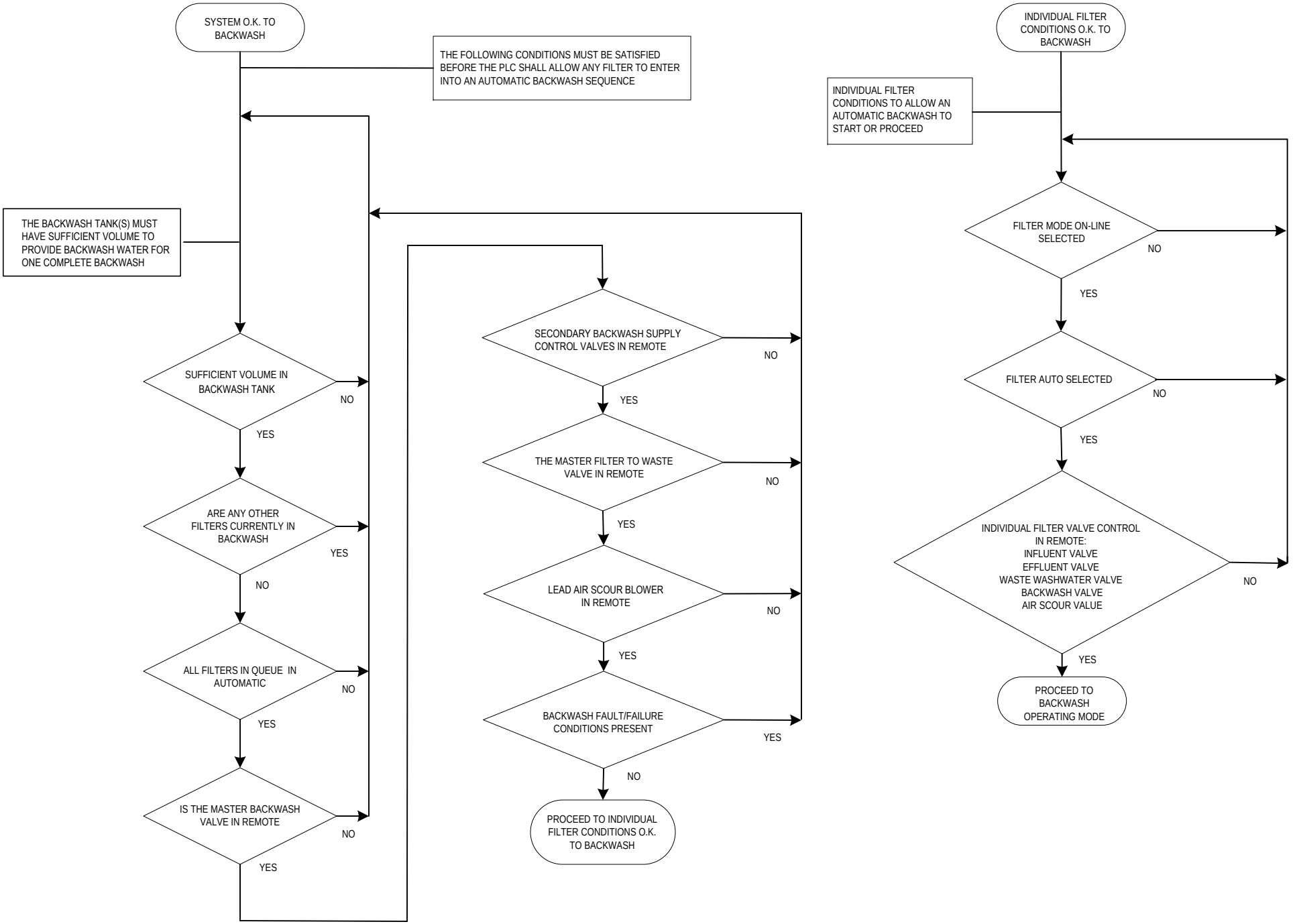
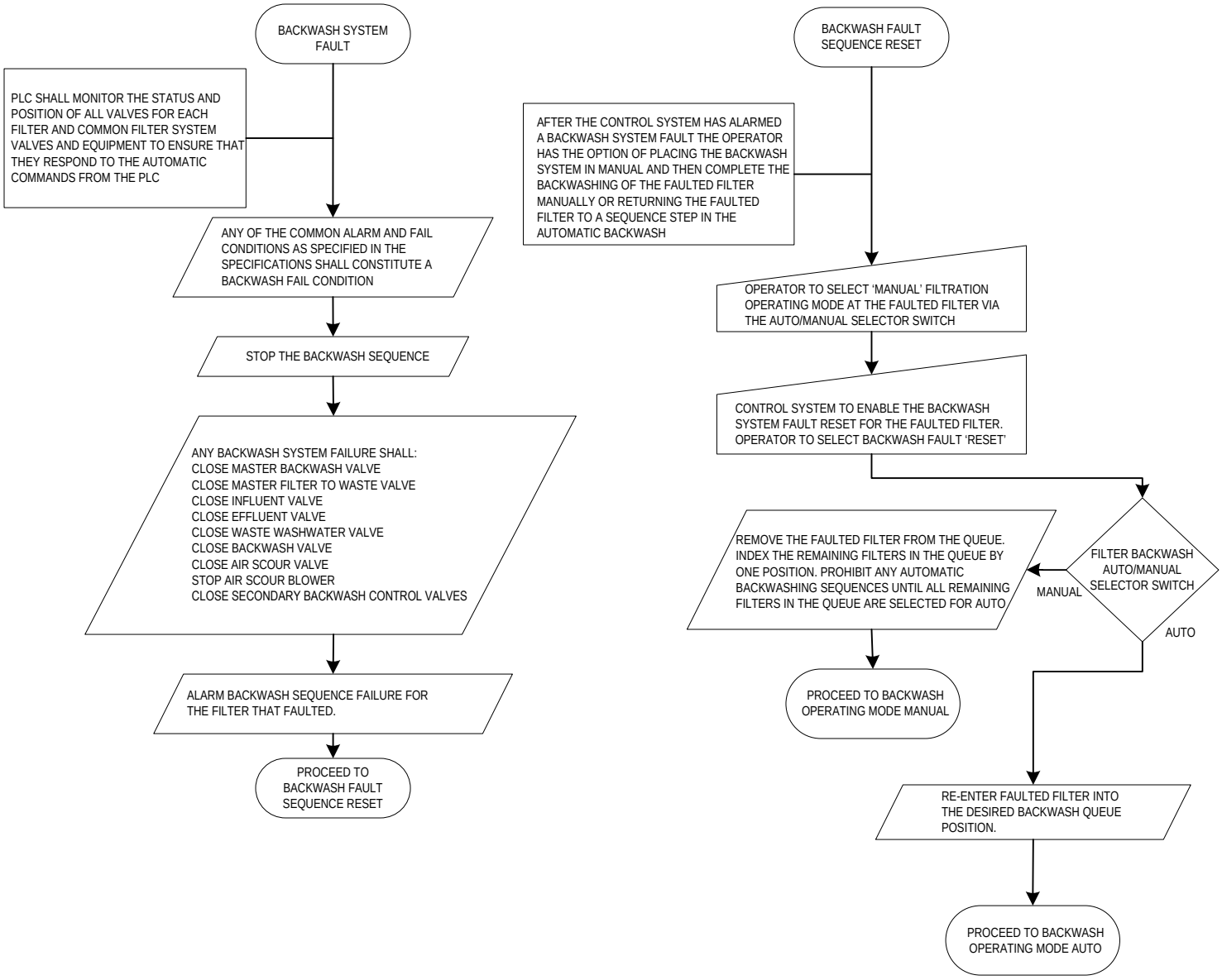
17101 FCS2
FILTER CONTROL STRATEGY
BACKWASH OPERATING MODE
PAGE 2 OF 2

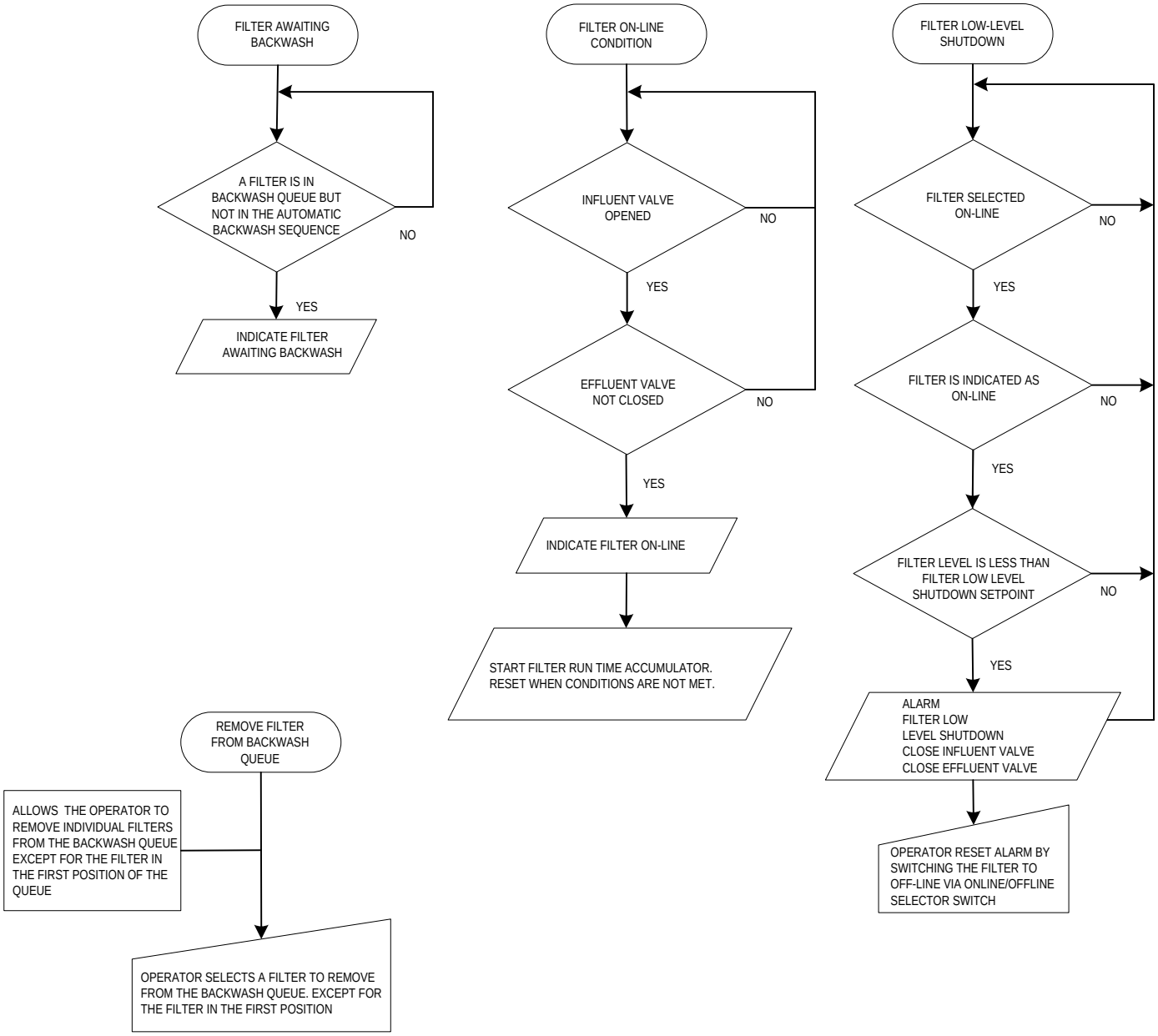


17101 FCS3
FILTER CONTROL STRATEGY
BACKWASH PERMISSIVE CHECKS
PAGE 1 OF 2



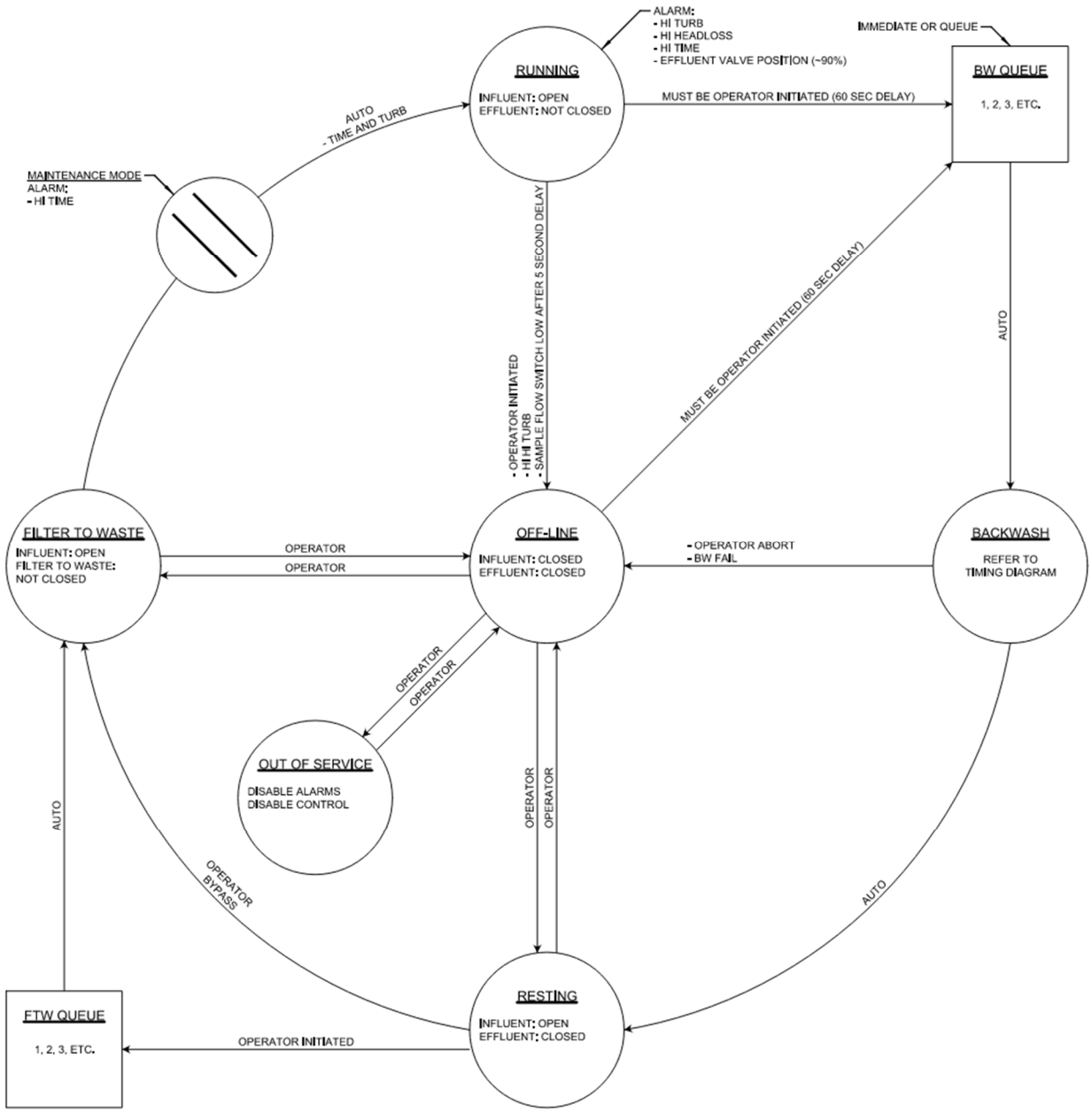
17101 FCS3
FILTER CONTROL STRATEGY
BACKWASH PERMISSIVE CHECKS
PAGE 2 OF 2


BACKWASH SYSTEM FAULT
PLC SHALL MONITOR THE STATUS AND POSITION OF ALL VALVES FOR EACH FILTER AND COMMON FILTER SYSTEM VALVES AND EQUIPMENT TO ENSURE THAT THEY RESPOND TO THE AUTOMATIC COMMANDS FROM THE PLC
ANY OF THE COMMON ALARM AND FAIL CONDITIONS AS SPECIFIED IN THE SPECIFICATIONS SHALL CONSTITUTE A BACKWASH FAIL CONDITION
STOP THE BACKWASH SEQUENCE
ANY BACKWASH SYSTEM FAILURE SHALL:
CLOSE MASTER BACKWASH VALVE
CLOSE MASTER FILTER TO WASTE VALVE
CLOSE INFLUENT VALVE
CLOSE EFFLUENT VALVE
CLOSE WASTE WASHWATER VALVE
CLOSE BACKWASH VALVE
CLOSE AIR SCOUR VALVE
STOP AIR SCOUR BLOWER
CLOSE SECONDARY BACKWASH CONTROL VALVES
ALARM BACKWASH SEQUENCE FAILURE FOR THE FILTER THAT FAULTED.
PROCEED TO BACKWASH FAULT SEQUENCE RESET
BACKWASH FAULT SEQUENCE RESET
AFTER THE CONTROL SYSTEM HAS ALARMED A BACKWASH SYSTEM FAULT THE OPERATOR HAS THE OPTION OF PLACING THE BACKWASH SYSTEM IN MANUAL AND THEN COMPLETE THE BACKWASHING OF THE FAULTED FILTER MANUALLY OR RETURNING THE FAULTED FILTER TO A SEQUENCE STEP IN THE AUTOMATIC BACKWASH
OPERATOR TO SELECT 'MANUAL' FILTRATION OPERATING MODE AT THE FAULTED FILTER VIA THE AUTO/MANUAL SELECTOR SWITCH
CONTROL SYSTEM TO ENABLE THE BACKWASH SYSTEM FAULT RESET FOR THE FAULTED FILTER. OPERATOR TO SELECT BACKWASH FAULT 'RESET'
FILTER BACKWASH AUTO/MANUAL SELECTOR SWITCH
MANUAL
AUTO
REMOVE THE FAULTED FILTER FROM THE QUEUE. INDEX THE REMAINING FILTERS IN THE QUEUE BY ONE POSITION. PROHIBIT ANY AUTOMATIC BACKWASHING SEQUENCES UNTIL ALL REMAINING FILTERS IN THE QUEUE ARE SELECTED FOR AUTO
PROCEED TO BACKWASH OPERATING MODE MANUAL
RE-ENTER FAULTED FILTER INTO THE DESIRED BACKWASH QUEUE POSITION.
PROCEED TO BACKWASH OPERATING MODE AUTO



17101 FCS4
FILTER CONTROL STRATEGY
FILTER FAULTS
PAGE 2 OF 2

ATTACHMENT E – FILTER OPERATIONAL MODES



17101 FCS9
FILTER CONTROL STRATEGY
FILTER OPERATIONAL MODES

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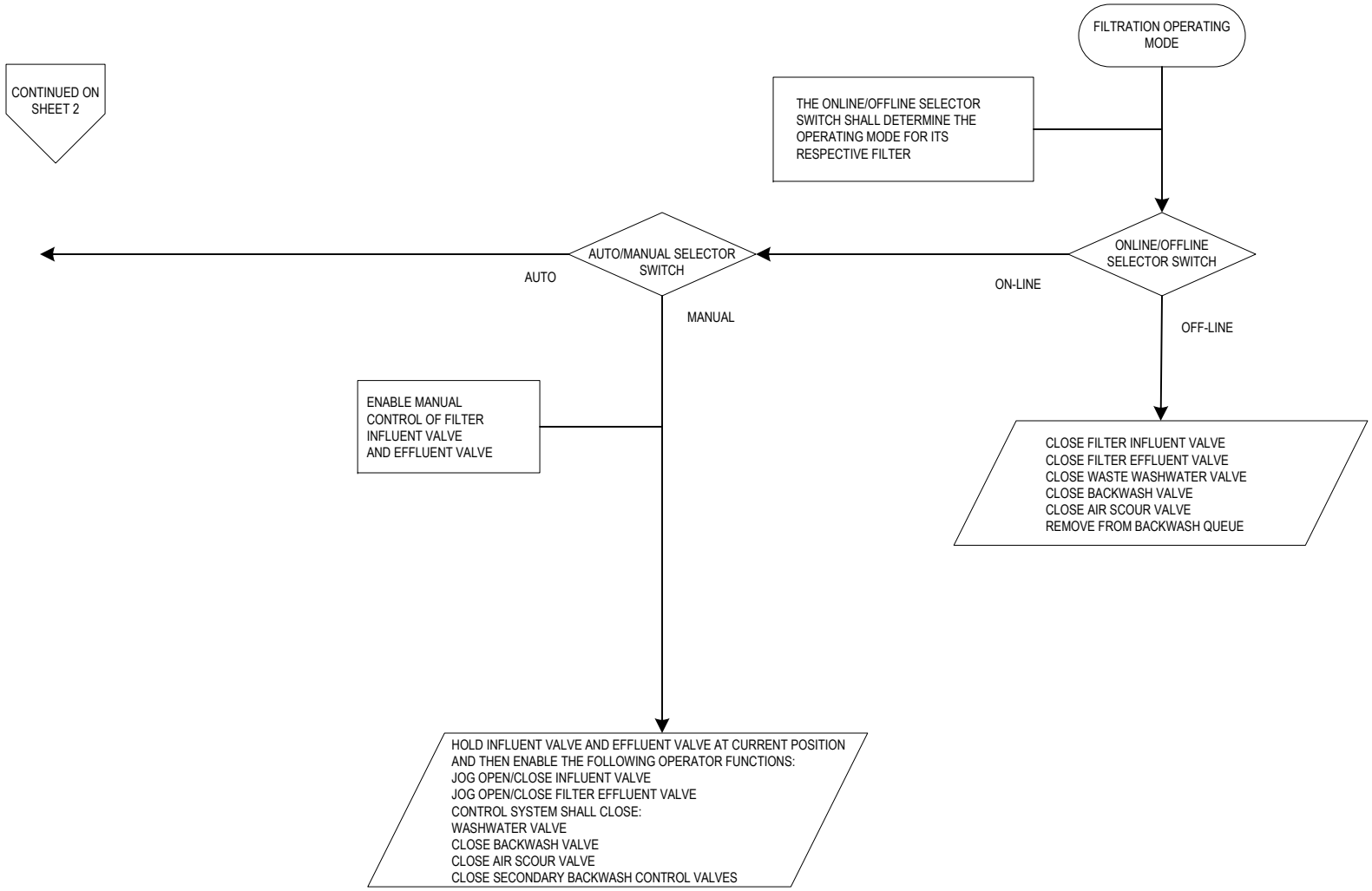
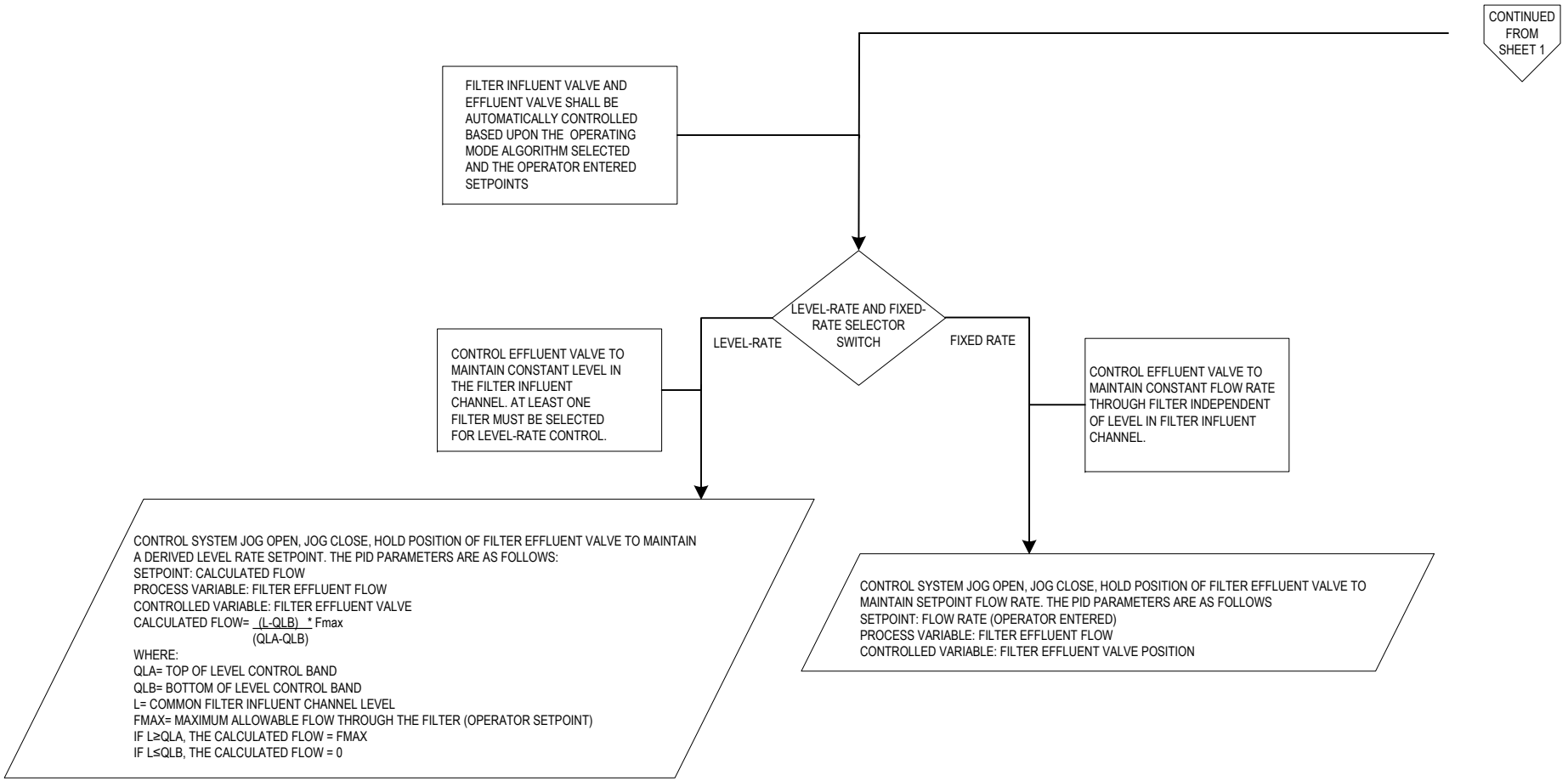


17101 FCS6

FILTER CONTROL STRATEGY
FLOW RATE OF CONTROL
FILTRATION OPERATION



17101 FCS6

FILTER CONTROL STRATEGY
FLOW RATE OF CONTROL
FILTRATION OPERATION

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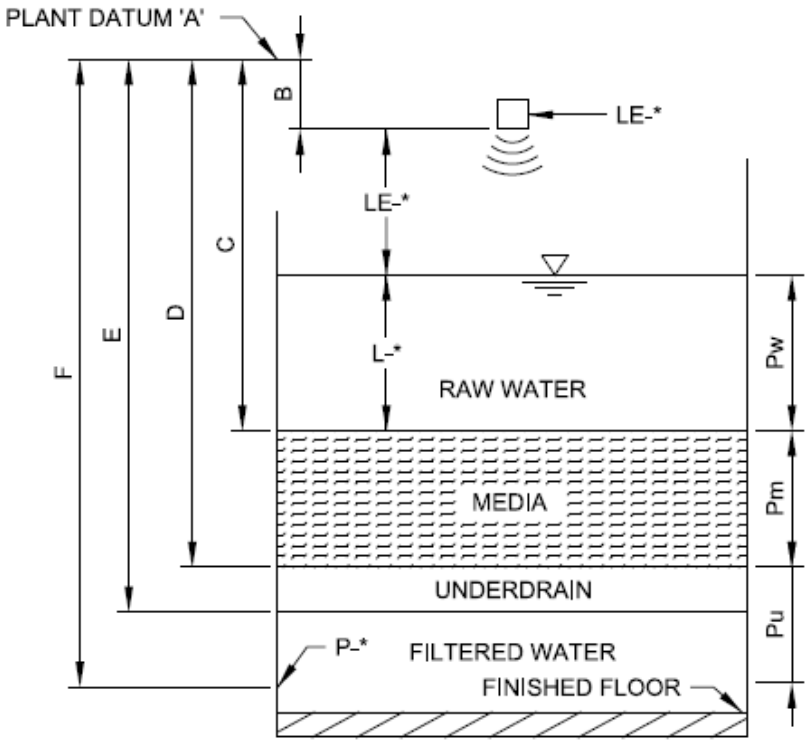
EQUIPMENT**	NORMAL FILTRATION	START BACKWASH SEQUENCE					DRAWDOWN		
SEQUENCE TAG	NF0	SB3 (Applicable if there is a resting filter in the system and it is selected to go through Filter to Waste) NOTE: Eliminate steps SB steps 3 thru 7 if no resting filter is used)	SB4	SB5	SB6	SB7	DD1	DD2	DD3
FILTER INFLUENT VALVE	OPENED	OPENED	MODULATE CLOSE BASED UPON HOLD AND JOG CLOSE TIME SETPOINT.	CLOSED	CLOSED	CLOSED	MODULATE CLOSE BASED UPON HOLD AND JOG CLOSE TIME SETPOINT.	CLOSED	CLOSED
FILTER EFFLUENT VALVE	MODULATE TO MAINTAIN LEVEL CONTROL OR FLOW CONTROL BASED UPON EITHER LEVEL OR FLOW SETPOINT	MODULATE TO MAINTAIN LEVEL CONTROL OR FLOW CONTROL BASED UPON EITHER LEVEL OR FLOW SETPOINT	HOLD IN CURRENT POSITION	HOLD IN CURRENT POSITION	HOLD IN CURRENT POSITION	HOLD IN CURRENT POSITION	HOLD IN CURRENT POSITION	HOLD IN CURRENT POSITION	CLOSE
FILTER BACKWASH VALVE	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
FILTER WASTE WASHWATER VALVE	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	OPENED
MASTER BACKWASH VALVE	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
SECONDARY BACKWASH VALVES	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
MASTER FILTER TO WASTE VALVE	CLOSED	CLOSED	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FTW METER JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FTW METER JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT	MODULATE CLOSE BASED UPON HOLD AND JOG CLOSED TIME SET POINT.	CLOSED	CLOSED	CLOSED	CLOSED
FILTER TO WASTE VALVE	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
AIR SCOUR BLOWER	STOPPED	STOPPED	STOPPED	STOPPED	STOPPED	STOPPED	STOPPED	STOPPED	STOPPED
FILTER AIR SCOUR VALVE	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
FILTER AIR SCOUR VENT VALVE	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
NEXT FILTER IN BACKWASH QUEUE INFLUENT VALVE	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED
RESTING FILTER EFFLUENT VALVE	CLOSED	CLOSED	CLOSED	CLOSED	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON SUM OF FTW AND FE METER	RESTING FILTER ENTERS NORMAL FILTRATION MODE NF0. MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL.	NA	NA	NA
RESTING FILTER TO WASTE VALVE	CLOSED	OPEN	OPENED	OPENED	OPENED	CLOSE	N/A	NA	NA
NEXT FILTER IN BACKWASH QUEUE EFFLUENT VALVE	MODULATE TO MAINTAIN LEVEL CONTROL OR FLOW CONTROL BASED UPON EITHER LEVEL OR FLOW SETPOINT	MODULATE TO MAINTAIN LEVEL CONTROL OR FLOW CONTROL BASED UPON EITHER LEVEL OR FLOW SETPOINT	HOLD IN CURRENT POSITION	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.
REMAINING FILTERS IN FILTRATION MODE'S EFFLUENT VALVE	MODULATE TO MAINTAIN LEVEL CONTROL OR FLOW CONTROL BASED UPON EITHER LEVEL OR FLOW SETPOINT	MODULATE TO MAINTAIN LEVEL CONTROL OR FLOW CONTROL BASED UPON EITHER LEVEL OR FLOW SETPOINT	HOLD IN CURRENT POSITION	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.
CONTINUE UNTIL:	BACKWASH CALL IS INITIATED THEN IF RESTING FILTER IS TO UNDERGO FTW, CONTINUE TO STEP SB3 ELSE SKIP TO STEP DD1	RESTING FILTER TO WASTE VALVE IS PROVEN OPEN	FILTER INFLUENT VALVE IS PROVEN CLOSED	TURBIDITY IS LESS THAN FTW TURBIDITY SETPOINT AND VOLUME FILTERED TO WASTE IS GREATER THAN FILTERED TO WASTE VOLUME SETPOINT	MASTER FILTER TO WASTE VALVE IS PROVEN CLOSED	RESTING FILTER TO WASTE VALVE IS PROVEN CLOSED RESTING FILTER ENTERS NORMAL FILTRATION	FILTER INFLUENT VALVE IS CLOSED AND FILTER LEVEL IS LESS THAN ELEVATION 4736.62 OR IF FILTER DRAWDOWN TIMER=0, STOP BACKWASH, PLACE FILTER IN FAULTED STATE, AND REFER TO TYPICAL NC904	(FILTER WASTE WASH WATER VALVE IS PROVEN OPEN AND FILTER LEVEL IS LESS THAN FILTER DRAWDOWN LEVEL SETPOINT) OR IF FILTER DRAWDOWN TIMER=0, STOP BACKWASH, PLACE FILTER IN FAULTED STATE, AND REFER TO TYPICAL NC904	FILTER EFFLUENT VALVE IS PROVEN CLOSED
START TIMER:							START FILTER DRAWDOWN TIMER AT FILTER DRAWDOWN TIMER SETPOINT		
** = CAN REPRESENT ANY FILTER (01-16)									
							TIMER	SETPOINT	
							FILTER DRAWDOWN TIMER	FILTER DRAWDOWN LEVEL SETPOINT	
							FUNCTION	FUNCTION	
							SETS THE DURATION FOR FILTER DRAWDOWN	SETS THE FILTER LEVEL SETPOINT WHILE DRAWING DOWN FILTER	

EQUIPMENT**	AIR SCOUR				DUAL WASH (SIMULTANEOUS AIR-WATER WASH)					LOW FLOW BACKWASH	HIGH FLOW BACKWASH	RINSE TO WASTE
SEQUENCE TAG	AS1	AS2	AS3	AS4	DW1	DW2	DW3	DW4	DW5	LB1	DB1	RW1
FILTER INFLUENT VALVE	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
FILTER EFFLUENT VALVE	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
FILTER BACKWASH VALVE	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED
FILTER WASTE WASHWATER VALVE	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED
MASTER BACKWASH VALVE	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	MODULATE TO MAINTAIN FLOW RATE EQUAL TO DUAL WASH BACKWASH SETPOINT	MODULATE TO MAINTAIN FLOW RATE EQUAL TO DUAL WASH BACKWASH SETPOINT	MODULATE TO MAINTAIN FLOW RATE EQUAL TO DUAL WASH BACKWASH SETPOINT	MODULATE TO MAINTAIN FLOW RATE EQUAL TO DUAL WASH BACKWASH SETPOINT	MODULATE TO MAINTAIN FLOW RATE EQUAL TO LOW FLOW BACKWASH FLOW SETPOINT	MODULATE TO MAINTAIN FLOW RATE EQUAL TO HIGH FLOW BACKWASH FLOW SETPOINT	MODULATE TO MAINTAIN FLOW RATE EQUAL TO RINSE TO WASTE FLOW SETPOINT
SECONDARY BACKWASH VALVES	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	MODULATE TO MAINTAIN FLOW RATE EQUAL TO DUAL WASH BACKWASH SETPOINT (VALVE POSITION SAME AS MASTER BACKWASH VALVE)	MODULATE TO MAINTAIN FLOW RATE EQUAL TO DUAL WASH BACKWASH SETPOINT (VALVE POSITION SAME AS MASTER BACKWASH VALVE)	MODULATE TO MAINTAIN FLOW RATE EQUAL TO DUAL WASH BACKWASH SETPOINT (VALVE POSITION SAME AS MASTER BACKWASH VALVE)	MODULATE TO MAINTAIN FLOW RATE EQUAL TO DUAL WASH BACKWASH SETPOINT (VALVE POSITION SAME AS MASTER BACKWASH VALVE)	MODULATE TO MAINTAIN FLOW RATE EQUAL TO LOW FLOW BACKWASH FLOW SETPOINT (VALVE POSITION SAME AS MASTER BACKWASH VALVE)	MODULATE TO MAINTAIN FLOW RATE EQUAL TO HIGH FLOW BACKWASH FLOW SETPOINT (VALVE POSITION SAME AS MASTER BACKWASH VALVE)	MODULATE TO MAINTAIN FLOW RATE EQUAL TO RINSE TO WASTE FLOW SETPOINT (VALVE POSITION SAME AS MASTER BACKWASH VALVE)
MASTER FILTER TO WASTE VALVE	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
FILTER TO WASTE VALVE	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
AIR SCOUR BLOWER	STOPPED	START	RUNNING	RUNNING	RUNNING	RUNNING	RUNNING	STOP	STOPPED	STOPPED	STOPPED	STOPPED
FILTER AIR SCOUR VALVE	OPEN	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED	CLOSE	CLOSED	CLOSED	CLOSED
FILTER AIR SCOUR VENT VALVE	OPEN	OPENED	CLOSE	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	OPENED	CLOSE	CLOSED	CLOSED
NEXT FILTER IN BACKWASH QUEUE INFLUENT VALVE	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED	OPENED
RESTING FILTER EFFLUENT VALVE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
RESTING FILTER TO WASTE VALVE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NEXT FILTER IN BACKWASH QUEUE EFFLUENT VALVE	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.
REMAINING FILTERS IN FILTRATION MODE'S EFFLUENT VALVE	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.
CONTINUE UNTIL:	FILTER AIR SCOUR VALVE AND AIR SCOUR VENT VALVE ARE PROVEN OPENED	AIR SCOUR BLOWER IS PROVEN RUNNING	AIR VENT VALVE IS PROVEN CLOSED	AIR SCOUR TIMER = 0	FILTER BACKWASH VALVE IS PROVEN OPENED	MASTER BACKWASH VALVE AND SECONDARY BACKWASH VALVE ARE PROVEN OPENED	FILTER LEVEL IS GREATER THAN FILTER DUAL WASH FILL LEVEL SETPOINT.	AIR SCOUR BLOWER IS PROVEN STOPPED	FILTER AIR SCOUR VALVE IS PROVEN CLOSED	LOW FLOW FILTER TIMER = 0	HIGH FLOW FILTER TIMER = 0 THEN IF RINSE TO WASTE IS SELECTED, CONTINUE TO RW1. IF RINSE TO WASTE IS NOT SELECTED: THEN CONTINUE TO FR1 (FILTER REFILL).	VOLUME RINSED TO WASTE IS GREATER THAN RINSE TO WASTE VOLUME SETPOINT THEN, CONTINUE TO STEP FR1 (FILTER REFILL).
START TIMER:				START AIR SCOUR TIMER AT AIR SCOUR TIMER SETPOINT						START LOW FLOW FILTER BACKWASH TIMER AT LOW FLOW FILTER BACKWASH SETPOINT	START HIGH FLOW FILTER BACKWASH TIMER AT HIGH FLOW FILTER BACKWASH SETPOINT	
** = CAN REPRESENT ANY FILTER (01-16)												
				TIMER			SETPOINT			TIMER	TIMER	SETPOINT
				AIR SCOUR TIMER			FILTER DUAL WASH FILL LEVEL SETPOINT			LOW FLOW FILTER BACKWASH TIMER	HIGH FLOW FILTER BACKWASH TIMER	RINSE TO WASTE VOLUME SETPOINT
				FUNCTION			FUNCTION			FUNCTION	FUNCTION	FUNCTION
				SETS TIME FOR AIR SCOUR			SETS THE FILTER LEVEL SETPOINT WHILE FILLING FILTER DURING DUAL WASH			SETS THE TIME FOR LOW FLOW FILTER BACKWASH	SETS THE TIME FOR HIGH FLOW FILTER BACKWASH	PRODUCT OF THE FILTER VOLUME (TOP OF MEDIA TO TOP OF FILTER) AND AN ADJUSTABLE MULTIPLER

EQUIPMENT**	FILTER REFILL (INFLUENT)				
SEQUENCE TAG	FR1	FR2	FR3	FR4	FR5
FILTER INFLUENT VALVE	CLOSED	JOG OPEN TO FILTER REFILL VALVE POSITION SETPOINT	OPEN	OPENED	OPENED
FILTER EFFLUENT VALVE	CLOSED	CLOSED	CLOSED	CLOSED	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT
FILTER BACKWASH VALVE	CLOSE	CLOSED	CLOSED	CLOSED	CLOSED
FILTER WASTE WASHWATER VALVE	CLOSE	CLOSED	CLOSED	CLOSED	CLOSED
MASTER BACKWASH VALVE	CLOSE	CLOSED	CLOSED	CLOSED	CLOSED
SECONDARY BACKWASH VALVES	CLOSE	CLOSED	CLOSED	CLOSED	CLOSED
MASTER FILTER TO WASTE VALVE	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
FILTER TO WASTE VALVE	CLOSED	CLOSED	CLOSED	OPEN	CLOSED
AIR SCOUR BLOWER	STOPPED	STOPPED	STOPPED	STOPPED	STOPPED
FILTER AIR SCOUR VALVE	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
FILTER AIR SCOUR VENT VALVE	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
NEXT FILTER IN BACKWASH QUEUE INFLUENT VALVE	OPENED	OPENED	OPENED	OPENED	OPENED
RESTING FILTER EFFLUENT VALVE	NA	NA	NA	NA	NA
RESTING FILTER TO WASTE VALVE	NA	NA	NA	NA	NA
NEXT FILTER IN BACKWASH QUEUE EFFLUENT VALVE	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.
REMAINING FILTERS IN FILTRATION MODE'S EFFLUENT VALVE	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.
CONTINUE UNTIL:	FILTER WASTE WASHWATER VALVE IS PROVEN CLOSED AND FILTER BACKWASH VALVE IS PROVEN CLOSED AND MASTER BACKWASH VALVE IS PROVEN CLOSED AND SECONDARY BACKWASH VALVES ARE PROVEN CLOSED	FILTER LEVEL IS GREATER THAN FILTER REFILL LEVEL SETPOINT	FILTER INFLUENT VALVE IS PROVEN OPEN THEN IF RESTING MODE IS ENABLED SKIP TO RM1 ELSE IF FILTER TO WASTE IS SELECTED, CONTINUE TO FR4, ELSE SKIP TO FR5	FILTER TO WASTE VALVE IS PROVEN OPEN THEN SKIP TO STEP FW1	FILTER EFFLUENT VALVE IS PROVEN NOT CLOSED THEN SKIP TO NF0
START TIMER:					
** = CAN REPRESENT ANY FILTER (01-16)					
		SETPOINT			
		FILTER REFILL LEVEL SETPOINT			
		FUNCTION			
		SETS THE LEVEL WHEN REFILL IS COMPLETE. CALCULATED AS FILTER INFLUENT CHANNEL MINUS AN ADJUSTABLE DIFFERENTIAL			
		SETPOINT			
		FILTER REFILL VALVE POSITION SETPOINT			
		FUNCTION			
		SETS THE INFLUENT VALVE POSITION DURING FILTER REFILL SEQUENCE			

EQUIPMENT**	FILTER TO WASTE				RESTING MODE	NORMAL FILTRATION
SEQUENCE TAG	FW1	FW2	FW3	FW4	RM1	NF0
FILTER INFLUENT VALVE	OPEN	OPENED	OPENED	OPENED	OPENED	OPENED
FILTER EFFLUENT VALVE	CLOSED	CLOSED	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON SUM OF FE AND FTW METERS	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT	CLOSED	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT
FILTER BACKWASH VALVE	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
FILTER WASTE WASHWATER VALVE	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
MASTER BACKWASH VALVE	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
SECONDARY BACKWASH VALVES	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
MASTER FILTER TO WASTE VALVE	CLOSED	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE CLOSED BASED ON JOG HOLD AND JOG CLOSE TIME SETPOINT	CLOSED	CLOSED	CLOSED
FILTER TO WASTE VALVE	OPENED	OPENED	OPENED	CLOSE	CLOSE	CLOSED
AIR SCOUR BLOWER	STOPPED	STOPPED	STOPPED	STOPPED	STOPPED	STOPPED
FILTER AIR SCOUR VALVE	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
FILTER AIR SCOUR VENT VALVE	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED
NEXT FILTER IN BACKWASH QUEUE INFLUENT VALVE	MODULATE CLOSE BASED UPON HOLD AND JOG CLOSE TIME SETPOINT.	CLOSED, THEN UNDERGOES BACKWASH	N/A	N/A	OPENED	OPENED
RESTING FILTER EFFLUENT VALVE	NA	NA	NA	NA	VALVE IS CLOSED AND THE BACKWASHED FILTER BECOMES THE RESTING FILTER	CLOSED IF RESTING IS ENABLED
RESTING FILTER TO WASTE VALVE	NA	NA	NA	NA	VALVE IS CLOSED AND THE BACKWASHED FILTER BECOMES THE RESTING FILTER	CLOSED IF RESTING IS ENABLED
NEXT FILTER IN BACKWASH QUEUE EFFLUENT VALVE	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	HOLD IN CURRENT POSITION	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.
REMAINING FILTERS IN FILTRATION MODE'S EFFLUENT VALVE	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	HOLD IN CURRENT POSITION	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.	MODULATE TO MAINTAIN LEVEL RATE CONTROL OR FLOW CONTROL BASED UPON FILTER EFFLUENT VALVE JOG OPEN, HOLD AND JOG CLOSE TIME SETPOINT.
CONTINUE UNTIL:	FILTER INFLUENT VALVE IS PROVEN OPENED AND NEXT FILTER IN BACKWASH QUEUE'S FILTER INFLUENT VALVE IS PROVEN NOT OPENED	(FILTER TURBIDITY IS LESS THAN FTW TURBIDITY SETPOINT AND VOLUME FILTERED TO WASTE IS GREATER THAN FILTERED TO WASTE VOLUME SETPOINT) OR IF FILTER TO WASTE TIMER=0, STOP BACKWASH, PLACE FILTER IN FAULTED STATE, AND REFER TO TYPICAL NC904	MASTER FILTER TO WASTE VALVE IS PROVEN CLOSED	FILTER TO WASTE VALVE IS PROVEN CLOSED THEN FILTER ENTERS NORMAL FILTRATION STEP NF0	HOLD IN CURRENT POSITION AT THIS STEP UNTIL ANOTHER FILTER IS READY TO BACKWASH	BACKWASH CALL IS INITIATED
START TIMER:		START FILTER TO WASTE TIMER AT FILTER TO WASTE TIMER SETPOINT				
** = CAN REPRESENT ANY FILTER (01-16)						
		TIMER				
		FILTER TO WASTE TIMER				
		FUNCTION				
		SETS THE TIME FOR FILTER TO WASTE				
		SETPOINT				
		FTW TURBIDITY SETPOINT				
		FUNCTION				
		SETS THE FILTER TO WASTE TURBIDITY SETPOINT				
		SETPOINT				
		FILTER TO WASTE VOLUME SETPOINT				
		FUNCTION				
		PRODUCT OF THE FILTER VOLUME (TOP OF MEDIA TO TOP OF FILTER) AND AN ADJUSTABLE MULTIPLIER				

ATTACHMENT H – FILTER HEAD LOSS



P_W = PRESSURE OF THE WATER ABOVE THE MEDIA IN FEET

P_M = PRESSURE THROUGH THE MEDIA WHICH CONSISTS OF THE STATIC PRESSURE IN THE MEDIA, P_{MS} AND THE DYNAMIC PRESSURE DROP THROUGH THE MEDIA (HEAD LOSS), P_{HL}
$P_M = P_{MS} - P_{HL}$

P_U = PRESSURE BETWEEN THE MEDIA BOTTOM AND THE INSTRUMENT LOCATION

THEREFORE:

P_{HL} = TOTAL DYNAMIC HEAD LOSS THROUGH THE MEDIA AND INTO THE EFFLUENT PIPE.

$P\text{-}^* = P_W + P_M + P_U$

$P\text{-}^* = P_W + P_{MS} - P_{HL} + P_U$

$P_{HL} = P_W + P_{MS} + P_U - (P\text{-}^*)$

$P_W = C - B - (LA\text{-}^*) = L\text{-}^*$

$P_{MS} = D - C$

$P_U = F - D$

$P_{HL} = (L\text{-}^*) + [D - C] + [F - D] - (P\text{-}^*)$

$P_{HL} = (L\text{-}^*) - C + F - (P\text{-}^*)$

NOTE:

1. ALL DIMENSIONS AND PRESSURE READINGS ARE IN DECIMAL FEET.
2. * = FILTER TAG NUMBER, REFER TO P&ID FOR APPROPRIATE TAG.

17101 FCS10
FILTER CONTROL STRATEGY
FILTER HEAD LOSS MEASUREMENT

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SECTION 17101A

SPECIFIC CONTROL STRATEGIES - FILTERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Filters.
   2. Filter Drain Pumps.
   3. Filter Backwash Supply Pumps.
   4. Filter Air Scour Blowers.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Develop detailed loop descriptions based on the information in the Contract Documents:
   1. Submit loop descriptions with all implemented modifications from this Section clearly marked.
   2. Remove all markings on final loop descriptions submitted with the applicable operation and maintenance manuals.

1.04 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 FILTERS

A. General:
   1. References:
      a. 30N03.
      b. 30N04.
      c. 30N05.
      d. 30N06.

e. 30N07.
f. 30N08.
g. 30N09.
h. 30N10.
i. 30N11.
j. 30N12.
k. 30N13.
l. 30N14.
m. 30N15.
n. 30N16.
o. 30N17.
p. 30N18.
q. Attachments A - G

2. Key equipment:
   a. FV-3XX1: Filter Inlet Valve.
   b. FV-3XX2: Filter Effluent Valve.
   c. FV-3XX3: Filter to Waste Valve.
   d. FV-3XX4: Filter Backwash Valve.
   e. FV-3XX5: Filter Air Scour Valve.
   f. FV-3XX6: Filter Vent Valve.
   g. FV-3XX7: Filter Waste Washwater Valve.
   h. LIT-3XX1: Ultrasonic Level Meter.
   i. PIT-3XX1: Pressure Transmitter.
   j. FIT-3XX1: Magnetic Flow Meter.
   k. AIT-3XX0: Turbidity.
   l. AIT-3XX1: Backwash Expansion Analyzer.
   m. FI-3XX0: Rotameter.
3. Abstract:
   a. Process Description:
      1) Granular media filtration removes settled water turbidity and particles for compliance with water treatment requirements of the surface water treatment rule (SWTR) and the long-term 2 SWTR. Filtration physically removes particulate matter and associated microbial contaminants. There are 16 filters available for the filtration process, divided into 2 sets; Filters 1-6 are original to the plant and Filters 7-16 were constructed during the 1985 expansion.
      2) During the filtration stage pretreated water is delivered to each filter through the filter influent channel and the upper gullet. Water passes down through the filter media and enters the lower gullet. Filtered water is conveyed via the lower gullet and filter effluent piping to the effluent clearwell.
      3) After the filtration stage, the backwash stage supplies water in the backwash piping and conveys waste washwater to the filter waste washwater system via the airgap manhole. Air added during the backwash stage enhances the effectiveness of backwash.
      4) The filters will have an automated backwash sequence with the option to include air scour, combined wash, rinse to waste, and/or filter to waste.

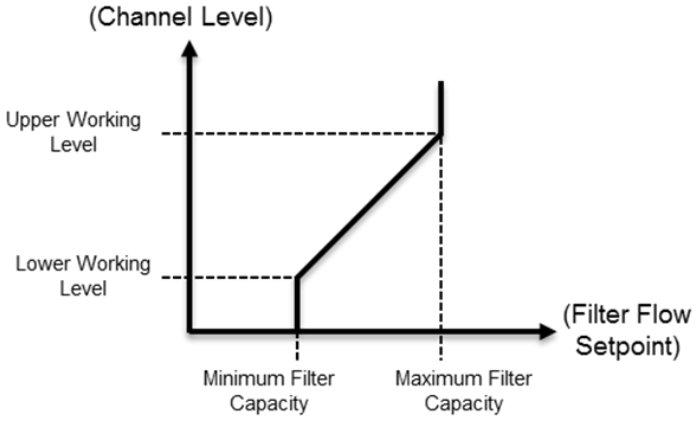
b. Filter Operating Modes: 5 filter operational modes are available for each filter, described below and in Attachment E - Filter Operating Modes:
    a) *Off-Line:* This is a “holding” mode for an operator to determine the next mode in which to place a specific filter. From this mode, operators may designate the filter as Out-of-Service, place it into Resting or place it in the Backwash Queue.
        (1) When a filter is designated as Out-of-Service, the filter’s alarms and remote control are disabled.
        (2) Once an operator selects an Off-Line filter to be backwashed, there is an adjustable 60 second delay before that filter enters the Backwash Queue.
    b) *Resting:* This mode occurs automatically when an automatic backwash is completed. From this mode, an operator can select Off-Line, or place the filter in the Filter-to-Waste Queue.
    c) *Backwash:* To begin backwashing, the operator places a filter in the Backwash Queue. An operator adjustable timer is provided to allow operators to remove a filter from the queue before backwash starts if an incorrect filter is placed into the queue. The Backwash Queue is the typical method for backwashing a filter. An operator can re-order or remove filters in the Backwash Queue.
        (1) Only one filter can be in backwash at a time.
    d) *Filter-to-Waste*: A filter in Resting must be placed in Filter-to-Waste prior to being placed Running. A filter enters this mode manually from Resting mode or automatically enters this mode through the Filter-to-Waste Queue. If a filter is manually placed in filter-to-waste the queue is automatically adjusted. A filter can transition out of this mode to Off-Line by a manual, or operator abort or automatically due to a filter-to-waste failure.
        (1) Operators may designate a filter in Filter-to-Waste in *Maintenance Mode*, which keeps a filter in Filter-to-Waste by prohibiting the filter from automatically transitioning to Running.
        (2) Only one filter can be in filter-to waste at a time.
    e) *Running*: A filter enters Running automatically after the completion of Filter-to-Waste.
        (1) Once an operator enters a Running filter into the backwash queue, there is an adjustable 60 second delay before the filter in the backwash queue enters the backwash.
    f) Refer to 17101 Attachment E - Filter Operating Modes.
c. Filter valves:
    1) Each filter has the following OPEN/CLOSE valves:
        a) One (1) filter waste washwater valve VAL-3XX7.
        b) One (1) filter backwash valve VAL-3XX4.
        c) One (1) filter vent VAL-3XX6A.
    2) Each filter has the following MODULATING control valves:
        a) One (1) filter influent valve VAL-3XX1.
        b) One (1) filter effluent valve VAL-3XX2.
        c) One (1) filter to waste valve VAL-3XX3.

3) Filter operations are supported by the following shared OPEN/CLOSE valves:
   a) Master filter to waste valve (VAL-4411).
   b) BW storage isolation valve (VAL-4131).
   c) BW tank 1 effluent valve (VAL-4112).
   d) BW tank 1 effluent valve (VAL-4122).
4) Filter operations are supported by the following shared MODULATING control valves:
   a) North backwash isolation valve (VAL-4051).
   b) South backwash isolation valve (VAL-4061).
   c) Master filter backwash valve (VAL-4041).

d. Forward Flow Control Modes: During the forward ("Running" and "Filter to Waste") flow through the filter is controlled by the filter effluent valve (FV-3XX2) in the running operational mode and the filter to waste valve (FV-3XX3) in the filter-to-waste operational mode. When in this state, the filter operation can be set to one of three modes. These modes are: Fixed Rate Control, Level-Rate Control, Manual Control.
   1) Level-Rate Control is the default forward flow control mode.
   2) The forward flow control mode for each filter is controlled independently. However, it is not recommended that less than 4 filters in each bank (a bank consists of odd or even filters) be
   3) Fixed Rate Control:
      a) When operating in rate of flow mode, the filter flow will be controlled by the filter effluent valves and magnetic flow meters on a PID loop where:
         (1) Setpoint = Filter Flow.
         (2) Process Variable =
             FE-3XX1 in Running mode OR
             FE-4411 in Filter to Waste mode.
         (3) Controlled Variable =
             Position of filter effluent valve via actuator
             FV-3XX2 in Running Mode OR
             Position of Filter to Waste valve via actuator
             FV-3XX3 in Filter to Waste mode.

   4) Level-Rate Control:
      a) The respective filter influent channel will have an adjustable nominal working water surface elevation (WSE) band of 12 inches. The WSE in the channel will be monitored by level transmitters which will be used to determine the filter flow setpoint. When the WSE in the filter influent channel increases, this will proportionally increase the flow setpoint for each filter, up to the operator adjustable maximum filtration rate as

described in the calculation section.



Filter Level-Rate Control

b) The level instrument used for filters drawing of the south filter influent channel is LE/LIT 3002.
c) The level instrument used for filters drawing of the north filter influent channel is LE/LIT 3001.

5) Manual filter control:
   a) In this mode the filter effluent valve FV-3XX2 (or filter to waste valve FV-3XX3) is manually controlled through the HMI. The percent (%) open of the control valve is specified by the operator. A warning will in this mode, indicating that without careful attention, the filter may exceed it's regulatory maximum flow rate.
6) Refer to 17101 - Attachment F for additional information on these filter forward flow control modes.

e. Timers:
   1) Filter runtime is calculated when the following is occurring:
      a) Filter Influent Valve is NOT CLOSED.
      b) The Filter Effluent Valve is NOT CLOSED.
      c) The Filter to Waste Valve is NOT OPEN.
   2) Filter to waste time is calculated when the following is occurring:
      a) Filter Influent Valve is NOT CLOSED.
      b) The Filter to Waste Valve is NOT CLOSED.
      c) The Filter Effluent Valve is NOT OPEN.
   3) A Resting timer will initiate after an automatic backwash is complete to indicate the elapsed time that a filter has been in Resting. The purpose of the Resting timer is to provide the operator with the information to help them decide the order in the Filter-to-Waste Queue.

f. Off-Line:
   1) From this mode, operators may place a filter into the Backwash Queue, Resting, or designate the filter as Out-of-Service.
   2) In Off-Line mode, the Filter Influent Valve is closed, and all other filter valves are closed.

g. Resting:
   1) In this mode, an operator must manually select Off-Line, Filter-to-Waste Queue, or place the filter directly into Filter to Waste. A

backwashed filter is automatically placed into Resting mode. An operator must manually move a Resting filter to Off-Line, Filter-to-Waste Queue, or directly into Filter-to-Waste.

2) In Resting mode, the Filter Influent Valve is set to OPEN and all other valves are closed.
3) An operator-initiated Filter-to-Waste Queue will be provided to sequence filters from Resting to Filter-to-Waste.
4) A resting filter will be prohibited from entering Filter-to-Waste if any of the following conditions are present:
    a) Associated Backwash Isolation Valve is open.
    b) Another filter is in backwash.
    c) Another filter is in filter-to-waste.

h. Backwash:
    1) Backwash is an automatic process:
        a) When an operator enables a filter for automatic backwash by placing it into the Backwash Queue (a first-in, first-out stack), Auto Mode control is enabled for the following valves associated with that filter: Filter Influent Valve, Filter Effluent Valve, Backwash Waste Valve, Backwash Supply Valve, and Air Scour Valve.
        b) Filter valves may be placed in AUTO during a backwash without disrupting the current backwash step, however this action may inhibit the sequence from progressing to subsequent steps (e.g., placing the Backwash Supply Valve in AUTO may result in the system being unable to achieve the flow setpoint and the sequence would be stuck in that step until the operator takes action such as putting the valve back into AUTO or aborting the backwash).
        c) The control system backwashes each filter in the Backwash Queue in succession based on its position in the stack and prohibits more than one filter in the Backwash Queue from backwashing at once. Refer to the Backwash Timing Diagram for backwash sequencing.
        d) During a backwash, backwash pressure is monitored by the individual filter effluent pressure sensors (PE/PIT-3XX1). In the event that the maximum backwash pressure setpoint is exceeded, the backwash shall immediately cease, and the backwash master backwash flow control valves will close.
        e) Running filters must be manually added to the Backwash Queue.
        f) Each step of the backwash sequence has an adjustable maximum duration timer. If the backwash step timer elapses, the backwash sequence will fail. Refer to “Failure Modes” for Backwash Failure system response.
        g) During backwash, an indicator for “Filter in Backwash” is displayed for the operator, along with the current sequence step, a flow rate for that step, and the remaining filters’ positions in the Backwash Queue. The backwash timer is started when backwash begins. When a backwash is complete, the filter is automatically placed into Resting.

h) The operator may remove or reorder individual filters in the Backwash Queue and immediately backwash a filter by bypassing the Backwash Queue.
i) Only one filter is permitted in backwash at a time.
j) The backwash sequence may be triggered on time, filtered water quality, or high headloss based on operator entered setpoints.
k) The timing and setpoints for filter operation and backwashing are adjustable through HMI.

2) Refer to 17101 Attachment G - Filter Timing Diagram for backwash sequencing. (SB3 - SB7, AS1 - AS3, DW1 - DW5, LB1, HB1, and RW1)

i. Filter Refill:

1) At the completion of a backwash the filter is refilled. Filter refill is achieved in one of two automatic ways, selectable in the HMI. The filter is refilled to an adjustable filter operating level, indicated by LE/LIT-3XX1,
a) Backwash Supply Refill: The filter is refilled by modulating the backwash control valves to maintain a maximum flow rate of 3,000 gpm.
b) Filter Influent Refill: The filter is refilled by slowly opening the filter influent valve. The valve shall open to between 5 percent and 10 percent open (operator adjustable) and hold until the filter reaches the filter operating level setpoint.

2) Refer to 17101 Attachment G - Filter Timing Diagram for filter refill sequencing (FR1 - FR3 and FRB1 - FRB5)

j. Filter-to-Waste:

1) In this mode, the Filter to Waste Valve (FV-3XX3) for the associated filter is modulated to control the rate of flow for FTW operations. The Filter Influent Valve (FV-3XX1) is open and the Filter Effluent Valve (FV-3XX2) is closed. The individual filter backwash valve (FV-3XX4) and waste washwater valve (FV-3XX7) is closed. The common filter to waste valve (FV-4411) is open.
2) Filter to waste can operate in any of the standard forward flow modes. The filter to waste flow rate is monitored by the common filter to waste flow meter (FE/FIT 4411), which is used as the control signal for modulation of the associated filter to waste valve (FV-3XX3).
3) Operators can manually enter filters in Resting directly into Filter-to-Waste or into the Filter-to-Waste Queue, a first-in, first-out stack; alternately, the control system can automatically bring a resting filter into the Filter-to-Waste Queue when another filter enters a backwash. The control system places each filter in Filter-to-Waste mode in succession based on its position in the Filter-to-Waste Queue. Only 1 filter in filter may be in filter to waste at the same time. The control system will prohibit multiple filters from entering into Filter-to-Waste simultaneously.
4) A setpoint filter box volume counter starts at the beginning of Filter-to-Waste. The operator will be able to enter the setpoint multiple of the fixed box volume (i.e., 1.1 box volumes). Once the volume wasted equals the setpoint box volume, the control system

will then compare the effluent turbidity to the Filter-to-Waste turbidity setpoint. The filter will remain in Filter-to-Waste mode until the filter effluent turbidity is below the Filter-to-Waste turbidity setpoint. Once the effluent turbidity is below the turbidity setpoint, the Turbidity Proving Timer starts. When the Turbidity Proving Time has expired and Maintenance Mode is not active the Filter will be placed in Running mode in accordance with the Filter Timing Diagram.

5) Only one filter is permitted in filter-to-waste at a time.
6) An operator may abort the process at any point during the Filter-to-Waste procedure. Aborting Filter-to-Waste places the filter in Off-Line mode.
7) A Filter-to-Waste failure alarms but does not automatically place the filter into Off-Line mode. A Filter-to-Waste failure occurs when:
    a) Turbidity does not reach the Filter-to-Waste Turbidity setpoint after the TURBIDITY OK WAIT TIME setpoint.
    b) Any of the filter valves fail to respond after a setpoint time.
8) Level switches in the air gap manhole provide level feedback during filter to waste operation. If the level switch high (LE-4425) is triggered and warning will appear in the HMI. If the level switch high-high (LE-4427) is triggered, all open filter to waste valves shall close.
9) Refer to the 17101 Attachment E - Filter Operational Modes Diagram and 17101 Attachment G - Filter Timing Diagram for Filter-to-Waste control and sequencing (FW1 - FW4).

k. Running:
    1) During operation, if any of the following occur, an alarm is displayed notifying the operator that a filter needs a backwash:
        a) HIGH turbidity: Turbidity exceeds the turbidity setpoint. Unless a filter reaches HIGH-HIGH turbidity, the filter remains in Running mode until it is Backwashed or placed into Off-Line by an operator.
        b) HIGH headloss: Filter headloss exceeds the headloss setpoint for an adjustable proving time. See headloss calculation.
        c) HIGH filter runtime: Filter runtime exceeds the runtime setpoint.
        d) The Filter Effluent Valve position is above a setpoint percentage open value, initially set to 90 percent open.
    2) An operator must manually enter each Running filter into the Backwash Queue.
    3) During operation, an alarm is issued if any of the following occur:
        a) Flow deviation alarm of filter effluent (adjustable, initially set to deviation of 5 percent from flow setpoint).
        b) Instrument failure alarms:
            (1) The filter effluent turbidity, combined filter effluent turbidity, and finished water chlorine residual and turbidity analyzers have flatline and rate-of-change alarms to indicate potential issues.
            (2) The individual filter effluent turbidity rate of change and flatline alarms will be disabled when a filter is not in Running or in Filter-to-Waste.
    4) Refer to the 17101 Attachment E - Filter Operational Modes Diagram and 17101 Attachment G - Filter Timing Diagram for Filter running control and sequencing (NF0 and DD1 - DD3).

l. Sampling:
   1) Individual filter effluent sampling:
      a) Turbidity.
      b) Particle counter.

m. Calculations:
   1) Level-Rate Flow:
      a) $Calculated\ Flow = \frac{L-QLB}{QLA-QLB} * F_{max}$
      b) Where:
         (1) QLA = Top of level control band (adjustable, default set 18 inches below QLA)
         (2) QLB = Bottom of level control band
         (3) L = Associated common filter influent channel level
         (4) F_{max} = Maximum allowable flow through the filter (operator setpoint)
         (5) If L ≥ QLA, Calculated Flow = F_max
         (6) If L ≤ QLB, Calculated Flow = 0
   2) Unit filter Run Volume (UFRV)
      a) $URV = \frac{Qtot_{Filter}}{A_{Filter}}$
      b) Where:
         (1) UFRV = Unit filter run volume, gal/sq ft (calculated)
         (2) UBWV = Unit backwash volume, gal backwash/sq ft (calculated)
         (3) $Q_{totfilter}$ = Totalized filter effluent flow during a filter run, gallons (from PCS)
         (4) A_{filter} = Filter area, sq ft (1,408 sq ft)
         (5) UFSC = Unit Filter Solids Capture, lbs/sq ft
   3) Efficiency
      a) $Efficiency = \frac{Qtot_{Filter}-Qtot_{FTW}-Qtot_{BW}}{Qtot_{Filter}}$
      b) Where:
         (1) Efficiency = Filter volumetric efficiency, percent (Efficiency shall be tracked since last backwash and the average weekly, monthly, and yearly efficiency)
            (a) Each efficiency value shall be displayed on each filter SCADA screen.
         (2) Q_{totFTW} = Totalized filter-to-waste flow during a filter-to-waste when bringing a filter online, gallons (from PCS)
         (3) Q_{totBW} = Volume of water wasted during a backwash, gallons (from PCS)
   4) Headloss
      a) Refer to 17101 - Attachment H for measurement of filter headloss.
   5) Normalized Headloss
      a) $HL_n =$

$$HL_m x\ {}^{10{,}700\ (gpm)}\Big/_{Filter\ Flow\ (gpm)}\ {}^{x}\ {}^{1.01x10^{-6}\ \left(\frac{m^2}{sec}\right)}\Big/_{\nu_T\left(\frac{m^2}{sec}\right)}$$

      b) Where:
         (1) HL_n = Normalized filter headloss if the headloss if the filter were operated at maximum rate and at 20 degrees Celsius.

(2) HL_m = Measured headloss is as calculated in Attachment C - Filter Head Loss
(3) v_T = Kinematic Viscosity of Filter Influent at current temperature T. A lookup table may be used for kinematic viscosity.

6) Approximate Solids Loading Rate
a) $$Approximate\ Solids\ Loading\ Rate\ \left(\frac{lb}{sf\ x\ day}\right) = \frac{Q_{Filt}\ (mgd)}{1{,}125\ (sf)}\ x\ 8.34\ (Unit\ Conversion)\ x\ Turb_{SW}(NTU)\ x\ Conversion\left(\frac{TSS}{NTU}\right)$$
b) Where:
(1) Approximate solids loading rate is a measure of the total suspended solids per unit filtration area.
(2) Q_{Filt} = Filter Flow Rate
(3) $Turb_{SW}$ = Settled Water Turbidity
(4) Conversion = Operator adjustable conversion between TSS and NTU (default this value to 3.5).

7) Approximate Solids Capture
a) $$Approximate\ Solids\ Capture\ \left(\frac{lb}{sf}\right) = \frac{Q_{Filt}\ (mgd)}{1{,}125\ (sf)}\ x\ 8.34\ (Unit\ Conversion)\ x\ [Turb_{SW}(NTU) - Turb_{FE}(NTU)]\ x\ Conversion\left(\frac{TSS}{NTU}\right)$$
b) Where:
(1) Approximate Solids Capture is cumulative starting at zero pounds per square foot at the beginning of each filter run.
(2) Q_{Filt} = Filter Flow Rate
(3) $Turb_{SW}$ = Settled Water Turbidity
(4) $Turb_{FE}$ = Filter Effluent Turbidity
(5) Conversion = Operator adjustable conversion between TSS and NTU (default this value to 2.0).

B. PCS controls:
1. Manual mode:
a. Refer to 17101 - Attachment F.
2. Auto mode:
a. Refer to 17101 - Attachment F.
3. Indicators and alarms:
a. Refer to Drawings and Section 17100 - Control Strategies for indicators and alarms.
b. Additional indicators and alarms:
1) If the level in the Clearwell Outlet Structure reaches the high level setpoint, provide a “High Clearwell Outlet Structure Level” warning. If the level increases to the high-high level setpoint, provide an alarm. If the level increases further to the flood level setpoint, provide an additional alarm and begin automatically closing the filter effluent valves.

2) A turbidity breakthrough condition will be alarmed based on the turbidity change of rate as follows:
a) The control system will check every minute for the following condition and alarm on Turbidity Breakthrough when true:
(1) (Filter Effluent Turbidity) > ((Filter Effluent Turbidity from 1 minute ago) + (Turbidity Breakthrough Setpoint))
3) All calculations and associated constants and variables shall be visible on the HMI.

c. An alarm shall be presented in the HMI if four filters or less, in each filter bank (odd or even filters) are in Level-Rate forward flow control mode. "Flow Distribution To Filters Compromised Due To Number Of Filters In A Non-Standard Mode. Filter Overflow or Underflow May Occur."

d. An alarm shall be presented in the HMI if two filters or less, in each filter bank (odd or even filters) are in Level-Rate forward flow control mode. "Flow Distribution To Filters Compromised Due To Number Of Filters In A Non-Standard Mode. Filter Overflow or Underflow May Occur."

C. Software interlocks:
1. A filter will automatically transition from Running to Off-Line upon:
a. Detection of a HIGH-HIGH turbidity condition.
b. Low flow alarm activated on the filter effluent sampling line.
c. Failure of the filter effluent turbidity analyzer.
2. A filter Backwash Failure will be activated if any of the following conditions are present:
a. Individual backwash step timer expires.
b. Hi Hi level from Level instrument LE/LIT-3XX1.
3. To begin an automatic backwash sequence, the level in the associated washwater equalization basin must be below the backwash level setpoint. The Backwash Pumps, Air Scour Blowers, and Master Backwash Valves must be in AUTO mode. No other backwash failure conditions may be present. All filter valves except for the Filter Effluent for the filter to be backwashed must be in AUTO mode.

D. Failure modes:
1. In the event of PLC communication loss:
a. Continue operation at the same state prior to the PLC communication loss, unless communications failure occurs during backwash. Input values from other PLCs shall be fixed at the last value prior to losing communications.
1) If communication is lost during backwash, backwash is aborted and the filter is automatically placed into Off-Line.
2. In the event of a power loss:
a. Refer to Power Loss Control Description in 17100 - Control Strategies.
3. In the event of a failed backwash:
a. A Backwash Failure pop-up notification with an adjustable Backwash Failure Proving Timer is displayed for the operator. The pop-up will say, "Backwash Failure. Backwash will abort in 60 seconds" and the cause will be displayed i.e. "Backwash failure due to Filter Effluent valve fail to respond."
b. Upon timeout of the Backwash Failure Proving Timer the backwash sequence is stopped. The Filter Air Scour Valve, Filter to Waste Valve,

Filter Influent Valve, Filter Effluent Valve, Filter Waste Washwater Valve, and Filter Backwash Valve are closed.

c. To conduct a manual backwash, the operator must place the filter Off-Line and select AUTO mode for each piece of equipment involved in backwashing a filter and complete backwashing of the filter manually. The operator must place the manually backwashed filter into Off-Line after completion of the manual backwash. Normal, automatic backwash operation for the next filter is resumed when the manually backwashed filter is complete, and all equipment involved in the next filter to be backwashed is in AUTO mode.

4. Refer to 17101 Attachment D - Filter and Backwash System Faults.

3.02 BACKWASH SUPPLY, BACKWASH FLOW METERING, AND BACKWASH FLOW CONTROL

A. General:

1. References:
   a. 30N20, 30N21.
   b. Attachment A - Filter Operational Modes.
   c. Attachment B - Backwash Timing Diagram.
   d. Attachment C - Backwash Permissive Checks.
   e. Attachment D - Filter and Backwash System Faults.
2. Key Equipment:
   a. TNK-4111: Backwash Tank No. 1 (existing).
   b. TNK-4121: Backwash Tank No. 2.
   c. VAL-4112: BW Tank 1 Isolation Valve.
   d. VAL-4122: BW Tank 2 Isolation Valve.
   e. VAL-4131: BW Storage Isolation Valve.
   f. FE-4041: Backwash Supply Flow Meter.
   g. FV-4041: Master Backwash Flow Control Valve.
   h. FV-4051: North Secondary Backwash Flow Control Valve.
   i. FV-4061: South Secondary Backwash Flow Control Valve.
3. Abstract:
   a. Backwash water is supplied from two circular prestressed concrete tanks. Each tank provides 1MG of storage.
      1) The tanks can be manually isolated by closing the associated isolation valves (VAL-4112 for Tank 1 and VAL-4122 for Tank 2)
      2) Both tanks can be isolated simultaneously by closing VAL-4131.
   b. There are three valves that control flow during filter backwash. The Master Backwash Control Valve (FV-4041) and the Secondary Backwash Control Valves (FV-4051 and FV-4061). Each of these valves is equipped with electric modulating actuators. FV-4041 is common to all 16 filters, FV-4051 is dedicated to filters on the north (odd filters) and FV-4061 is dedicated to filters on the south (even filters).
   c. The backwash control valves modulate identically (in tandem) to maintain a flow setpoint for the filter in backwash in accordance with the backwash timing diagram.
      1) The backwash rate for north filters (odd filters) is controlled by modulation of both FV-4041 and FV 4061. These valves will be matched in their percent open setpoints during backwash operations.

2) The backwash rate for south filters (even filters) is controlled by modulation of both FV-4041 and FV 4051. These valves will be matched in their percent open setpoints during backwash operations.

B. PCS Controls:
   1. Manual mode:
      a. Refer to 17101 - Attachments A, B, and C.
   2. Auto mode:
      a. Refer to 17101 - Attachments A, B, and C.
   3. Indicators and alarms:
      a. Refer to Drawings and Section 17100 - Control Strategies for indicators and alarms.
      b. Additional indicators and alarms:
         1) Unable to maintain backwash flow setpoint indicator
         2) High backwash pressure alarm.
         3) High-High backwash pressure alarm.
         4) Backwash tank low level indicator.
         5) Backwash tank high level indicator.
         6) Backwash tank high-high level alarm.

C. Software Interlocks:
   a. During a backwash, backwash pressure is monitored by the individual filter effluent pressure sensors (PE/PIT-3XX1). In the event that the maximum backwash pressure setpoint (default setpoint 10 PSI) is exceeded, the backwash shall immediately cease and the backwash master backwash flow control valves will close.
      1) Backwash pressure is cataloged and trended for each filter.
      2) A warning shall be displayed on the HMI when the backwash pressure gets within 10 percent of the maximum backwash pressure setpoint (default setpoint 9.0 PSI)
   b. In order for a backwash to be initiated the BW Storage Isolation Valve (VAL-4131) must be open and at least one of the individual tank isolation valves must be open (VAL-4112 and/or VAL-4122).
   c. A backwash shall not be permitted to be initiated automatically for the following reasons, related to tank level:
      1) The level in both tanks is below a designated minimum volume setpoint (approx. 7.5 feet) and both tank isolation valves are open (VAL-4112 and VAL-4122).
      2) The level in the online tank is below a designated minimum volume setpoint (approx. 15 feet) and one tank isolation valves is open (VAL-4112 or VAL-4122).

D. Failure Modes:
   1. In the event of a power loss:
      a. Refer to Power Loss Control Description in 17100 - Control Strategies.
      b. The backwash control valves shall close.
   2. In the event of a valve or flow control failure, the backwash shall be terminated and the operator will be alerted in the HMI.
   3. Refer to 17101 Attachment D - Filter and Backwash System Faults.

3.03 FILTER DRAIN PUMPS

A. General:
   1. References:
      a. 30N25.
   2. Key equipment:
      a. PMP-3911: Filter Drain Pump 1.
      b. PMP-3921: Filter Drain Pump 2.
   3. Abstract:
      a. There are 2 filter drain pumps, 1 pump for the north/odd filters (Filter Drain Pump 1, PMP-3911) and one pump for the south/even filters (Filter Drain Pump 2, PMP-3921).
         1) The Filter Drain pumps allow for draining of the filters more rapidly and to a lower level than gravity drainage would allow.
         2) The Filter Drain pumps move liquid from the filters to the Filter Waste Washwater system via the airgap manhole.
      b. Startup of each filter drain pump is initiated manually. There is no automatic sequence for filter draining. The operator must manually position the appropriate filter valves for draining and manually initiate the filter drain pump start command, either through the remote HMI or at the local control station.
      c. The filter drain pumps will stop based on triggering the low effluent flow switch (FSL-3911 and FSL-3921), as described in the software interlocks

B. PCS controls:
   1. Manual mode:
      a. Refer to Section 17100 - Control Strategies.
      b. With AUTO selected at the Driver/starter enclosure and HAND selected in the PCS the following controls may be used:
         1) RUN.
         2) STOP.
         3) High discharge pressure indication.
         4) General fail alarm.
   2. Auto mode:
      a. None.
   3. Indicators and alarms:
      a. Refer to Drawings and Section 17100 - Control Strategies for indicators and alarms.
      b. Additional indicators and alarms:
         1) Motor high temperature indication.
         2) Motor winding heater indication.
         3) High discharge pressure indication.

C. Software Interlocks:
   1. Pump stop on low flow (FSL-3911 and FSL-3921).
   2. Indicators and alarms:
      a. Field:
         1) None.
      b. LCP:
         1) None.

c. Drive/starter enclosure:
    1) Pump Running indicator light.
    2) Pump Fail indicator light.
d. VCP:
    1) None.

D. Failure Modes:
1. In the event of a power loss:
    a. Refer to Power Loss Control Description in 17100 - Control Strategies.
2. In the event of pump failure the pump should turn off and remain off until an operator has reset the pump. Once reset the pump should remain off until called to start again.

3.04 FILTER BACKWASH SUPPLY PUMPS

A. General:
1. References:
    a. 30N27.
2. Key equipment:
    a. PMP-4101: Large Backwash Pump 1.
    b. PMP-4102: Large Backwash Pump 2.
    c. PMP-4103: Small Backwash Pump 1.
    d. PMP-4104: Small Backwash Pump 2.
3. Abstract:
    a. There are 2 sets of backwash pumps that convey filtered water to the backwash storage tanks for use in filter backwash.
    b. The backwash storage tanks will normally be hydraulically linked and, under normal process conditions, will have approximately the same water level.
    c. The large backwash pumps convey from the Clearwell Outlet Structure, while the small backwash pumps convey from the Original Clearwell. The large backwash pumps are equipped with variable frequency drives.
    d. Pumps are controlled locally by the operator via the drive/starter enclosure or remotely through the plant HMI.

B. PCS controls:
1. Manual mode:
    a. With AUTO selected at the Driver/starter enclosure and HAND selected in the PCS the following controls may be used:
        1) RUN.
        2) STOP.
        3) SPEED (percent) (large backwash pumps only).
2. Auto mode:
    a. In Auto mode the operator shall designate the desired pumps to run and the maximum desired pump speed (large backwash pumps only). These values are entered into the HMI. The operator will designate a primary or lead backwash supply pump as well as the standby pump(s).
    b. The Operator shall select which level reading to be used for backwash tank level control. (PIT-4011, Tank No. 1 or LE/LIT-4122, Tank No. 2)
    c. The Operator shall select or confirm the backwash tank fill level setpoint and backwash tank low level set point.

d. The fill level and low level setpoints shall be used as a control loop to increase or decrease the overall pumped flow to the backwash supply tank.
    1) When the water level in the selected backwash tank is below the low level setpoint, all pumps in AUTO shall run.
    2) When the water level in the selected backwash tank is between the low level set point and mid level (50 percent between low level and high level setpoints) the primary backwash pump shall run at the maximum designated speed (operator adjustable).
    3) When the level in the selected backwash tank is between mid-level and fill level the primary backwash pump shall run at 70 percent speed (operator adjustable).
    4) When the level in the selected backwash tank is between the fill level and tank high level setpoint the primary backwash pump shall run at 50 percent speed.
    5) When the level in the selected backwash tank is above the high level setpoint all pumps shall be shut off.
e. Pump operations shall be normalized such that sudden changes in level (such as during a backwash) do not trigger sudden changes in pump operations.

3. Semi-Auto Mode:
    a. In Auto mode the operator shall designate the desired pump(s) to run and the desired flow rate (large backwash pumps only). These values are entered into the HMI.
    b. The Operator shall select which level reading to be used for backwash tank level control. (PIT-4011, Tank No. 1 or LE/LIT-4122, Tank No. 2)
    c. The Operator shall select or confirm the backwash tank fill level setpoint.
    d. The designated pump(s) will operate at the indicated flow rates until:
        1) The designated level controller reaches the tank high level setpoint. At that level, the pump will automatically be shut down.
        2) The mode is changed to either Auto or Manual.
        3) The operator designates an alternative pump(s).
    e. The designated pump(s) shall restart when the tank level falls below the designated operator fill level setpoint.
    f. Pump operations shall be normalized such that sudden changes in level (such as during a backwash) do not trigger sudden changes in pump operations.
4. Indicators and alarms:
    a. Refer to Drawings and Section 17100 - Control Strategies for indicators and alarms.
    b. Additional indicators and alarms:
        1) Motor high temperature indication.

C. Software Interlocks:
1. If either tank level instrument (PIT-4011, Tank No. 1 or LE/LIT-4122, Tank No. 2) registers a level above the tank high-high level setpoint the backwash supply pumps shall automatically shut down. The pumps shall be prevented to start if the tank instruments indicate a high-high level.
2. To operate the backwash pumps in AUTO the BW Storage Isolation Valve (VAL-4131) must be open and at least one of the tank isolation valves must be open (VAL-4112 and/or VAL-4122)

D. Failure Modes:
    1. In the event of a power loss:
        a. Refer to Power Loss Control Description in 17100 - Control Strategies.
    2. In the event of pump failure the pump should turn off and remain off until an operator has reset the pump. Once reset the pump should remain off until called to start again.

3.05 AIR SCOUR BLOWERS

A. General:
    1. References:
        a. 30N28.
        b. Attachment G - Filter Timing Diagram.
    2. Key Equipment:
        a. BLO-4201: Air Scour Blower 1 (existing).
        b. BLO-4211: Air Scour Blower 2 (existing).
    3. Abstract:
        a. There are two Air Scour Blowers that serve all 16 filters that are equipped with reduced voltage solid state (RVSS) starters. The blowers operate in a duty/standby configuration.
        b. The duty blower operates during the air scour and combined air water wash (dual wash) portions of a filter backwash as described in the filter backwash timing diagram.
        c. The Air Scour Blowers provide air to the filters during the backwash process. The Air Scour Blowers are controlled through the MCC and remotely through the plant HMI. Blower operation is start/stop only, the air flow rate is fixed.
        d. The blowers operate in a duty/standby configuration.
    4. Calculations:
        a. None.

B. PCS Control:
    1. Manual Mode:
        a. the air scour blower is controlled in accordance with the description in Section 17100 - General Control Strategy.
    2. Auto Mode:
        a. The duty blower operates during the air scour portion of a filter backwash as described in 17101 Attachment G - Filter Timing Diagram.
        b. When an air scour is called to start, the air scour valve (VAL-3XX5) and the blowoff valve (FV-3XX6) on the associated filter to be backwashed shall open.
        c. After a setpoint delay (default 30 seconds) the duty blower will be called to start.
        d. Once the blower has been running for a setpoint time, the blowoff valve will close.
        e. At the completion of the air scour and combined air water wash (dual wash) portion of the backwash cycle the air scour blower shall be called to stop.
        f. Simultaneously, the filter blowoff valve (FV-3XX6) shall be called to open and the filter air scour valve (VAL-3XX5) shall be called to close.

g. After a setpoint amount of time the filter blowoff valve shall be called to close.

3. Indicators and alarms
   a. As indicated on the Drawings, Digital Table, and specified in Section 17101 - General Control Strategy.
   b. All calculations and associated constants and variables shall be visible on SCADA.

C. Software interlocks:
   1. Both air scour blowers shall be prohibited from running simultaneously.

D. Failure modes:
   1. As indicated on the Drawings and specified in Section 17100 - General Control Strategy.
   2. In the event of a PLC communication loss:
      a. Continue operation at the same state prior to the PLC communication loss. Input values from other PLCs shall be fixed at the last value prior to losing communications.
   3. In the event of a power loss:
      a. Refer to Power Loss Control Description in Section 17100 - General Control Strategy

END OF SECTION

SECTION 17101B

SPECIFIC CONTROL STRATEGIES - CAUSTIC SODA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Caustic Soda Storage Loading Station.
   2. Caustic Soda Transfer Pumps.
   3. Caustic Soda Small Feed Pumps.
   4. Caustic Soda Large Feed Pumps.
   5. Primary Coagulant Transfer Pumps.
   6. Primary Coagulant Feed Pumps
   7. PAC System
   8. PEA Filter Aid Small Feed Pumps.
   9. PEA Filter Aid Large Feed Pumps.
   10. PEA Floc Aid Feed Pumps.
   11. PEA Filter Aid Dosing Pump.
   12. PEC Feed Storage and Loading Station.
   13. PEC Transfer Pumps.
   14. PEC Feed Pumps.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Definitions:
   1. Loop description: Specific control requirements and functional descriptions for individual control loops.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Develop detailed loop descriptions based on the information in the Contract Documents:
   1. Submit loop descriptions with all implemented modifications from this Section clearly marked.
   2. Remove all markings on final loop descriptions submitted with the applicable operation and maintenance manuals.

1.04 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CAUSTIC SODA STORAGE LOADING STATION

A. General:
   1. References:
      a. 65N01.
   2. Key equipment:
      a. TNK-6501: Caustic Soda Tank 1.
      b. TNK-6502: Caustic Soda Tank 2.
      c. TNK-6503: Caustic Soda Tank 3.
      d. LCP-6500: Caustic Soda Loading Panel.
   3. Abstract:
      a. The PLC transmits the real-time tank levels of the Caustic storage tanks (TNK-6501, TNK-6502, TNK-6503) to digital indicators at the new Caustic fill station level alarm panel

B. Hardwired controls:
   1. Pilot devices:
      a. Field:
         1) None.
      b. LCP:
         1) None.
      c. Drive/starter enclosure:
         1) None.
      d. VCP:
         1) None.
   2. Interlocks:
      a. Field:
         1) None.
      b. Drive/starter enclosure:
         1) None.
      c. VCP:
         1) None.
   3. Indicators and alarms:
      a. Field:
         1) None.
      b. LCP:
         1) HORN.
         2) SILENCE.
         3) STROBE.
         4) Level Indicator: LI-6501.
         5) Level Indicator: LI-6502.
         6) Level Indicator: LI-6503.
      c. Drive/starter enclosure:
         1) None.
      d. VCP:
         1) None.

C. VCP control:
    1. None.

D. LOI control:
    1. None.

E. PCS controls:
    1. Manual mode:
        a. None.
    2. Auto mode:
        a. If the tank level reaches the High level setpoint (20.5 feet) the strobe will initiate. If the tank level reaches the High-High level setpoint (21 feet) the horn will initiate. The silence button must manually be pushed to stop the strobe and horn**.**
    3. Indicators and alarms:
        a. Refer to Drawings and Section 17100 - Control Strategies for indicators and alarms.
        b. Additional indicators and alarms:
            1) None.

3.02 CAUSTIC SODA TRANSFER PUMPS

A. General:
    1. References:
        a. 65N02.
    2. Key equipment:
        a. PMP-6511: Caustic Soda Transfer Pump 1.
        b. PMP-6521: Caustic Soda Transfer Pump 2.
    3. Abstract:
        a. The Caustic Soda (CS) transfer pumps operate in a duty standby configuration to transfer Caustic Soda (25 percent or 50 percent) from the CS bulk storage tanks to the CS day tank. The transfer pumps will be 1 duty + 1 standby configuration. The standby pump will be called to run automatically if the duty pump fails to run when called. A transfer pump is called to run when the CS day tank reaches an operator-enterable low-level, as determined by the weight or level. The transfer pump will continue to run at constant speed until the level in the tank reaches an operator adjustable high level as determined by the weight (WIT-6531) or level (LIT-6531), as selected by the operator. An operator adjustable time delay will monitor the tank level; if the tank level does not begin to increase with the time delay after a transfer pump has been called to run, or does not reach the high level set point within a maximum time setpoint, an alarm will be issued and the transfer pump will be given a fail status.
            1) The pumps may be controlled locally or remotely in manual or automatic operations.
            2) The pumps switch between duty and standby after each run cycle. Pumps with a status of “Not Ready” or “Out-of-Service” (OOS) shall be automatically removed from the start sequence. The pumps shall respond to a start permissive from the PLC. If a pump fails, fails to start or stop, or becomes otherwise unavailable (i.e. Not Ready) the condition shall be alarm registered at the HMI and the next pump in

sequence shall be immediately called to start or stop (thereby bypassing the preset timers).

3) In automatic control, they are operated based on level or weight setpoints in the day tank.
4) Pumps are automatically shut down if an overflow is detected by a High High level in the day tank, max weight exceedance on scale, or flood switch trigger in the containment area. Pump can also be shut down by a maximum pump run time exceedance.
5) Operators manually select which bulk tank they transfer pumps are pumping from by opening/closing isolation valves. Online tank should be selected/indicated in SCADA.
6) Operators must select the caustic percent concentration (25 percent or 50 percent) to automatically adjust setpoints.

B. Hardwired control:
   1. Pilot devices:
      a. Field:
         1) None.
      b. LCP:
         1) None
      c. Drive/starter enclosure:
         1) HAND- OFF- AUTO (HOA) selector switch.
         2) In HAND mode the following controls may be used:
            a) START/STOP Pushbutton.
      d. VCP:
         1) None.
   2. Interlocks:
      a. Field:
         1) Pump is stopped, the motor latched out, and the FAIL alarm activated if:
            a) Motor high temperature switch is activated.
            b) The motor winding heater is activated.
            c) Pressure switch high is activated: high discharge pressure is detected, indicating a block in the line, while the pump is running.
            d) Tank Level HIGH HIGH is detected (7 feet) OR Max Weight on Scale is exceeded (21,100 pounds for 50 percent or 17,900 pounds for 25 percent), indicating a tank overflow, while the pump is running. Setpoint indicator (level or weight) is selected by the operator and adjustable.
            e) Flood switch trigger in the containment area.
      b. Drive/starter enclosure:
         1) For each pump:
            a) With the HOA selector switch at the MCC in HAND position, the pump is started and stopped using the by moving the HOA selector switch from HAND to OFF at the MCC.
            b) When the HOA selector switch on the MCC is set to AUTO mode, the pump is controlled by the facility PLC.
            c) When the HOA selector switch on the MCC is set to OFF mode, the pump is prevented from running.
            d) Pump Alarms can be RESET by cycling the HOA selector switch from HAND or AUTO to OFF and back again.

c. VCP:
    1) None.

3. Indicators and alarms:
    a. Field:
        1) None.
    b. LCP:
        1) None.
    c. Drive/starter enclosure:
        1) Pumps:
            a) RUNNING indicator light.
            b) FAIL indicator light.
    d. VCP:
        1) None.

C. VCP control:
1. None.

D. LOI control:
1. None.

E. PCS control:
1. Manual mode:
    a. Refer to Section 17100 - Control Strategies.
    b. With AUTO selected from the HOA Selector Switch and HAND selected in the PCS the following controls may be used:
        1) RUN.
        2) STOP.
2. Auto mode:
    a. The CS Transfer Pumps operate in a duty/standby configuration. The pumps will rotate between duty and standby after each tank fill - after the duty pump is called to stop, when it reaches the tank high setpoint, it will rotate to the standby pump and the standby pump will rotate to the duty pump.
    b. Operator selects concentration of caustic from a dropdown menu (25 percent or 50 percent)
    c. With AUTO selected from the HOA Selector Switch and AUTO selected in the PCS the pump is controlled as follows:
        1) Start the duty transfer pump when day tank level (LIT-6531) LOW (0.5 feet) or weight (WIT-6531) LOW (1,500 pounds for 50 percent or 1,30 pounds for 25 percent) set point is reached. Setpoint indicator (level or weight) is selected by the operator and adjustable.
        2) Stop the duty transfer pump when day tank level (LIT-6531) HIGH (6.5 feet) or weight (WIT-6531) HIGH (19,700 pounds for 50 percent or 16,600 pounds for 25 percent) set point is reached. Setpoint indicator (level or weight) is selected by the operator and adjustable.
            a) If tank level HIGH setpoint is not reached within a maximum time limit after the pump turns on (70 minutes), the pump will automatically shut down.
            b) If tank level does not increase within a maximum time limit after the pump turns on (2 minutes), the pump will automatically shut down.

3) The CS transfer pumps will be prohibited from starting or will shut down if the online bulk tank low level set point (1 foot) is reached. The SCADA HMI screen shall be modified to provide a CS bulk tank duty selection toggle, so that the PLC program knows which level transmitter (LIT-6501, LIT-6502, LIT-6503) data to use to determine when to shut the transfer pumps off.

3. Indicators, alarms, and setpoints:
   a. Indicators and alarms:
      1) AUTO mode indication.
      2) RUNNING indication.
      3) High Temperature Alarm.
      4) High Discharge Pressure Alarm
      5) Refer to Drawings and Section 17100 - Control Strategies for indicators and alarms.
      6) Additional indicators and alarms:
         a) Alarm if the online bulk tank low level set point is triggered.

3.03 CAUSTIC SODA SMALL FEED PUMPS

A. General:
   1. References:
      a. 65N03.
   2. Key equipment:
      a. PMP-6541: Caustic Soda Small Feed Pump 1.
      b. PMP-6562: Caustic Soda Small Feed Pump 2.
   3. Abstract:
      a. The Caustic Soda (CS) Small Feed pumps provide pH adjustment to Clearwell Outlet Structure. The small CS pumps operate in a duty/standby configuration and are supplied by the CS Day Tank (TNK-6531). The standby pump can be brought automatically online following an alarm from the duty pump.
      b. The pumps may be controlled locally or remotely in manual or automatic operations. In automatic control they operate in FLOW PACED MODE or TRIM MODE.
      c. Operator must adjust manual isolation valves to switch between the large (for high flows) and small (for low flows) pumps. There will be a toggle on the SCADA HMI screen to allow the operator to select whether the plant is operating in the High Flow, or Low Flow modes.
      d. Operators must select the caustic percent concentration (25 percent or 50 percent) to automatically adjust setpoints.

B. Hardwired controls:
   1. Pilot devices:
      a. Field:
         1) None.
      b. LCP:
         1) None.
      c. Drive/starter enclosure:
         1) Speed setpoint: 4-20 mA.
         2) Speed feedback: 4-20 mA.
         3) REMOTE status dry contact.

4) RUN status dry contact.
5) LEAK alarm dry contact.
6) FAILURE alarm dry contact.
7) Pump Run Command.

d. VCP:
1) Integral VCP on pump face with manual or automatic modes.
2) See pump control enclosure components listed above. In manual mode the following controls may be used from the VCP
a) START/STOP Pushbutton.
b) SPEED Keypad.
c) Navigation Click Wheel.

2. Interlocks:
a. Field:
1) In any mode of operation, the pumps are stopped and prohibited from starting if:
a) High discharge pressure switch is activated (as relayed by PLC logic).

b. Drive/starter enclosure:
1) None.

c. VCP:
1) As provided by Vendor.

3. Indicators and alarms:
a. Field:
1) None.

b. LCP:
1) None.

c. Drive/starter enclosure:
1) None.

d. VCP:
1) Speed setpoint: 4-20 mA.
2) Speed feedback: 4-20 mA.
3) REMOTE status dry contact.
4) LEAK alarm dry contact.
5) FAILURE alarm dry contact.
6) Pump Run Command
7) Pump RUNNING Indication.
8) Pump FAIL Alarm.
9) As provided by Vendor.

C. VCP control:
1. None.

D. LOI control:
1. None.

E. PCS controls:
1. Manual mode:
a. Refer to Section 17100 - Control Strategies.

b. With HAND selected from the pump's VCP the following controls may be used:
    1) RUN.
    2) STOP.
    3) Analog SPEED control via rotating knob on panel front.
    4) Analog dose selection from VCP HMI screen.

2. Auto mode:
    a. With AUTO selected from the pump's VCP the following controls may be used:
        1) Pumps operate in a duty/standby configuration. Pumps automatically rotate positions (duty/standby) any time they are shut down. The standby pump can be brought automatically online following an alarm from the other pump.
        2) Provide an HMI screen selection palette that allows the Operator to choose if the individual CS Feed Pump is Duty, Standby, or Out-of-Service (OOS).
        3) The PLC shall command the pump to stop if the discharge pressure (PISH-6541, PISH-6562) set point is reached.
        4) The PLC shall signal an alarm when the operator selectable max temperature (150 degrees F) on TIT-6585 is exceeded.
        5) FLOW PACED MODE:
            a) The PLC will adjust the speed of the running pump to maintain flow pacing with the plant finished water flow. The PLC will adjust the speed of the running pump via a PID control algorithm to maintain a setpoint flow, where:
                (1) Q_A = Desired chemical dosage set point in the process stream (mg/L).
                (2) Q_B = Percentage concentration of the chemical in the chemical solution to be fed (%) - 25 percent or 50 percent.
                (3) Q_C = Specific gravity of the chemical solution - 1.28 for 25 percent and 1.53 for 50 percent.
                (4) Q_D = Calibrated maximum flow rate of the feed pump (GPH).
                (5) Process flow rate F.
                    (a) F = Finished water flow rate as measured by FWR-FE-101 flow meter.
                (6) Calculated pump speed (0 - 100 percent) = 100 percent x $(4.18 \times Q_A \times F) / (Q_B \times Q_C \times Q_D)$.
        6) TRIM MODE:
            a) The Operator selects Residual pH Trim Mode On or Off. If the Trim Mode is On, the PLC is programmed with a PID control algorithm to provide pH residual feedback control. The PID parameters are as follows:
                (1) Set Point = Operator entered desired pH set point.
                (2) Process Variable = pH as measured by 12.5 MG Reservoir Outlet pH Transmitter (FWR-AIT-106).
                (3) Output = pH calculated trim, -15 percent to 15 percent.
            b) The pH calculated trim is added to the Calculated Pump Speed. The maximum trim modification to the Calculated Pump Speed is +/- 15 percent.

7) If the calculated pump speed is less than an operator adjustable minimum speed set point or greater than 100 percent, the PLC generates a SCADA alarm.
8) Calculated pounds chemical per gallon of chemical solution = (8.33 x Q_B x Q_C) / 100 percent. The PLC displays the calculated value on the SCADA graphic screen.
9) Calculated desired chemical solution flow rate (GPH) = (4.18 x Q_A x F) / (Q_B x Q_C). The PLC displays the calculated value on the SCADA graphic screen.
10) Chemical solution flow rate (GPH) as measured by the CS large or small magnetic flow meter (FIT-6563 "Low Flow" or FIT-6583 "High Flow," as selected by manual isolation valves) is displayed by the PLC on the SCADA graphic screen. There will be a flow meter mode selection toggle on the SCADA HMI screen to allow the operator to select FIT-6563 or FIT-6583 (as determined by the Operator's selection of whether the plant is operating in the High Flow, or Low Flow modes).
    a) If the chemical solution flow rate (GPH) as measured by the CS large or small magnetic flow meter (FIT-6563 or FIT-6583; as selected by manual isolation valves) differs from the calculated desired chemical solution flow rate (GPH) the PLC generates a SCADA alarm.

3. In any mode of operation, if the associated carrier water solenoid valve (SV-6584) is ONLINE, the valve will be commanded to OPEN when the pump START/RUN command has been selected. The valve will remain OPENED for an operator adjustable time delay after the pump has STOPPED.
4. Indicators and alarms:
    a. Refer to Drawings and Section 17100 - Control Strategies for indicators and alarms.
    b. Additional indicators and alarms:
        1) Alarm if pH drops below 8 for more than 10 minutes.
        2) Alarm if caustic temperature probe reading is above 150 degrees Fahrenheit.
        3) High Discharge Pressure indication for each pump.

3.04 CAUSTIC SODA LARGE FEED PUMPS

A. General:
    1. References:
        a. 65N04.
    2. Key equipment:
        a. PMP-6572: Caustic Soda Large Feed Pump 1.
        b. PMP-6582: Caustic Soda Large Feed Pump 2.
    3. Abstract:
        a. The Caustic Soda (CS) Large Feed pumps provide pH adjustment to Clearwell Outlet Structure. The large CS pumps operate in a duty/standby configuration and are supplied by the CS Day Tank (TNK-6531). The standby pump can be brought automatically online following an alarm from the duty pump

b. The pumps may be controlled locally or remotely in manual or automatic operations. In automatic control they operate in FLOW PACED MODE or TRIM MODE.
c. Operator must adjust manual isolation valves to switch between the large (for high flows) and small (for low flows) pumps. There will be a toggle on the SCADA HMI screen to allow the operator to select whether the plant is operating in the High Flow, or Low Flow modes.
d. Operators must select the caustic percent concentration (25 percent or 50 percent) to automatically adjust setpoints.

B. Hardwired controls:
1. Pilot devices:
a. Field:
1) None.
b. LCP:
1) None.
c. Drive/starter enclosure:
1) HAND-OFF-AUTO (HOA) selector switch.
2) SPEED keypad.
3) RESET pushbutton.
d. VCP:
1) None.
2. Interlocks:
a. Field:
1) In any mode of operation, the pumps are stopped and prohibited from starting if:
a) Motor high temperature switch is activated.
b) The motor winding heater is activated when the pump is not running in any mode of operation.
c) High discharge pressure switch is activated.
b. Drive/starter enclosure:
1) None.
c. VCP:
1) None.
3. Indicators and alarms:
a. Field:
1) None.
b. LCP:
1) None.
c. Drive/starter enclosure:
1) Pump Running indicator light.
2) Pump Fail indicator light.
d. VCP:
1) None.

C. VCP control:
1. None.

D. LOI control:
1. None.

E. PCS controls:
1. Manual mode:
a. With AUTO selected from the HOA Selector Switch and HAND selected in the PCS the following controls may be used:
1) RUN.
2) STOP.
3) SPEED INPUT.
2. Auto mode:
a. With AUTO selected from the HOA Selector Switch and AUTO selected in the PCS the following controls may be used:
1) Pumps operate in a duty/standby configuration. Pumps automatically rotate positions (duty/standby) any time they are shut down. The standby pump can be brought automatically online following an alarm from the other pump.
2) Provide an HMI screen selection palette that allows the Operator to choose if the individual CS Feed Pump is Duty, Standby, or Out-of-Service (OOS).
3) The PLC shall command the pump to stop if the discharge pressure (PISH-6572, PISH-6582) set point is reached.
4) The PLC shall signal an alarm when the operator selectable max temperature (150 degrees F) on TIT-6585 is exceeded.
5) FLOW PACED MODE:
a) The PLC will adjust the speed of the running pump to maintain flow pacing with the plant finished water flow. The PLC will adjust the speed of the running pump via a PID control algorithm to maintain a setpoint flow, where:
(1) Q_A = Desired chemical dosage set point in the process stream (mg/L).
(2) Q_B = Percentage concentration of the chemical in the chemical solution to be fed (%) - 25 percent or 50 percent.
(3) Q_C = Specific gravity of the chemical solution - 1.28 for 25 percent and 1.53 for 50.
(4) Q_D = Calibrated maximum flow rate of the feed pump (GPM).
(5) Process flow rate F.
(a) F = Finished water flow rate as measured by FWR-FE-101 flow meter.
(6) Calculated pump speed (0 - 100 percent) = 100 percent x $(4.18 \times Q_A \times F) / (Q_B \times Q_C \times Q_D \times 60)$.
6) Trim mode:
a) The Operator selects Residual pH Trim Mode On or Off. If the Trim Mode is On, the PLC is programmed with a PID control algorithm to provide pH residual feedback control. The PID parameters are as follows:
(1) Set Point = Operator entered desired pH set point.
(2) Process Variable = pH as measured by 12.5 MG Reservoir Outlet pH Transmitter (FWR-AIT-106).
(3) Output = pH calculated trim, -15 percent to 15 percent.
b) The pH calculated trim is added to the Calculated Pump Speed. The maximum trim modification to the Calculated Pump Speed is +/- 15 percent.

7) If the calculated pump speed is less than an operator adjustable minimum speed set point or greater than 100 percent, the PLC generates a SCADA alarm.
8) Calculated pounds chemical per gallon of chemical solution = (8.33 x Q_B x Q_C) / 100 percent. The PLC displays the calculated value on the SCADA graphic screen.
9) Calculated desired chemical solution flow rate (GPM) = (4.18 x Q_A x F) / (Q_B x Q_C x 60). The PLC displays the calculated value on the SCADA graphic screen.
10) Chemical solution flow rate (GPM) as measured by the CS large or small magnetic flow meter (FIT-6563 "Low Flow" or FIT-6583 "High Flow," as selected by manual isolation valves) is displayed by the PLC on the SCADA graphic screen. There will be a flow meter mode selection toggle on the SCADA HMI screen to allow the operator to select FIT-6563 or FIT-6583 (as determined by the Operator's selection of whether the plant is operating in the High Flow, or Low Flow modes).
a) If the chemical solution flow rate (GPM) as measured by the CS large or small magnetic flow meter (FIT-6563 or FIT-6583; as selected by manual isolation valves) differs from the calculated desired chemical solution flow rate (GPH) the PLC generates a SCADA alarm.

3. In any mode of operation, if the associated carrier water solenoid valve (SV-6584) is ONLINE, the valve will be commanded to OPEN when the pump START/RUN command has been selected. The valve will remain OPENED for an operator adjustable time delay after the pump has STOPPED.
4. Indicators and alarms:
   a. Refer to Drawings and Section 17100 - Control Strategies for indicators and alarms.
   b. Additional indicators and alarms:
      1) Alarm if pH drops below 8 for more than 10 minutes.
      2) Alarm if caustic temperature probe reading is above 150 degrees Fahrenheit.
      3) High Discharge Pressure indication.

3.05 PRIMARY COAGULANT TRANSFER PUMPS

A. General:
   1. References:
      a. 62N02.
   2. Key equipment:
      a. PMP-6201: Primary Coagulant Transfer Pump 1.
      b. PMP-6202: Primary Coagulant Transfer Pump 2.
      c. LIT-6211: Primary Coagulant Day Tank Radar Level.
      d. TNK-6211: Primary Coagulant Day Tank.
   3. Abstract:

      The Primary Coagulant (PC) transfer pumps operate in a duty standby configuration to transfer chemicals (PACL) from the PC bulk storage tanks to the PC day tank. The transfer pumps will be 1 duty + 1 standby configuration. The standby pump will be called to run automatically if the duty pump fails to run when called. A transfer pump is called to run when

the primary coagulant day tank reaches an operator-enterable low-level, as determined by the weight or level. The transfer pump will continue to run at constant speed until the level in the tank reaches an operator adjustable high level as determined by the weight (WIT-6211) or level (LIT-6211), as selected by the operator. An operator adjustable time delay will monitor the tank level; if the tank level does not begin to increase with the time delay after a transfer pump has been called to run, or does not reach the high level set point within a maximum time setpoint, an alarm will be issued and the transfer pump will be given a fail status.

1) The pumps may be controlled locally or remotely in manual or automatic operations.
2) The pumps switch between duty and standby after each run cycle. Pumps with a status of “Not Ready” or “Out-of-Service” (OOS) shall be automatically removed from the start sequence. The pumps shall respond to a start permissive from the PLC. If a pump fails, fails to start or stop, or becomes otherwise unavailable (i.e. Not Ready) the condition shall be alarm registered at the HMI and the next pump in sequence shall be immediately called to start or stop (thereby bypassing the preset timers).
3) In automatic control, they are operated based on level or weight setpoints in the day tank.
4) Pumps are automatically shutdown if an overflow is detected by High High level in the primary coagulant day tank, max weight exceedance on scale, or flood switch trigger in the containment area. Pumps can also be shutdown by a maximum pump run time exceedance.
5) Operators manually select which bulk tank the transfer pumps are pumping from by opening/closing existing isolation valves. Online tank should be selected/indicated in SCADA.

B. Hardwired control:
   1. Pilot devices:
      a. Field:
         1) None.
      b. LCP:
         1) None.
      c. Drive/starter enclosure:
         1) HAND- OFF- AUTO (HOA) selector switch.
         2) In HAND mode the following controls may be used:
            a) START/STOP Pushbutton.
      d. VCP:
         1) None.
   2. Interlocks:
      a. Field:
         1) Pump is stopped, the motor latched out, and the FAIL alarm activated if:
            a) Pressure switch high is activated: high discharge pressure is detected, indicating a block in the line, while the pump is running.
            b) Tank Level HIGH HIGH is detected (5.5 feet) OR Max Weight on Scale is exceeded (10,100 lbs), indicating a tank overflow, while the pump is running. Setpoint indicator (level or weight) is selected by the operator and adjustable.

c) Flood switch trigger in the containment area.
d) Motor high temperature switch is activated.
e) The motor winding heater is activated.

b. Drive/starter enclosure:
1) For each pump:
a) With the HOA selector switch at the MCC in HAND position, the pump is started and stopped using the by moving the HOA selector switch from HAND to OFF at the MCC.
b) When the HOA selector switch on the MCC is set to AUTO mode, the pump is controlled by the facility PLC.
c) When the HOA selector switch on the MCC is set to OFF mode, the pump is prevented from running.
d) Pump Alarms can be RESET by cycling the HOA selector switch from HAND or AUTO to OFF and back again.

c. VCP:
1) None.

3. Indicators and alarms:
a. Field:
1) None.
b. LCP:
1) None.
c. Drive/starter enclosure:
1) Pumps:
a) RUNNING indicator light.
b) FAIL indicator light.
d. VCP:
1) None.

C. VCP control:
1. None.

D. LOI control:
1. None.

E. PCS control:
1. Manual mode:
a. Refer to Section 17100 - Control Strategies.
b. With AUTO selected from the HOA Selector Switch and HAND selected in the PCS the following controls may be used:
1) RUN.
2) STOP.
2. Auto mode:
a. The Primary Coagulant Transfer Pumps operate in a duty/standby configuration. The pumps will rotate between duty and standby after each tank fill - after the duty pump is called to stop, when it reaches the tank high setpoint, it will rotate to the standby pump and the standby pump will rotate to the duty pump.
b. With AUTO selected from the HOA Selector Switch and AUTO selected in the PCS the pump is controlled as follows:
1) Start the duty transfer pump when day tank level (LIT-6211) LOW (0.5 feet) or weight (WIT-6211) LOW (950 pounds) set point is

reached. Setpoint indicator (level or weight) is selected by the operator and adjustable.

2) Stop the duty transfer pump when day tank level (LIT-6211) HIGH (5 feet) or weight (WIT-6211) HIGH (9,500 pounds) set point is reached. Setpoint indicator (level or weight) is selected by the operator and adjustable.
   a) If tank level HIGH setpoint is not reached within a maximum time limit after the pump turns on (25 minutes), the pump will automatically shut down.
   b) If tank level does not increase within a maximum time limit after the pump turns on (2 minutes), the pump will automatically shut down.
3) The primary coagulant transfer pumps will be prohibited from starting or will shut down if the online bulk tank low level set point (1 foot) is reached. The SCADA HMI screen shall be modified to provide a primary coagulant bulk tank duty selection toggle, so that the PLC program knows which level transmitter (LIT-0126, LIT-0127, or LIT-0128) data to use to determine when to shut the transfer pumps off.

3. Indicators, alarms, and setpoints:
   a. Indicators and alarms:
      1) AUTO mode indication.
      2) RUNNING indication.
      3) High Temperature Alarm.
      4) High Discharge Pressure Alarm.
      5) Refer to Drawings and Section 17100 - Control Strategies for indicators and alarms.
      6) Additional indicators and alarms:
         a) Alarm if the online bulk tank low level set point is triggered.

3.06 PRIMARY COAGULANT FEED PUMPS

A. General:
   1. References:
      a. 62N02.
      b. 62N03.
      c. 62N04.
      d. 63N27.
   2. Key equipment:
      a. PMP-6204: Primary Coagulant Feed Pump 1.
      b. PISH-6204: Primary Coagulant Pressure Switch High.
      c. PMP-6205: Primary Coagulant Feed Pump 2.
      d. PISH-6205: Primary Coagulant Pressure Switch High.
      e. PMP-6211: Primary Coagulant Feed Pump 3.
      f. PISH-6211: Primary Coagulant Pressure Switch High.
      g. PMP-6221: Primary Coagulant Feed Pump 4.
      h. PISH-6221: Primary Coagulant Pressure Switch High.
      i. FIT-6215: Primary Coagulant Low Flow Meter.
      j. FIT-6216: Primary Coagulant High Flow Meter.
      k. TNK-6211: Primary Coagulant Day Tank.
      l. LIT-6211: PC Day Tank Level Transmitter.

m. WIT-6211: PC Day Tank Scale.

3. Abstract:
   a. The Primary Coagulant (PC) Feed pumps provide primary coagulant to the Rapid Mix System. The 4 PC pumps operate in a lead/lag1/lag2/standby configuration and are supplied by the PC Day Tank (TNK-6211).
   b. The pumps may be controlled locally or remotely in manual or automatic operations. In automatic control they operate in FLOW PACED MODE.
   c. The lead pump is called to turn on when flow at the Raw Water Meter Vault is detected (M-14 or M-15). If plant flows and dosages are such that the lead pump reaches an operator adjustable speed (90 percent), then the lag 1 pump is automatically brought online. If both lead and lag 1 pump are at or above the operator adjustable speed (90 percent), the lag 2 pump is automatically brought online. The standby pump can be brought automatically online following an alarm from any of the other pumps.

B. Hardwired controls:
   1. Pilot devices:
      a. Field:
         1) None.
      b. LCP:
         1) None.
      c. Drive/starter enclosure:
         1) Speed setpoint: 4-20 mA.
         2) Speed feedback: 4-20 mA.
         3) REMOTE status dry contact.
         4) RUN status dry contact.
         5) LEAK alarm dry contact.
         6) FAILURE alarm dry contact.
         7) Pump Run Command.
      d. VCP:
         1) Integral VCP on pump face with manual or automatic modes.
         2) See pump control enclosure components listed above. In manual mode the following controls may be used from the VCP:
            a) START/STOP Pushbutton.
            b) SPEED Keypad.
            c) Navigation Click Wheel.
   2. Interlocks:
      a. Field:
         1) In any mode of operation, the pumps are stopped and prohibited from starting if:
            a) High discharge pressure switch is activated (as relayed by PLC logic).
      b. Drive/starter enclosure:
         1) None.
      c. VCP:
         1) As provided by Vendor.
   3. Indicators and alarms:
      a. Field:
         1) None.

b. LCP:
    1) None.
c. Drive/starter enclosure:
    1) None.
d. VCP:
    1) Speed setpoint: 4-20 mA.
    2) Speed feedback: 4-20 mA.
    3) REMOTE status dry contact.
    4) LEAK alarm dry contact.
    5) FAILURE alarm dry contact.
    6) Pump Run Command.
    7) Pump RUNNING Indication.
    8) Pump FAIL Alarm.
    9) As provided by Vendor.

C. VCP control:
1. None.

D. LOI control:
1. None.

E. PCS controls:
1. Manual mode:
    a. Refer to Section 17100 - Control Strategies.
    b. With HAND selected from the pump's VCP the following controls may be used:
        1) START.
        2) STOP.
        3) Analog SPEED control via rotating knob on panel front.
        4) Analog dose selection from VCP HMI screen.
2. Auto mode:
    a. With AUTO selected from the pump's VCP the following controls may be used:
        1) Pumps operate in a lead/lag/lag/standby configuration. The lead pump is called to turn on when flow at the Raw Water Meter Vault is detected (M-14 or M-16). If plant flows and dosages are such that the lead pump reaches an operator adjustable speed (90 percent), then the lag1 pump is automatically brought online. If both lead and lag 1 pump are at or above the operator adjustable speed (90 percent), the lag 2 pump is automatically brought online. The standby pump can be brought automatically online following an alarm from any of the other pumps.
        2) Pumps automatically rotate positions (lead, lag 1, lag 2, standby) any time they are shut down.
        3) Provide an HMI screen selection palette that allows the Operator to choose if the individual Primary Coagulant Feed Pump is Duty, Standby, or Out-of-Service (OOS).
        4) The PLC shall command the pump to stop if the discharge pressure (PISH-6204, PISH-6205, PISH-6211, PISH-6221) set point is reached.

5) FLOW PACED MODE:
   a) The PLC will adjust the speed of the running pump(s) to maintain flow pacing with the influent flow. The PLC will adjust the speed of the running pump(s) via a PID control algorithm to maintain a setpoint flow, where:
      (1) Q_A = Desired chemical dosage set point in the process stream (mg/L).
      (2) Q_B = Percentage concentration of the chemical in the chemical solution to be fed (%).
      (3) Q_C = Specific gravity of the chemical solution.
      (4) Q_D = Calibrated maximum flow rate of the feed pump (GPH).
      (5) Process flow rate F.
         (a) F = Raw water flow rate as measured by the small (M-14) or large (M-15) flow meter.
      (6) Calculated pump speed (0 - 100%) = 100% x (4.18 x Q_A x F) / (Q_B x Q_C x Q_D).
6) If the calculated pump speed is less than an operator adjustable minimum speed set point or greater than 100%, the PLC generates a SCADA alarm.
7) Calculated pounds chemical per gallon of chemical solution = (8.33 x Q_B x Q_C) / 100%. The PLC displays the calculated value on the SCADA graphic screen.
8) Calculated desired chemical solution flow rate (GPH) = (4.18 x Q_A x F) / (Q_B x Q_C). The PLC displays the calculated value on the SCADA graphic screen.
9) Chemical solution flow rate (GPH) as measured by the PC large or small magnetic flow meter (FIT-6215 “Low Flow” or FIT-6216 “High Flow,” as selected by manual isolation valves) is displayed by the PLC on the SCADA graphic screen. There will be a flow meter mode selection toggle on the SCADA HMI screen to allow the operator to select FIT-6215 or FIT-6216 (as determined by the Operator’s selection of whether the plant is operating in the High Flow, or Low Flow modes).
   a) If the chemical solution flow rate (GPH) as measured by the PC large or small magnetic flow meter (FIT-6215 or FIT-6216; as selected by manual isolation valves) differs from the calculated desired chemical solution flow rate (GPH) the PLC generates a SCADA alarm.

3. Indicators and alarms:
   a. Refer to Drawings and Section 17100 - Control Strategies for indicators and alarms.
   b. Additional indicators and alarms:
      1) High discharge pressure indication for each pump.

3.07 PAC SYSTEM

A. General:
   1. References:
      a. 68N01.
      b. 68N02.

c. 68N03.
d. 68N04.
e. 68N05.
f. 68N06.

2. Key equipment:
   a. VCP-6800: PAC Feed System Vendor Control Panel.
   b. VCP-6801: Truck Unloading Vendor Control Panel.
   c. VCP-6802: Vendor Motor Starter Panel.
   d. VCP-6820: Air Compressor Vendor Control Panel.
   e. VCP-6830: PAC Feed System Vendor Control Panel.
   f. VCP-6831: Truck Unloading Vendor Control Panel.
   g. VCP-6832: Vendor Motor Starter Panel.
   h. VCP-6850: Air Compressor Vendor Control Panel.
3. Abstract:
   a. There are 2 PAC systems. Each system consists of a feed system, truck unloading, motor starter and air compressor control panels. Refer to Section 13270 - PAC Storage and Handling System.

B. VCP control:
1. Hand mode:
   a. Refer to Section 13270 - PAC Storage and Handling System.
2. Auto mode:
   a. Refer to Section 13270 - PAC Storage and Handling System.

C. LOI control:
1. None.

D. PCS controls:
1. Hand mode:
   a. Refer to Section 13270 - PAC Storage and Handling System.
2. Auto mode:
   a. Refer to Section 13270 - PAC Storage and Handling System.
3. Indicators and alarms:
   a. Refer to Drawings, Section 13270 - PAC Storage and Handling System and Section 17100 - Control Strategies for indicators and alarms.
   b. Additional indicators and alarms:
      1) None.

3.08 PEA BATCHING SYSTEM

A. General:
1. References:
   a. 69N01.
   b. 69N02.
2. Key equipment:
   a. VCP-6901: PEA Feed System Vendor Control Panel.
3. Abstract:
   a. The PEA dry feeders operate in a duty/standby configuration to transfer dry polymer, via a blower, from the dry feeder hopper to one of two PEA Aging Tanks, where the dry polymer is emulsified and aged. The batch system may be controlled locally or remotely in manual or automatic

operations. In automatic control the dry feeders are operated based on level setpoints in the Aging Tanks (as measured by PDIT-6905, or PDIT-6915). The Aging tanks feed the PEA Filter Aid and Floc Aid feed pumps.

b. The dry feeders rotate after each cycle (i.e., after aging tank level setpoint is reached). Aging tank designation also rotates after each cycle to either batch mode or aging mode. The switch between dry feeders and batch tanks is automatically controlled by the diverter valves provided from the vendor.

B. Hardwired controls:
1. Pilot devices:
a. Field:
1) None.
b. LCP:
1) None.
c. Drive/starter enclosure:
1) None.
d. VCP:
1) With HAND selected from the HOA Selector Switch the following controls may be used from the VCP
a) START/STOP Pushbutton and solution concentration adjustment for the dry feeder.
b) RUN, STOP, and SPEED INPUT for the aging tank mixer.
e. Field:
1) The dry feeder is stopped, and the FAIL alarm activated if:
a) Low level hopper level is detected.
b) Blocked funnel alarm is detected.
c) Low water pressure alarm is detected.
d) Dilution water motorized valve (VAL-6903 or VAL-6913) FAIL alarm is activated.
e) Aging Tank High-High Level is detected.
f) Motor overload alarm detected.
2) As provided by Vendor.
f. Drive/starter enclosure:
1) None.
g. VCP:
1) As provided by Vendor.
2. Indicators and alarms:
a. Field:
1) None.
b. LCP:
1) None.
c. Drive/starter enclosure:
1) None.
d. VCP:
1) Blower Running Indication.
2) Blower Fail Alarm.
3) Low Hopper Level Alarm.
4) Blocked Funnel Alarm.
5) Mixer Running Indication.

6) Mixer Fail Alarm.
7) Diverter valve: AUTO status, CLOSED status, OPEN status.
8) Dilution Water valve: AUTO status, CLOSED status, OPEN status.
9) Rapid Fill valve: AUTO status, CLOSED status, OPEN status.
10) Dilution water low pressure alarm.
11) Batch counter.
10) As provided by Vendor.

C. VCP control:
   a. None.

D. LOI control:
   1. None.

E. PCS controls:
   1. Manual mode:
      a. With AUTO selected from the HOA Selector Switch and HAND selected in the PCS the following controls may be used for the dry feeder:
         1) START.
         2) STOP.
         3) Solution concentration adjustment.
         4) Dry feeder duty/standby selection to adjust diverter valve position.
      b. With AUTO selected from the HOA Selector Switch and HAND selected in the PCS the following controls may be used for the aging tank:
         1) START, STOP, SPEED INPUT for the mixer (MIX-6905, MIX-6915).
         2) OPEN/CLOSE for the dilution water motorized valves (VAL-6903, VAL-6913).
         3) OPEN/CLOSE for the aging tank outlet motorized valve (VAL-6906, VAL-6916).
         4) Aging tank mode to adjust diverter valve (FV-6902, FV-6912) position.
         5) Rapid Fill mode at either Aging tank (TNK-6905, TNK-6915) can be selected. This will open the rapid fill valve (VAL-6904, VAL-6914) to rapidly dilute the Aging Tank. The valve will automatically close when the tank high level set point (5.5 feet) is reached.
   2. Auto mode:
      a. The dry feeders (TNK-6901, TNK-6911) operate in a duty/standby configuration. After the duty dry feeder is called to stop (after batch tank high level setpoint is reached) it will rotate to standby mode and the other feeder will rotate to duty mode. Aging tanks (TNK-6905, TNK-6915) rotate in a similar fashion, but between Batch Mode and Aging Mode. The switch between dry feeders and batch tanks is automatically controlled by the diverter valves (FV-6902, FV-6912) provided from the vendor. The standby dry feeder can be brought automatically online following an alarm of the other dry feeder.
      b. With AUTO selected from the HOA Selector Switch and AUTO selected in the PCS the dry feeder is controlled as follows:
         1) START the duty dry feeder when aging tank low level (PDIT-6905, or PDIT-6915) setpoint is reached (1.5 feet).
            a) The blower (BL-6901, or BLO-6911) will be on an operator adjustable time delay. When the blower is called to RUN, the

dilution water motorized valve (VAL-6903, or VAL-6913) at the wetting head will OPEN several seconds before the blower turns on.

2) STOP the duty dry feeder when aging tank level (PDIT-6905, or PDIT-6915) setpoint is reached (5.0 feet).
   a) The dilution water motorized valve (VAL-6903, or VAL-6913) at the wetting head will be on an operator adjustable time delay. When the blower is called to STOP, the valve will be called to CLOSE a few seconds after the blower is turned off.
3) If the blower fails to start, the funnel is blocked, or hopper level is low, an alarm will trigger and the standby dry feeder will be called to START.
4) If the dilution water valve fails to open an alarm will trigger and the dry feeder will be called to STOP.

c. With AUTO selected from the HOA Selector Switch and AUTO selected in the PCS the aging tank is controlled as follows:
   1) The 2 aging tanks (TNK-6905, TNK-6915) can be in 1 of 2 modes: Batch Mode or Aging Mode.
      a) When in Batch Mode the outlet motorized valve (VAL-6906, VAL-6916) is open and polymer is being pumped from the tank. Once the low level setpoint is reached (1.5 feet) the motorized valve closes and the tank mode switches to Aging Mode.
      b) When in Aging Mode the outlet motorized valve (VAL-6906, VAL-6916) is closed and the diverter valve (FV-6902, FV-6912) is oriented to convey dry polymer to the tank. Once the high level setpoint (5.0 feet) is reached a timer will start to track polymer aging time. The tank will remain in Aging Mode until the Batch tank reaches its low level setpoint, at that point the Aging tank automatically switches to Batch Mode and the outlet motorized valve is called to open. If the Aging tank is called to Batch Mode before the timer reaches 60 minutes, an alarm will trigger.
   2) If the Aging Tank high-high level (5.5 feet) alarm is activated the dry feeders shall be called to STOP and the dilution water valve shall be called to CLOSE.
d. Provide weight readout on SCADA (WIT-6905, WIT-6915). If the maximum weight is exceeded (18,000 lbs) an alarm will trigger.

3. Indicators and alarms:
   a. Refer to Drawings and Section 17100 - Control Strategies for indicators and alarms.
   b. Additional indicators and alarms:
      1) Max weight exceedance (18,000 pounds).

3.09 PEA FILTER AID SMALL FEED PUMPS

A. General:
   1. References:
      a. 69N04.
      b. 69N12.
   2. Key equipment:
      a. PMP-6911: PEA Filter Aid Small Feed Pump 1.

b. PISH-6911: PEA Filter Aid Pressure Switch High.
c. PMP-6916: PEA Filter Aid Small Feed Pump 2.
d. PISH-6916: PEA Filter Aid Pressure Switch High.
e. FIT-6918: PEA Filter Aid North Filter Channel Flow Meter.
f. FIT-6919: PEA Filter Aid South Filter Channel Flow Meter.
g. SV-6927: South Filter Channel Carrier Water Solenoid Valve.
h. SV-6928: North Filter Channel Carrier Water Solenoid Valve.

3. Abstract:
   a. The PEA Filter Aid Small Feed pumps provide filter aid polymer to the north and south Filter Inlet Channels.
      1) The two small PEA Filter Aid pumps operate in a duty only configuration, where each pump is dedicated to a single location.
         a) If either pump fails, the PEA Filter Aid Dosing Pump (PMP-6956) acts as a standby, but must be brought online manually.
         b) The pumps are fed by the PEA batching system's aging tanks (TNK-6905, TNK-6915), which supply polymer for both the filter aid and flocculant aid systems.
   b. The pumps may be controlled locally or remotely in manual or automatic operations. In automatic control they operate in FLOW PACED MODE.
   c. Operator must adjust manual isolation valves to switch between the large (PMP-6921, PMP-6926) (for high flows) and small (PMP-6911, PMP-6916) (for low flows) pumps. Manual valves can be adjusted to select which pump pumps to which side of the filter inlet channel (north or south). There will be a toggle on the SCADA HMI screen to allow the operator to select whether the plant is operating in the High Flow, or Low Flow modes.

B. Hardwired controls:
   1. Pilot devices:
      a. Field:
         1) None.
      b. LCP:
         1) None.
      c. Drive/starter enclosure:
         1) Speed setpoint: 4-20 mA.
         2) Speed feedback: 4-20 mA.
         3) REMOTE status dry contact.
         4) RUN status dry contact.
         5) LEAK alarm dry contact.
         6) FAILURE alarm dry contact.
         7) Pump Run Command.
      d. VCP:
         1) Integral VCP on pump face with manual or automatic modes.
         2) See pump control enclosure components listed above. In manual mode the following controls may be used from the VCP
            a) START/STOP Pushbutton.
            b) SPEED Keypad.
            c) Navigation Click Wheel.

2. Interlocks:
    a. Field:
        1) In any mode of operation, the pumps are stopped and prohibited from starting if:
            a) High discharge pressure switch is activated (as relayed by PLC logic).
    b. Drive/starter enclosure:
        1) None.
    c. VCP:
        1) As provided by Vendor.
3. Indicators and alarms:
    a. Field:
        1) None.
    b. LCP:
        1) None.
    c. Drive/starter enclosure:
        1) None.
    d. VCP:
        1) Speed setpoint: 4-20 mA.
        2) Speed feedback: 4-20 mA.
        3) REMOTE status dry contact.
        4) LEAK alarm dry contact.
        5) FAILURE alarm dry contact.
        6) Pump Run Command
        7) Pump RUNNING Indication.
        8) Pump FAIL Alarm.
        9) As provided by Vendor.

C. VCP control:
1. None.

D. LOI control:
1. None.

E. PCS controls:
1. Manual mode:
    a. Refer to Section 17100 - Control Strategies.
    b. With HAND selected from the pump's VCP the following controls may be used:
        1) START.
        2) STOP.
        3) Analog SPEED control via rotating knob on panel front.
        4) Analog dose selection from VCP HMI screen.
2. Auto mode:
    a. With AUTO selected from the pump's VCP the following controls may be used:
        1) Pumps operate in a duty only configuration. If flow is detected in the north filter inlet channel (via summing filter effluent flow meters) then the north pump (as selected by operator) is called to turn on. If flow is detected in the south filter inlet channel (via summing filter effluent flow meters) then the south pump (as selected by operator) is called

to turn on. If flow is detected in the north and south filter inlet channel, both pumps should be called to run. If a pump fails the PEA Filter Aid Dosing Pump must manually be switched over to the duty PEA Filter Aid Small Feed Pump. There will be a flow meter mode selection toggle on the SCADA HMI screen to allow the operator to select FIT-6918, FIT-6919, or FIT-6958 for each pump (as determined by the operator's selection of where the chemical needs to go to - i.e., north filter inlet channel, south filter inlet channel, or individual filters for filter dosing).

a) Provide an HMI screen selection palette that allows the Operator to choose if the individual Filter Aid Small Feed pump is Out-of-Service (OOS).
b) The PLC shall command the pump to stop if the discharge pressure (PISH-6911, PISH-6916) set point is reached.

2) Flow paced mode:
   a) The PLC will adjust the speed of the running pump to maintain flow pacing with the north or south filter inlet channel flow. The PLC will adjust the speed of the running pump via a PID control algorithm to maintain a setpoint flow, where:
      (1) Q_A = Desired chemical dosage set point in the process stream (mg/L).
      (2) Q_B = Percentage concentration of the chemical in the chemical solution to be fed (%).
      (3) Q_C = Specific gravity of the chemical solution.
      (4) Q_D = Calibrated maximum flow rate of the feed pump (GPH).
      (5) Process flow rate F.
         (a) F = For the North Filter Inlet Channel Filter Aid Pump - sum of Filter 1 (FE-3011), Filter 3 (FE-3031), Filter 5 (FE-3051), Filter 7 (FE-3071), Filter 9 (FE-3091), Filter 11 (FE-3111), Filter 13 (FE-3131), Filter 15 (FE-3151) flow meters.
         (b) F = For the South Filter Inlet Channel Filter Aid Pump - sum of Filter 2 (FE-3021), Filter 4 (FE-3041), Filter 6 (FE-3061), Filter 8 (FE-3081), Filter 10 (FE-3101), Filter 21 (FE-3121), Filter 14 (FE-3141), Filter 16 (FE-3161) flow meters.
      (6) Calculated pump speed (0 - 100%) = 100% x ($4.18 \times Q_A \times F$) / ($Q_B \times Q_C \times Q_D$).
3) If the calculated pump speed is less than an operator adjustable minimum speed set point or greater than 100%, the PLC generates a SCADA alarm.
4) Calculated pounds chemical per gallon of chemical solution = ($8.33 \times Q_B \times Q_C$) / 100%. The PLC displays the calculated value on the SCADA graphic screen.
5) Calculated desired chemical solution flow rate (GPH) = ($4.18 \times Q_A \times F$) / ($Q_B \times Q_C$). The PLC displays the calculated value on the SCADA graphic screen.
6) Chemical solution flow rate (GPH) as measured by the small Filter Aid Feed Pumps North or South Filter Inlet Channel magnetic flow meter (FIT-6918 or FIT-6919) is displayed by the PLC on the SCADA

graphic screen. There will be a flow meter mode selection toggle on the SCADA HMI screen to allow the operator to select FIT-6918, FIT-6919, or FIT-6958 (as determined by the operator's selection of where the chemical needs to go to - i.e., north filter inlet channel, south filter inlet channel, or individual filters for filter dosing).

a) If the chemical solution flow rate (GPH) as measured by the small Filter Aid Feed Pumps North or South Filter Inlet Channel magnetic flow meter (FIT-6918 or FIT-6919) differs from the calculated desired chemical solution flow rate (GPH) the PLC generates a SCADA alarm

3. In any mode of operation, if the associated carrier water solenoid valve (SV-6927 or SV-6928) is ONLINE, the valve will be commanded to OPEN when the pump START/RUN command has been selected. The valve will remain OPENED for an operator adjustable time delay after the pump has STOPPED.
4. Indicators and alarms:
   a. Refer to Drawings and Section 17100 - Control Strategies for indicators and alarms.
   b. Additional indicators and alarms:
      1) High discharge pressure indication for each pump.

3.10 PEA FILTER AID LARGE FEED PUMPS

A. General:
   1. References:
      a. 69N05.
      b. 69N06.
      c. 69N11.
   2. Key equipment:
      a. PMP-6921: PEA Filter Aid Large Feed Pump 1.
      b. PISH-6921: PEA Filter Aid Pressure Switch High.
      c. PMP-6926: PEA Filter Aid Large Feed Pump 2.
      d. PISH-6926: PEA Filter Aid Pressure Switch High.
      e. PMP-6951: PEA Standby Feed Pump.
      f. PISH-6951: PEA Standby Feed Pump Pressure Switch High.
      g. FIT-6928: PEA Filter Aid North Filter Channel Flow Meter.
      h. FIT-6929: PEA Filter Aid South Filter Channel Flow Meter.
      i. SV-6927: South Filter Channel Carrier Water Solenoid Valve.
      j. SV-6928: North Filter Channel Carrier Water Solenoid Valve.
   3. Abstract:
      a. The PEA Filter Aid Large Feed pumps provide filter aid polymer to the north and south Filter Inlet Channels.
         1) The two large PEA Filter Aid pumps operate in a duty only configuration, where each pump is dedicated to a single location.
            a) If either pump fails, the PEA Standby Pump (PMP-6951) acts as a standby, but must be brought online manually.
            b) The pumps are fed by the PEA batching system's aging tanks (TNK-6905, TNK-6915), which supply polymer for both the filter aid and flocculant aid systems.
      b. The pumps may be controlled locally or remotely in manual or automatic operations. In automatic control they operate in FLOW PACED MODE.

c. Operator must adjust manual isolation valves to switch between the large (PMP-6921, PMP-6926) (for high flows) and small (PMP-6911, PMP-6916) (for low flows) pumps. Manual valves can be adjusted to select which pump pumps to which side of the filter inlet channel (north or south). There will be a toggle on the SCADA HMI screen to allow the operator to select whether the plant is operating in the High Flow, or Low Flow modes.

B. Hardwired controls:
   1. Pilot devices:
      a. Field:
         1) None.
      b. LCP:
         1) None.
      c. Drive/starter enclosure:
         1) HAND- OFF- AUTO (HOA) selector switch.
         2) SPEED keypad.
         3) RESET pushbutton.
      d. VCP:
         1) None.
   2. Interlocks:
      a. Field:
         1) In any mode of operation, the pumps are stopped and prohibited from starting if:
            a) Motor high temperature switch is activated.
            b) The motor winding heater is activated when the pump is not running in any mode of operation.
            c) High discharge pressure switch is activated.
      b. Drive/starter enclosure:
         1) None.
      c. VCP:
         1) None.
   3. Indicators and alarms:
      a. Field:
         1) None.
      b. LCP:
         1) None.
      c. Drive/starter enclosure:
         1) Pump Running indicator light.
         2) Pump Fail indicator light.
      d. VCP:
         1) None.

C. VCP control:
   1. None.

D. LOI control:
   1. None.

E. PCS controls:
1. Manual mode:
a. Refer to Section 17100 - Control Strategies.
b. With AUTO selected from the HOA Selector Switch and HAND selected in the PCS the following controls may be used:
1) RUN.
2) STOP.
3) SPEED INPUT
2. Auto mode:
a. With AUTO selected from the HOA Selector Switch and AUTO selected in the PCS the following controls may be used:
1) Pumps operate in a duty only configuration. If flow is detected in the north filter inlet channel (via summing filter effluent flow meters) then the north pump (as selected by operator) is called to turn on. If flow is detected in the south filter inlet channel (via summing filter effluent flow meters) then the south pump (as selected by operator) is called to turn on. If flow is detected in the north and south filter inlet channel, both pumps should be called to run. If a pump fails the PEA Standby Pump (PMP-6951) must manually be switched over to the duty PEA Filter Aid Large Feed Pump. There will be a flow meter mode selection toggle on the SCADA HMI screen to allow the operator to select FIT-6928 or FIT-6929 for each pump (as determined by the operator's selection of where the chemical needs to go to - i.e., north filter inlet channel or south filter inlet channel).
a) Provide an HMI screen selection palette that allows the Operator to choose if the individual Filter Aid Small Feed pump is Out-of-Service (OOS).
b) The PLC shall command the pump to stop if the discharge pressure (PISH-6921, PISH-6926, PISH-6951) set point is reached.
2) FLOW PACED MODE:
a) The PLC will adjust the speed of the running pump to maintain flow pacing with the north or south filter inlet channel flow. The PLC will adjust the speed of the running pump via a PID control algorithm to maintain a setpoint flow, where:
(1) Q_A = Desired chemical dosage set point in the process stream (mg/L).
(2) Q_B = Percentage concentration of the chemical in the chemical solution to be fed (%).
(3) Q_C = Specific gravity of the chemical solution.
(4) Q_D = Calibrated maximum flow rate of the feed pump (GPM).
(5) Process flow rate F.
(a) F = For the North Filter Inlet Channel Filter Aid Pump - sum of Filter 1 (FE-3011), Filter 3 (FE-3031), Filter 5 (FE-3051), Filter 7 (FE-3071), Filter 9 (FE-3091), Filter 11 (FE-3111), Filter 13 (FE-3131), Filter 15 (FE-3151) flow meters.
(b) F = For the South Filter Inlet Channel Filter Aid Pump - sum of Filter 2 (FE-3021), Filter 4 (FE-3041), Filter 6 (FE-3061), Filter 8 (FE-3081), Filter 10 (FE-3101),

Filter 21 (FE-3121), Filter 14 (FE-3141), Filter 16 (FE-3161) flow meters.

(6) Calculated pump speed (0 - 100%) = 100% x (4.18 x Q_A x F) / (Q_B x Q_C x Q_D x 60).

3) If the calculated pump speed is less than an operator adjustable minimum speed set point or greater than 100%, the PLC generates a SCADA alarm.

4) Calculated pounds chemical per gallon of chemical solution = (8.33 x Q_B x Q_C) / 100%. The PLC displays the calculated value on the SCADA graphic screen.

5) Calculated desired chemical solution flow rate (GPM) = (4.18 x Q_A x F) / (Q_B x Q_C x 60). The PLC displays the calculated value on the SCADA graphic screen.

6) Chemical solution flow rate (GPM) as measured by the large Filter Aid Feed Pumps North or South Filter Inlet Channel magnetic flow meter (FIT-6928 or FIT-6929) is displayed by the PLC on the SCADA graphic screen. There will be a flow meter mode selection toggle on the SCADA HMI screen to allow the operator to select FIT-6928 or FIT-6929 (as determined by the operator's selection of where the chemical needs to go to - i.e., north filter inlet channel or south filter inlet channel).

a) If the chemical solution flow rate (GPM) as measured by the large Filter Aid Feed Pumps North or South Filter Inlet Channel magnetic flow meter (FIT-6918 or FIT-6919) differs from the calculated desired chemical solution flow rate (GPM) the PLC generates a SCADA alarm

3. In any mode of operation, if the associated carrier water solenoid valve (SV-6927 or SV-6928) is ONLINE, the valve will be commanded to OPEN when the pump START/RUN command has been selected. The valve will remain OPENED for an operator adjustable time delay after the pump has STOPPED.
4. Indicators and alarms:
   a. Refer to Drawings and Section 17100 - Control Strategies for indicators and alarms.
   b. Additional indicators and alarms:
      1) None.

3.11 PEA FLOC AID FEED PUMPS

A. General:
   1. References:
      a. 69N07.
      b. 69N09.
      c. 69N11.
   2. Key equipment:
      a. PMP-6931: PEA Floc Aid Feed Pump 1.
      b. PMP-6936: PEA Floc Aid Feed Pump 2.
      c. PMP-6941: PEA Floc Aid Feed Pump 3.
      d. PMP-6946: PEA Floc Aid Feed Pump 4.
      e. PMP-6951: PEA Standby Feed Pump.

3. Abstract:
    a. The PEA Floc Aid Feed pumps provide floc aid polymer to the second stage of the flocculation basins.
        1) The four PEA Floc Aid pumps operate in a duty only configuration, where each pump is dedicated to a single location.
            a) Operators must manually adjust rotameters (FI1-6948, FI2-6948, FI1-6949,FI2-6949) to split flow evenly between Floc Basins 3 and 4 and 5 and 6.
        2) If either pump fails, the PEA Standby Pump (PMP-6951) acts as a standby, but must be brought online manually.
        3) The pumps are fed by the PEA batching system's aging tanks (TNK-6905, TNK-6915), which supply polymer for both the filter aid and flocculant aid systems.
    b. The pumps may be controlled locally or remotely in manual or automatic operations. In automatic control they operate in FLOW PACED MODE.

B. Hardwired controls:
1. Pilot devices:
    a. Field:
        1) None.
    b. LCP:
        1) None.
    c. Drive/starter enclosure:
        1) HAND- OFF- AUTO (HOA) selector switch.
        2) SPEED keypad.
        3) RESET pushbutton.
    d. VCP:
        1) None.
2. Interlocks:
    a. Field:
        1) In any mode of operation, the pumps are stopped and prohibited from starting if:
            a) Motor high temperature switch is activated.
            b) The motor winding heater is activated when the pump is not running in any mode of operation.
            c) High discharge pressure switch is activated.
    b. Drive/starter enclosure:
        1) None.
    c. VCP:
        1) None.
3. Indicators and alarms:
    a. Field:
        1) None.
    b. LCP:
        1) None.
    c. Drive/starter enclosure:
        1) Pump Running indicator light.
        2) Pump Fail indicator light.
    d. VCP:
        1) None.

C. VCP control:
   1. None.

D. LOI control:
   1. None.

E. PCS controls:
   1. Manual mode:
      a. Refer to Section 17100 - Control Strategies.
      b. With AUTO selected from the HOA Selector Switch and HAND selected in the PCS the following controls may be used:
         1) RUN.
         2) STOP.
         3) SPEED INPUT.
   2. Auto mode:
      a. With AUTO selected from the HOA Selector Switch and AUTO selected in the PCS the following controls may be used:
         1) Pumps operate in a duty only configuration. If a pump fails, the PEA Standby Pump (PMP-6951) must manually be switched over to the duty PEA Floc Aid Feed Pump. There will be a flow meter mode selection toggle on the SCADA HMI screen to allow the operator to select FIT-6937, FIT-6938, FIT-6948, or FIT-6949 for the standby pump (as determined by the operator's selection of where the chemical needs to go to - i.e., basin 1, 2, 3 & 4, or 5 & 6).
            a) Provide an HMI screen selection palette that allows the Operator to choose if the individual Floc Aid Feed pump is Out-of-Service (OOS).
            b) The PLC shall command the pump to stop if the discharge pressure (PISH-6931, PISH-6936, PISH-6941, PISH-6946, PISH-6951) set point is reached.
         2) FLOW PACED MODE:
            a) The PLC will adjust the speed of the running pump to maintain flow pacing with raw water flow, divided by the number of floc basins online. The PLC will adjust the speed of the running pump via a PID control algorithm to maintain a setpoint flow, where:
               (1) Q_A = Desired chemical dosage set point in the process stream (mg/L).
               (2) Q_B = Percentage concentration of the chemical in the chemical solution to be fed (%).
               (3) Q_C = Specific gravity of the chemical solution.
               (4) Q_D = Calibrated maximum flow rate of the feed pump (GPM).
               (5) Process flow rate F.
                  (a) F = Raw water flow rate as measured by the small (M-14) or large (M-15) flow meter divided by the number of inner basins online plus the number of outer basins online divided by 2: Flow/(inner+outer/2).
               (6) Calculated pump speed (0 - 100%) = 100% x (4.18 x Q_A x F) / (Q_B x Q_C x Q_D x 60).

3) If the calculated pump speed is less than an operator adjustable minimum speed set point or greater than 100%, the PLC generates a SCADA alarm.
4) Calculated pounds chemical per gallon of chemical solution = (8.33 x Q_B x Q_C) / 100%. The PLC displays the calculated value on the SCADA graphic screen.
5) Calculated desired chemical solution flow rate (GPM) = (4.18 x Q_A x F) / (Q_B x Q_C x 60). The PLC displays the calculated value on the SCADA graphic screen.
6) Chemical solution flow rate (GPM) as measured by Floc Aid Floc Basin 1, 2, 3 & 4, and 5 & 6 magnetic flow meters (FIT-6937, FIT-6938, FIT-6948, FIT-6949) is displayed by the PLC on the SCADA graphic screen.
a) If the chemical solution flow rate (GPM) as measured by Floc Aid Floc Basin 1, 2, 3 & 4, and 5 & 6 magnetic flow meters (FIT-6937, FIT-6938, FIT-6948, FIT-6949) differs from the calculated desired chemical solution flow rate (GPM) the PLC generates a SCADA alarm.

3. In any mode of operation, if the associated carrier water solenoid valve (SV-6934, SV-6935, SV-6940 or SV-6941) is ONLINE, the valve will be commanded to OPEN when the pump START/RUN command has been selected. The valve will remain OPENED for an operator adjustable time delay after the pump has STOPPED.
4. Indicators and alarms:
   a. Refer to Drawings and Section 17100 - Control Strategies for indicators and alarms.
   b. Additional indicators and alarms:
      1) None.

3.12 PEA FILTER AID DOSING PUMP

A. General:
   1. References:
      a. 69N12.
   2. Key equipment:
      a. PMP-6956: PEA Filter Aid Dosing Pump.
   3. Abstract:
      a. The PEA Filter Aid Dosing pump provides filter aid polymer to individual filters on an as needed basis. The pumps are fed by the PEA batching system's aging tanks (TNK-6905, TNK-6915), which supply polymer for both the filter aid and flocculant aid systems.
         1) This pump acts as a standby pump for the PEA Filter Aid Small Feed pumps. See control narrative for details.
      b. The pump may be controlled locally or remotely in manual or automatic operations. In automatic control they operate in FLOW PACED MODE.

B. Hardwired controls:
   1. Pilot devices:
      a. Field:
         1) None.

b. LCP:
    1) None.
c. Drive/starter enclosure:
    1) Speed setpoint: 4-20 mA.
    2) Speed feedback: 4-20 mA.
    3) REMOTE status dry contact.
    4) RUN status dry contact.
    5) LEAK alarm dry contact.
    6) FAILURE alarm dry contact.
    7) Pump Run Command.
d. VCP:
    1) Integral VCP on pump face with manual or automatic modes.
    2) See pump control enclosure components listed above. In manual mode the following controls may be used from the VCP
        a) START/STOP Pushbutton.
        b) SPEED Keypad.
        c) Navigation Click Wheel.

2. Interlocks:
    a. Field:
        1) In any mode of operation, the pumps are stopped and prohibited from starting if:
            a) High discharge pressure switch is activated(as relayed by PLC logic).
    b. Drive/starter enclosure:
        1) None.
    c. VCP:
        1) As provided by Vendor.
3. Indicators and alarms:
    a. Field:
        1) None.
    b. LCP:
        1) None.
    c. Drive/starter enclosure:
        1) None.
    d. VCP:
        1) Speed setpoint: 4-20 mA.
        2) Speed feedback: 4-20 mA.
        3) REMOTE status dry contact.
        4) LEAK alarm dry contact.
        5) FAILURE alarm dry contact.
        6) Pump Run Command
        7) Pump RUNNING Indication.
        8) Pump FAIL Alarm.
        9) As provided by Vendor.

C. VCP control:
    1. None.

D. LOI control:
    1. None.

E. PCS controls:
   1. Manual mode:
      a. Refer to Section 17100 - Control Strategies.
      b. With HAND selected from the pump's VCP the following controls may be used:
         1) START.
         2) STOP.
         3) Analog SPEED control via rotating knob on panel front.
         4) Analog dose selection from VCP HMI screen
   2. Auto mode:
      a. With AUTO selected from the pump's VCP the following controls may be used:
         1) Pump operate in a duty only configuration. If a PEA Filter Aid Small Feed Pump fails, the PEA Filter Aid Dosing Pump can manually be switched over to a duty PEA Filter Aid Small Feed Pump. There will be a flow meter mode selection toggle on the SCADA HMI screen to allow the operator to select FIT-6918, FIT-6919, or FIT-6958 for the pump (as determined by the operator's selection of where the chemical needs to go to - i.e., north filter inlet channel, south filter inlet channel, or individual filters for filter dosing).
            a) Provide an HMI screen selection palette that allows the Operator to choose if the individual Filter Aid Dosing pump is Out-of-Service (OOS).
            b) The PLC shall command the pump to stop if the discharge pressure (PISH-6956) set point is reached.
         2) Operator must select which Filter (1 through 16) they would like to dose with filter aid from a dropdown menu. Only one filter can be selected at a time.
         3) FLOW PACED MODE:
            a) The PLC will adjust the speed of the running pump to maintain flow pacing with the individual filter flow. The PLC will adjust the speed of the running pump via a PID control algorithm to maintain a setpoint flow, where:
               (1) Q_A = Desired chemical dosage set point in the process stream (mg/L).
               (2) Q_B = Percentage concentration of the chemical in the chemical solution to be fed (%).
               (3) Q_C = Specific gravity of the chemical solution.
               (4) Q_D = Calibrated maximum flow rate of the feed pump (GPH).
               (5) Process flow rate F.
                  (a) F = For the selected filter flow meter - Filter 1 (FE-3011), Filter 3 (FE-3031), Filter 5 (FE-3051), Filter 7 (FE-3071), Filter 9 (FE-3091), Filter 11 (FE-3111), Filter 13 (FE-3131), Filter 15 (FE-3151), Filter 2 (FE-3021), Filter 4 (FE-3041), Filter 6 (FE-3061), Filter 8 (FE-3081), Filter 10 (FE-3101), Filter 21 (FE-3121), Filter 14 (FE-3141), or Filter 16 (FE-3161).
               (6) Calculated pump speed (0 - 100%) = 100% x (4.18 x Q_A x F) / (Q_B x Q_C x Q_D).

4) If the calculated pump speed is less than an operator adjustable minimum speed set point or greater than 100%, the PLC generates a SCADA alarm.
5) Calculated pounds chemical per gallon of chemical solution = (8.33 x Q_B x Q_C) / 100%. The PLC displays the calculated value on the SCADA graphic screen.
6) Calculated desired chemical solution flow rate (GPH) = (4.18 x Q_A x F) / (Q_B x Q_C). The PLC displays the calculated value on the SCADA graphic screen.
7) Chemical solution flow rate (GPH) as measured by the Filter Aid Dosing Pump magnetic flow meter (FIT-6958) is displayed by the PLC on the SCADA graphic screen.
a) If the chemical solution flow rate (GPH) as measured by the Filter Aid Dosing Pump magnetic flow meter (FIT-6958) differs from the calculated desired chemical solution flow rate (GPH) the PLC generates a SCADA alarm

3. In any mode of operation, the solenoid valve/pump sequence will go as follows:
a. After a filter is selected and the pump START/RUN command has been selected, the selected filter solenoid valve (SV-6961 - SV-6976) and the carrier water solenoid valve (SV-6957) will be commanded to OPEN.
b. The pump will run for an operator adjustable timer in minutes, after which it will be commanded to STOP.
c. The carrier water solenoid valve (SV-6957) will remain OPENED for an operator adjustable time delay after the pump has STOPPED.
d. The selected filter solenoid valve (SV-6961 - SV-6976) will remain OPENED for an operator adjustable time delay after the carrier water solenoid valve has CLOSED.
4. Indicators and alarms:
a. Refer to Drawings and Section 17100 - Control Strategies for indicators and alarms.
b. Additional indicators and alarms:
1) High discharge pressure indication.

3.13 PEC FEED STORAGE LOADING STATION

A. General:
1. References:
a. 71N01.
2. Key equipment:
a. TNK-7101: PEC Tank 1.
b. TNK-7102: PEC Tank 2.
c. LCP-7100: PEC Loading Panel.
3. Abstract:
a. The PLC transmits the real-time tank levels of the PEC storage tanks (TNK-7101, TNK-7102) to digital indicators at the new PEC fill station level alarm panel.

B. Hardwired controls:
    1. Pilot devices:
        a. Field:
            1) None.
        b. LCP:
            1) None.
        c. Drive/starter enclosure:
            1) None.
        d. VCP:
            1) None.
    2. Interlocks:
        a. Field:
            1) None.
        b. Drive/starter enclosure:
            1) None.
        c. VCP:
            1) None.
    3. Indicators and alarms:
        a. Field:
            1) None.
        b. LCP:
            1) HORN.
            2) SILENCE.
            3) STROBE.
            4) Level Indicator: LI-7101
            5) Level Indicator: LI-7102
        c. Drive/starter enclosure:
            1) None.
        d. VCP:
            1) None.

C. VCP control:
    1. None.

D. LOI control:
    1. None.

E. PCS controls:
    1. Manual mode:
        a. None.
    2. Auto mode:
        a. If the tank level reaches the High level setpoint (7.25 feet) the strobe will initiate. If the tank level reaches the High-High level setpoint (7.75 feet) the horn will initiate. The silence button must manually be pushed to stop the strobe and horn.
    3. Indicators and alarms:
        a. Refer to Drawings and Section 17100 - Control Strategies for indicators and alarms.
        b. Additional indicators and alarms:
            1) None.

3.14 PEC TRANSFER PUMPS

A. General:
   1. References:
      a. 71N02.
   2. Key equipment:
      a. PMP-7103: PEC Transfer Pump 1.
      b. PMP-7104: PEC Transfer Pump 2.
   3. Abstract:
      a. The PEC transfer pumps operate in a duty standby configuration to transfer chemicals from the PEC bulk storage tanks to the PEC day tank. The transfer pumps will be 1 duty + 1 standby configuration. The standby pump will be called to run automatically if the duty pump fails to run when called. A transfer pump is called to run when the PEC day tank reaches an operator-enterable low-level, as determined by the weight or level. The transfer pump will continue to run at constant speed until the level in the tank reaches an operator adjustable high level as determined by the weight (WIT-7105) or level (LIT-7105), as selected by the operator. An operator adjustable time delay will monitor the tank level; if the tank level does not begin to increase with the time delay after a transfer pump has been called to run, or does not reach the high level set point within a maximum time setpoint, an alarm will be issued and the transfer pump will be given a fail status.
         1) The pumps may be controlled locally or remotely in manual or automatic operations.
         2) The pumps switch between duty and standby after each run cycle. Pumps with a status of “Not Ready” or “Out-of-Service” (OOS) shall be automatically removed from the start sequence. The pumps shall respond to a start permissive from the PLC. If a pump fails, fails to start or stop, or becomes otherwise unavailable (i.e. Not Ready) the condition shall be alarm registered at the HMI and the next pump in sequence shall be immediately called to start or stop (thereby bypassing the preset timers).
         3) In automatic control, they are operated based on level or weight setpoints in the day tank.
         4) Pumps are automatically shut down if an overflow is detected by a High High level in the day tank, max weight exceedance on scale, or flood switch trigger in the containment area. Pumps can also be shutdown by a maximum pump run time exceedance.
         5) Operators manually select which bulk tank the transfer pumps are pumping from by opening/closing isolation valves. Online tank should be selected/indicated in SCADA.

B. Hardwired control:
   1. Pilot devices:
      a. Field:
         1) None.
      b. LCP:
         1) None
      c. Drive/starter enclosure:
         1) HAND- OFF- AUTO (HOA) selector switch.

2) In HAND mode the following controls may be used:
a) START/STOP Pushbutton

d. VCP:
1) None.

2. Interlocks:
a. Field:
1) Pump is stopped, the motor latched out, and the FAIL alarm activated if:
a) Motor high temperature switch is activated.
b) The motor winding heater is activated.
c) Pressure switch high is activated: high discharge pressure is detected, indicating a block in the line, while the pump is running.
d) Tank Level HIGH HIGH is detected (5.9 feet) OR Max Weight on Scale is exceeded (4,700 pounds), indicating a tank overflow, while the pump is running. Setpoint indicator (level or weight) is selected by the operator and adjustable.
e) Flood switch trigger in the containment area.

b. Drive/starter enclosure:
1) For each pump:
a) With the HOA selector switch at the MCC in HAND position, the pump is started and stopped using the by moving the HOA selector switch from HAND to OFF at the MCC.
b) When the HOA selector switch on the MCC is set to AUTO mode, the pump is controlled by the facility PLC.
c) When the HOA selector switch on the MCC is set to OFF mode, the pump is prevented from running.
d) Pump Alarms can be RESET by cycling the HOA selector switch from HAND or AUTO to OFF and back again.

c. VCP:
1) None.

3. Indicators and alarms:
a. Field:
1) None.

b. LCP:
1) None.

c. Drive/starter enclosure:
1) Pumps:
a) RUNNING indicator light.
b) FAIL indicator light.

d. VCP:
1) None.

C. VCP control:
1. None.

D. LOI control:
1. None.

E. PCS control:
1. Manual mode:
a. Refer to Section 17100 - Control Strategies.

b. With AUTO selected from the HOA Selector Switch and HAND selected in the PCS the following controls may be used:
    1) RUN.
    2) STOP.

2. Auto mode:
    a. The PEC Transfer Pumps operate in a duty/standby configuration. The pumps will rotate between duty and standby after each tank fill - after the duty pump is called to stop, when it reaches the tank high setpoint, it will rotate to the standby pump and the standby pump will rotate to the duty pump.
    b. With AUTO selected from the HOA Selector Switch and AUTO selected in the PCS the pump is controlled as follows:
        1) Start the duty transfer pump when day tank level (LIT-7105) LOW (0.5 feet) or weight (WIT-7105) LOW (430 lbs) set point is reached. Setpoint indicator (level or weight) is selected by the operator and adjustable.
        2) Stop the duty transfer pump when day tank (LIT-7105) level HIGH (5.4 feet) or weight (WIT-7105) HIGH (4,400 lbs) set point is reached. Setpoint indicator (level or weight) is selected by the operator and adjustable.
            a) If tank level HIGH setpoint is not reached within a maximum time limit after the pump turns on (25 minutes), the pump will automatically shut down.
            b) If tank level does not increase within a maximum time limit after the pump turns on (2 minutes), the pump will automatically shut down.
        3) The PEC transfer pumps will be prohibited from starting or will shut down if the online bulk tank low level set point (1 foot) is reached. The SCADA HMI screen shall be modified to provide a PEC bulk tank duty selection toggle, so that the PLC program knows which level transmitter (LIT-7101 or LIT-7102) data to use to determine when to shut the transfer pumps off.

3. Indicators, alarms, and setpoints:
    a. Indicators and alarms:
        1) AUTO mode indication.
        2) RUNNING indication.
        3) High Temperature Alarm.
        4) High Discharge Pressure Alarm
        5) Refer to Drawings and Section 17100 - Control Strategies for indicators and alarms.
        6) Additional indicators and alarms:
            a) Alarm if the online bulk tank low level set point is triggered.

3.15 PEC FEED PUMPS

A. General:
    1. References:
        a. 71N03.
    2. Key equipment:
        a. PMP-7106: PEC Feed Pump 1.
        b. PMP-7107: PEC Feed Pump 2.

3. Abstract:
    a. The PEC Feed pumps provide PEC to the Rapid Mix System. The 2 PEC pumps operate in a duty/standby configuration and are supplied by the PEC Day Tank (TNK-7105).
    b. The pumps may be controlled locally or remotely in manual or automatic operations. In automatic control they operate in FLOW PACED MODE.
    c. The lead pump is called to turn on when flow at the Raw Water Meter Vault is detected (M-14 or M-15). The standby pump can be brought automatically online following an alarm from the duty pump.

B. Hardwired controls:
1. Pilot devices:
    a. Field:
        1) None.
    b. LCP:
        1) None.
    c. Drive/starter enclosure:
        1) Speed setpoint: 4-20 mA.
        2) Speed feedback: 4-20 mA.
        3) REMOTE status dry contact.
        4) RUN status dry contact.
        5) LEAK alarm dry contact.
        6) FAILURE alarm dry contact.
        7) Pump Run Command.
    d. VCP:
        1) Integral VCP on pump face with manual or automatic modes.
        2) See pump control enclosure components listed above. In manual mode the following controls may be used from the VCP
            a) START/STOP Pushbutton.
            b) SPEED Keypad.
            c) Navigation Click Wheel.
2. Interlocks:
    a. Field:
        1) In any mode of operation, the pumps are stopped and prohibited from starting if:
            a) High discharge pressure switch is activated (as relayed by PLC logic).
    b. Drive/starter enclosure:
        1) None.
    c. VCP:
        1) As provided by Vendor.
3. Indicators and alarms:
    a. Field:
        1) None.
    b. LCP:
        1) None.
    c. Drive/starter enclosure:
        1) None.
    d. VCP:
        1) Speed setpoint: 4-20 mA.
        2) Speed feedback: 4-20 mA.

3) REMOTE status dry contact.
4) LEAK alarm dry contact.
5) FAILURE alarm dry contact.
6) Pump Run Command
7) Pump RUNNING Indication.
8) Pump FAIL Alarm.
9) As provided by Vendor.

C. VCP control:
   a. None.

D. LOI control:
   1. None.

E. PCS controls:
   1. Manual mode:
      a. Refer to Section 17100 - Control Strategies.
      b. With HAND selected from the pump's VCP the following controls may be used:
         1) RUN.
         2) STOP.
         3) Analog SPEED control via rotating knob on panel front.
         4) Analog dose selection from VCP HMI screen.
   2. Auto mode:
      a. With AUTO selected from the pump's VCP the following controls may be used:
         1) Pumps operate in a duty/standby configuration. Pumps automatically rotate positions (duty/standby) any time they are shut down. The standby pump can be brought automatically online following an alarm from the other pump.
         2) Provide an HMI screen selection palette that allows the Operator to choose if the individual PEC Feed Pump is Duty, Standby, or Out-of-Service (OOS).
         3) The PLC shall command the pump to stop if the discharge pressure (PISH-7106, PISH-7107) set point is reached.
         4) Flow paced mode:
            a) The PLC will adjust the speed of the running pump to maintain flow pacing with the influent flow. The PLC will adjust the speed of the running pump via a PID control algorithm to maintain a setpoint flow, where:
               (1) Q_A = Desired chemical dosage set point in the process stream (mg/L).
               (2) Q_B = Percentage concentration of the chemical in the chemical solution to be fed (%).
               (3) Q_C = Specific gravity of the chemical solution.
               (4) Q_D = Calibrated maximum flow rate of the feed pump (GPH).
               (5) Process flow rate F.
                  (a) F = Raw water flow rate as measured by the small (M-14) or large (M-15) flow meter.

(6) Calculated pump speed (0 - 100%) = 100% x (4.18 x Q_A x F) / (Q_B x Q_C x Q_D).

5) If the calculated pump speed is less than an operator adjustable minimum speed set point or greater than 100%, the PLC generates a SCADA alarm.

6) Calculated pounds chemical per gallon of chemical solution = (8.33 x Q_B x Q_C) / 100%. The PLC displays the calculated value on the SCADA graphic screen.

7) Calculated desired chemical solution flow rate (GPH) = (4.18 x Q_A x F) / (Q_B x Q_C). The PLC displays the calculated value on the SCADA graphic screen.

8) Chemical solution flow rate (GPH) as measured by the PEC magnetic flow meter (FE-7108) is displayed by the PLC on the SCADA graphic screen.

a) If the chemical solution flow rate (GPH) as measured by the PEC magnetic flow meter (FE-7108) differs from the calculated desired chemical solution flow rate (GPH) the PLC generates a SCADA alarm.

3. Indicators and alarms:

a. Refer to Drawings and Section 17100 - Control Strategies for indicators and alarms.

b. Additional indicators and alarms:

1) High discharge pressure indication for each pump.

END OF SECTION

SECTION 17201

LEVEL MEASUREMENT: SWITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Capacitance level switch.
   2. Ball float level switch.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide complete documentation covering the traceability of calibration instruments.

1.04 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

C. Manufacture instrument facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation and Servicing.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 01850 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

1.09 MAINTENANCE

A. Furnish parts, materials, fluids, etc., necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. Capacitance level switch:
      a. E+H, Liquicap M FTI51/FTI52.
   2. Ball float level switch:
      a. E+H, Liquifloat T FTS20.
      b. Evoqua Water Technologies, 9G-EF.
      c. ITT Flygt, Model ENM-10.
      d. Anchor Scientific Inc., Ecofloat/Solofloat.

2.04 MANUFACTURED UNITS

A. As specified in this Section, including Attachment A - ISA Datasheet - Level Measurement: Switches.

B. Capacitance level switch:
   1. General: Capacitance type level switches shall be made up of a control relay, mechanically rigid and rugged non-metallic probe and probe housing.

2. Switch:
    a. Provide a rigid, non-metallic element.
    b. The control relay senses the liquid level by capacitance measurement between the electrode probe, the process liquid, and the equipment ground:
        1) Power supply:
            a) As indicated in the datasheets.
        2) Outputs:
            a) Relay outputs:
                (1) As indicated in the datasheets.
                (2) 1 Form C contact.
                (3) Rated at 6 amps at 120 VAC.
                (4) Programmable for adjustable hysteresis.
    c. Electrical connection: One 1/2-inch NPT conduit entry.
    d. Enclosure:
        1) As indicated in the datasheets.
        2) Non-hazardous area:
            a) NEMA Type 4X.
        3) For more information, see Attachment A - ISA Datasheet - Level Measurement: Switches.

C. Ball float level switch:
    1. General:
        a. Encapsulated body with a switch to determine position of float.
    2. Outputs:
        a. Power supply.
        b. Relay outputs.
        c. 1 Form C contact.
        d. Rated at 6 amps at 120 VAC.
        e. Programmable for adjustable hysteresis.
    3. Element:
        a. Mechanical switch encapsulated in waterproof floating ball of nominal diameter, supported by flexible PVC cable and jacket or heavy neoprene.
        b. The length of the PVC cable shall be, at a minimum, equal to sump depth plus 5 feet.
        c. Float: Provide Type 316 stainless steel or polypropylene, maximum 5.5 inches in diameter.
        d. An operating temperature rating: -4 degrees Fahrenheit to +185 degrees Fahrenheit.
        e. Mercury switches are not acceptable.
        f. Suspend ball float and adjust for level setpoint as required.
        g. Lead wires: Mounted in flexible waterproof PVC cable from switch to junction box terminals without splices.
        h. Provide the number of floats per level system as indicated on the Drawings.
    4. Switch:
        a. Power supply:
            1) None.
        b. Outputs:
            1) As indicated in the datasheets.

2) Single pole double throw contacts rated 10 amps resistive at 120 VAC.

c. Enclosure:
   1) As indicated in the datasheets.
   2) Non-hazardous area:
      a) NEMA Type 4X.
   3) For more information, see Attachment A - ISA Datasheet - Level Measurement: Switches.

5. Components:
   a. Floats shall include Type 316 stainless steel clamp and brackets and 1/4-inch cable to allow testing of the float without entering the basin or wet well.
   b. Provide strain relief at both ends of the float cable.
   c. Float anchors:
      1) Furnish 15-pound PVC coated anchor kit with 10 feet of Type 316 stainless steel chain.
      2) Provide stainless steel shackles and float clamps.
      3) Manufacturers: The following or equal:
         a) Conery Mfg. Inc.

2.05 ACCESSORIES

A. Provide sunshades for outdoor installation.

2.06 FINISHES (NOT USED)

2.07 SOURCE QUALITY CONTROL

A. FM approval certification or equal when installed in classified areas.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.04 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be as indicated on the Drawings, as specified in the Specifications or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - LEVEL MEASUREMENT: SWITCHES

Level Switch

SPECIFICATION 17201

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID						
LSHH-3931	30N24	**SERVICE**	LEVEL SWITCH HIGH HIGH				
LE-3931		**FLUID**	WATER	**HAZARDOUS APP**	N/A	**POWER**	[*]
		MEASURING PRINCIPLE	REED SWITCH	**ELEM. ENC. CLASS**	NEMA 4X	**POWER LOCATION**	LOOP
		SET POINT	1 IN	**ELEM. MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		MOUNTING	INTEGRAL	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	SPDT
		TYPICAL DETAILS	NL101, NL103, NL106	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-ELEC1
		SURGE PROTECTION	NO				
TAG	**P&ID**						
LSHH-4123	30N20	**SERVICE**	BW VAULT HI HI				
LE-4123		**FLUID**	[*]	**HAZARDOUS APP**	N/A	**POWER**	[*]
		MEASURING PRINCIPLE	REED SWITCH	**ELEM. ENC. CLASS**	NEMA 4X	**POWER LOCATION**	LOOP
		SET POINT	1" AFF	**ELEM. MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		MOUNTING	INTEGRAL	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	SPDT
		TYPICAL DETAILS	NL106	**ENCL. MATERIAL**	MFR. STD.	**PLC**	[NOT FOUND ON P&ID]
		SURGE PROTECTION	NO				
TAG	**P&ID**						
LSH-4425	30N24	**SERVICE**	AIR GAP MANHOLE LEVEL HIGH				
LE-4425		**FLUID**	[*]	**HAZARDOUS APP**	N/A	**POWER**	[*]
		MEASURING PRINCIPLE	BALL FLOAT	**ELEM. ENC. CLASS**	NEMA 4X	**POWER LOCATION**	LOOP
		SET POINT	3.0 FT	**ELEM. MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		MOUNTING	INTEGRAL	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	SPDT
		TYPICAL DETAILS	NL101	**ENCL. MATERIAL**	MFR. STD.	**PLC**	[NOT FOUND ON P&ID]
		SURGE PROTECTION	NO				

Notes: PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.

Level Switch

SPECIFICATION 17201

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID	SERVICE	MANHOLE 1A FLOOD				
LSH-6001	63N24	**FLUID**	[*]	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
LE-6001		**MEASURING PRINCIPLE**	CAPACITANCE	**ELEM. ENC. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-CL
		SET POINT	2-IN AFF	**ELEM. MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		MOUNTING	INTEGRAL	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	SPDT
		TYPICAL DETAILS	NL114, NA900	**ENCL. MATERIAL**	MFR. STD.	**PLC**	[NOT FOUND ON P&ID]
		SURGE PROTECTION	YES				

Notes: PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.

TAG	P&ID	SERVICE	MANHOLE 2A FLOOD				
LSH-6002	63N24	**FLUID**	[*]	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
LE-6002		**MEASURING PRINCIPLE**	CAPACITANCE	**ELEM. ENC. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-CL
		SET POINT	2-IN AFF	**ELEM. MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		MOUNTING	INTEGRAL	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	SPDT
		TYPICAL DETAILS	NL114, NA900	**ENCL. MATERIAL**	MFR. STD.	**PLC**	[NOT FOUND ON P&ID]
		SURGE PROTECTION	YES				

Notes: PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.

TAG	P&ID	SERVICE	MANHOLE 3A FLOOD				
LSH-6003	63N24	**FLUID**	[*]	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
LE-6003		**MEASURING PRINCIPLE**	CAPACITANCE	**ELEM. ENC. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-CL
		SET POINT	2-IN AFF	**ELEM. MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		MOUNTING	INTEGRAL	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	SPDT
		TYPICAL DETAILS	NL114, NA900	**ENCL. MATERIAL**	MFR. STD.	**PLC**	[NOT FOUND ON P&ID]
		SURGE PROTECTION	YES				

Notes: PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.

Level Switch

SPECIFICATION 17201

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID	SERVICE	MANHOLE 4A FLOOD				
LSH-6004	63N24	**FLUID**	[*]	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
LE-6004		**MEASURING PRINCIPLE**	CAPACITANCE	**ELEM. ENC. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-CL
		SET POINT	2-IN AFF	**ELEM. MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		MOUNTING	INTEGRAL	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	SPDT
		TYPICAL DETAILS	NL114, NA900	**ENCL. MATERIAL**	MFR. STD.	**PLC**	[NOT FOUND ON P&ID]
		SURGE PROTECTION	YES				
		Notes: PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.					
TAG	**P&ID**	**SERVICE**	MANHOLE 5A FLOOD				
LSH-6005	63N24	**FLUID**	[*]	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
LE-6005		**MEASURING PRINCIPLE**	CAPACITANCE	**ELEM. ENC. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-CL
		SET POINT	2-IN AFF	**ELEM. MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		MOUNTING	INTEGRAL	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	SPDT
		TYPICAL DETAILS	NL114, NA900	**ENCL. MATERIAL**	MFR. STD.	**PLC**	[NOT FOUND ON P&ID]
		SURGE PROTECTION	YES				
		Notes: PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.					
TAG	**P&ID**	**SERVICE**	MANHOLE 6A FLOOD				
LSH-6006	63N25	**FLUID**	[*]	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
LE-6006		**MEASURING PRINCIPLE**	CAPACITANCE	**ELEM. ENC. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-CL
		SET POINT	2-IN AFF	**ELEM. MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		MOUNTING	INTEGRAL	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	SPDT
		TYPICAL DETAILS	NL114, NA900	**ENCL. MATERIAL**	MFR. STD.	**PLC**	[NOT FOUND ON P&ID]
		SURGE PROTECTION	YES				
		Notes: PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.					

Level Switch

SPECIFICATION 17201

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID	SERVICE					
LSH-6007	63N25		FLUID [*]	HAZARDOUS APP N/A		POWER	24VDC-1P
LE-6007			MEASURING PRINCIPLE CAPACITANCE	ELEM. ENC. CLASS NEMA 4X		POWER LOCATION	RTU-CL
			SET POINT 2-IN AFF	ELEM. MATERIAL MFR. STD.		OUTPUT	RELAY
			MOUNTING INTEGRAL	SWITCH ENCL. CLASS NEMA 4X		RELAY FORM	SPDT
			TYPICAL DETAILS NL114, NA900	ENCL. MATERIAL MFR. STD.		PLC	[NOT FOUND ON P&ID]
			SURGE PROTECTION YES				
		Notes: PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.					
TAG	**P&ID**	**SERVICE**	MANHOLE 8A FLOOD				
LSH-6008	63N25		FLUID [*]	HAZARDOUS APP N/A		POWER	24VDC-1P
LE-6008			MEASURING PRINCIPLE CAPACITANCE	ELEM. ENC. CLASS NEMA 4X		POWER LOCATION	RTU-CL
			SET POINT 2-IN AFF	ELEM. MATERIAL MFR. STD.		OUTPUT	RELAY
			MOUNTING INTEGRAL	SWITCH ENCL. CLASS NEMA 4X		RELAY FORM	SPDT
			TYPICAL DETAILS NL114, NA900	ENCL. MATERIAL MFR. STD.		PLC	[NOT FOUND ON P&ID]
			SURGE PROTECTION YES				
		Notes: PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.					
TAG	**P&ID**	**SERVICE**	MANHOLE 9A FLOOD				
LSH-6009	63N24		FLUID [*]	HAZARDOUS APP N/A		POWER	24VDC-1P
LE-6009			MEASURING PRINCIPLE CAPACITANCE	ELEM. ENC. CLASS NEMA 4X		POWER LOCATION	RTU-CL
			SET POINT 2-IN AFF	ELEM. MATERIAL MFR. STD.		OUTPUT	RELAY
			MOUNTING INTEGRAL	SWITCH ENCL. CLASS NEMA 4X		RELAY FORM	SPDT
			TYPICAL DETAILS NL114, NA900	ENCL. MATERIAL MFR. STD.		PLC	[NOT FOUND ON P&ID]
			SURGE PROTECTION YES				
		Notes: PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.					

Level Switch

SPECIFICATION 17201

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID	SERVICE	MANHOLE 10A FLOOD				
LSH-6010	63N24	FLUID	[*]	HAZARDOUS APP	N/A	POWER	24VDC-1P
LE-6010		MEASURING PRINCIPLE	CAPACITANCE	ELEM. ENC. CLASS	NEMA 4X	POWER LOCATION	RTU-CL
		SET POINT	2-IN AFF	ELEM. MATERIAL	MFR. STD.	OUTPUT	RELAY
		MOUNTING	INTEGRAL	SWITCH ENCL. CLASS	NEMA 4X	RELAY FORM	SPDT
		TYPICAL DETAILS	NL114, NA900	ENCL. MATERIAL	MFR. STD.	PLC	[NOT FOUND ON P&ID]
		SURGE PROTECTION	YES				

Notes: PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.

TAG	P&ID	SERVICE	MANHOLE 11A FLOOD				
LSH-6011	63N24	FLUID	[*]	HAZARDOUS APP	N/A	POWER	24VDC-1P
LE-6011		MEASURING PRINCIPLE	CAPACITANCE	ELEM. ENC. CLASS	NEMA 4X	POWER LOCATION	RTU-CL
		SET POINT	2-IN AFF	ELEM. MATERIAL	MFR. STD.	OUTPUT	RELAY
		MOUNTING	INTEGRAL	SWITCH ENCL. CLASS	NEMA 4X	RELAY FORM	SPDT
		TYPICAL DETAILS	NL114, NA900	ENCL. MATERIAL	MFR. STD.	PLC	[NOT FOUND ON P&ID]
		SURGE PROTECTION	YES				

Notes: PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.

TAG	P&ID	SERVICE	CAUSTIC SODA SUMP LEVEL				
LSH-6214	62N02	FLUID	[*]	HAZARDOUS APP	N/A	POWER	24VDC-1P
LE-6214		MEASURING PRINCIPLE	CAPACITANCE	ELEM. ENC. CLASS	NEMA 4X	POWER LOCATION	RTU-PEA
		SET POINT	3-IN AFF	ELEM. MATERIAL	MFR. STD.	OUTPUT	RELAY
		MOUNTING	INTEGRAL	SWITCH ENCL. CLASS	NEMA 4X	RELAY FORM	SPDT
		TYPICAL DETAILS	NL114, NA900	ENCL. MATERIAL	MFR. STD.	PLC	[NOT FOUND ON P&ID]
		SURGE PROTECTION	NO				

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID						
LSHH-6319	63N11	**SERVICE**	CHLORINE SUMP LEVEL HIGH HIGH				
LE-6319		**FLUID**	[*]	**HAZARDOUS APP**	N/A	**POWER**	[*]
		MEASURING PRINCIPLE	BALL FLOAT	**ELEM. ENC. CLASS**	NEMA 4X	**POWER LOCATION**	LOOP
		SET POINT	3 FT	**ELEM. MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		MOUNTING	INTEGRAL	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	SPDT
		TYPICAL DETAILS	NL101	**ENCL. MATERIAL**	MFR. STD.	**PLC**	[NOT FOUND ON P&ID]
		SURGE PROTECTION	NO				
TAG	**P&ID**						
LSH-6514	65N01	**SERVICE**	CAUSTIC SODA CONTAINMENT SUMP				
LE-6514		**FLUID**	CAUSTIC SODA	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
		MEASURING PRINCIPLE	CAPACITANCE	**ELEM. ENC. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-CS
		SET POINT	3-IN AFF	**ELEM. MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		MOUNTING	INTEGRAL	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	SPDT
		TYPICAL DETAILS	NL114, NA900	**ENCL. MATERIAL**	MFR. STD.	**PLC**	[NOT FOUND ON P&ID]
		SURGE PROTECTION	NO				
TAG	**P&ID**						
LSH-6534	65N02	**SERVICE**	CAUSTIC SODA SUMP LEVEL				
LE-6534		**FLUID**	CAUSTIC SODA	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
		MEASURING PRINCIPLE	CAPACITANCE	**ELEM. ENC. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-CS
		SET POINT	3-IN AFF	**ELEM. MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		MOUNTING	INTEGRAL	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	SPDT
		TYPICAL DETAILS	NL114, NA900	**ENCL. MATERIAL**	MFR. STD.	**PLC**	[NOT FOUND ON P&ID]
		SURGE PROTECTION	NO				
TAG	**P&ID**						
LSH-6907	69N03	**SERVICE**	LEVEL CAPACITANCE				
LE-6907		**FLUID**	[*]	**HAZARDOUS APP**	N/A	**POWER**	120VAC-1P
		MEASURING PRINCIPLE	CAPACITANCE	**ELEM. ENC. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-PEA
		SET POINT	3-IN AFF	**ELEM. MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		MOUNTING	INTEGRAL	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	SPDT
		TYPICAL DETAILS	NL114	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-PEA
		SURGE PROTECTION	NO				

Level Switch

SPECIFICATION 17201

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID	SERVICE	LEVEL CAPACITANCE				
LSH-7103	71N01	FLUID	[*]	HAZARDOUS APP	N/A	POWER	120VAC-1P
LE-7103		MEASURING PRINCIPLE	CAPACITANCE	ELEM. ENC. CLASS	NEMA 4X	POWER LOCATION	RTU-PEA
		SET POINT	3-IN AFF	ELEM. MATERIAL	MFR. STD.	OUTPUT	RELAY
		MOUNTING	INTEGRAL	SWITCH ENCL. CLASS	NEMA 4X	RELAY FORM	SPDT
		TYPICAL DETAILS	NL114	ENCL. MATERIAL	MFR. STD.	PLC	RTU-PEA
		SURGE PROTECTION	NO				

TAG	P&ID	SERVICE	PEC CONTAINMENT SUMP LEVEL				
LSH-7104	71N02	FLUID	PEC	HAZARDOUS APP	N/A	POWER	24VDC-1P
LE-7104		MEASURING PRINCIPLE	CAPACITANCE	ELEM. ENC. CLASS	NEMA 4X	POWER LOCATION	RTU-PEA
		SET POINT	3-IN AFF	ELEM. MATERIAL	MFR. STD.	OUTPUT	RELAY
		MOUNTING	INTEGRAL	SWITCH ENCL. CLASS	NEMA 4X	RELAY FORM	SPDT
		TYPICAL DETAILS	NL114, NA900	ENCL. MATERIAL	MFR. STD.	PLC	[NOT FOUND ON P&ID]
		SURGE PROTECTION	NO				

TAG	P&ID	SERVICE	AIR GAP MANHOLE LEVEL HIGH HIGH				
LSHH-4427	30N24	FLUID	[*]	HAZARDOUS APP	N/A	POWER	[*]
LE1-4427		MEASURING PRINCIPLE	BALL FLOAT	ELEM. ENC. CLASS	NEMA 4X	POWER LOCATION	LOOP
		SET POINT	4.0 FT	ELEM. MATERIAL	MFR. STD.	OUTPUT	RELAY
		MOUNTING	INTEGRAL	SWITCH ENCL. CLASS	NEMA 4X	RELAY FORM	SPDT
		TYPICAL DETAILS	NL101	ENCL. MATERIAL	MFR. STD.	PLC	[NOT FOUND ON P&ID]
		SURGE PROTECTION	NO				

Notes: PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.

SECTION 17204

LEVEL MEASUREMENT: CAPACITANCE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Level measurement devices using the principle of admittance/capacitance for level measurement.
   2. For discrete measurement of liquid, slurry and granular levels.
   3. For analog measurement of liquid, slurry and granular levels.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide complete documentation covering the traceability of calibration instruments.

1.04 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

C. Manufacture instrument facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation and Servicing.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 01850 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

1.09 MAINTENANCE

A. Furnish parts, materials, fluids, etc., necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. Continuous RF admittance/capacitance level:
   1. One of the following or equal:
      a. Drexelbrook, Universal Lite 509-15 Series.
      b. Delta Controls, Model TS173.
      c. Endress + Hauser, Liquicap Level Transmitter, Models FMI51/52.

2.04 MANUFACTURED UNITS

A. Discrete signal RF admittance/capacitance level measurement:
   1. General:
      a. RF signal enables a very small current flow from the sensor to reference ground.
         1) A change in RF admittance indicates presence or absence of the measured material.
         2) Transmitter circuitry enables the instrument to ignore the effect of buildup of material coating on the sensing element.

b. Single-point level switch sensing level of liquid, slurries, or granular materials.
c. Sensing interface between 2 liquids with significantly different dielectric constants (1 liquid must be non-conductive).

2. Performance requirements:
   a. Accuracy:
      1) Within 0.25-inch.
   b. Repeatability:
      1) Within 0.1-inch.
3. Element:
   a. Rigid probe or flexible cable with weight for large container liquid applications.
   b. Probe and insulation material must conform to measured material chemical compatibility as indicated in Attachment A - ISA Datasheet - Level Measurement: Capacitance or the instrument index.
4. Transmitter:
   a. Power supply:
      1) As indicated in the datasheets.
   b. Outputs:
      1) As indicated in the datasheets.
      2) Relay outputs:
         a) 2 SPDT Form C contacts.
         b) Rated min 5 A at 250 VAC.
         c) Programmable for adjustable hysteresis.
   c. Enclosure:
      1) As indicated in the datasheets.
      2) Non-hazardous area:
         a) NEMA Type 4X.
   d. Operating temperature range from -28 to 155 degrees Fahrenheit.

2.05 ACCESSORIES

A. Provide sunshades for outdoor installations.

2.06 SOURCE QUALITY CONTROL

A. Factory calibrate each instrument with a minimum 3-point calibration or according to Manufacturer's standard at a facility that is traceable to the NIST.
   1. Submit calibration datasheets to the Engineer at least 30 days before shipment of the instruments to the project site.

B. FM approval certification or equal when installed in classified areas.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.04 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - LEVEL MEASUREMENT: CAPACITANCE

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Level Transmitter

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG LSH-6514 (LE-6514)

SPECIFICATION NUMBER 17204

DRAWING NUMBER 65N01

SERVICE CAUSTIC SODA LEVEL SWITCH HIGH

MEASURING PRINCIPLE CAPACITANCE

PLC RTU-CS

TYPICAL DETAILS NL114

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE ___ FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-6514

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LSH-6514

MOUNTING INTEGRAL

POWER 24VDC-1P

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

NOTES

PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.

SECTION 17206

LEVEL MEASUREMENT: ULTRASONIC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Ultrasonic level instruments.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Abbreviations:
   1. DTM: Device Type Manager.
   2. FDT: Field Device Tool.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide complete documentation covering the traceability of calibration instruments.

C. For each instrument with Digital Bus communication protocol:
   1. Provide FDT certificate for the instrument's DTM.
   2. FDT certificate to be approved and listed by the FDT Group.

D. Furnish commissioning Submittals listed below, and as specified in this Section and Section 01756 - Commissioning:
   1. Manufacturer's representative qualifications.
   2. Owner Training.

1.04 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

C. Manufacture instruments facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 01850 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

1.09 MAINTENANCE

A. Furnish parts, materials, fluids, etc., necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. One of the following, no equal:
   1. Ultrasonic level sensor with 4-wire remote transmitter:
      a. Endress+Hauser, Prosonic M FMU 90 Series.
      b. Siemens, HydroRanger 200.

2.04 MANUFACTURED UNITS

A. As specified in this Section, including Attachment A - ISA Datasheet - Level Measurement: Ultrasonic.

B. Ultrasonic level measurement with 4-wire remote transmitter:
   1. General:
      a. Continuous non-contact level measurement device with remote transmitter using ultrasonic echo sensing.
         1) Transducer generates an ultrasonic pulse in the range of 12 to 50 kHz and measures the time required for the pulse to travel to the process surface and return.
         2) Distance is calculated from the send and receive times. Each 4-wire level transmitter system includes, but is not limited to:
            a) Ultrasonic transducer.
            b) Signal cable.
            c) Transmitter.
   2. Performance requirements:
      a. Accuracy:
         1) 0.25 percent of range.
      b. Repeatability:
         1) 0.1 percent of range.
   3. Ultrasonic transducer:
      a. Encapsulated in chemical- and corrosion-resistant material as indicated in Attachment A - ISA Datasheet - Level Measurement: Ultrasonic or Instrument Index.
      b. Class I Division 1 for transducer only.
      c. Operating temperature range: -5 to 122 degrees Fahrenheit (-20 to 50 degrees Celsius).
      d. Operating relative humidity range: 5 to 95 percent.
      e. Functions:
         1) Temperature compensation.
      f. Mounting: As indicated in the Contract Documents.
      g. Sensors:
         1) Rated for NEMA 6P submergence.
         2) Mechanical decoupling between sensor membrane and outer housing.
         3) Provided with automatic build up compensation to provide self-cleaning when condensation may occur.
         4) Provided with internal heating elements and separate power supplies for these elements when freezing condensation may occur.
         5) Automatic self-cleaning vibrating sensor diaphragms.
   4. Transmitter:
      a. Level-indicating transmitter:
         1) Indicator: Liquid crystal display with approximately 0.50-inch display scaled to read in engineering units.
         2) Sensitivity: Able to ignore momentary level spikes or momentary loss of echo and indicate loss of echo condition on indicating transmitter unit.
         3) Ability to allow for signal profiles and echo mapping:
            a) Provide manufacturer’s software for re-mapping the signal.

b. Functions:
    1) Level measurement.
    2) Tank volume.
    3) Flow measurement.
c. Power supply:
    1) As indicated in the datasheets.
d. Outputs:
    1) As indicated in the datasheets.
    2) Isolated 4 to 20 mA DC with HART communication protocol.
    3) Relay outputs:
        a) Minimum 6 Form A or Form C contacts.
        b) Rated 5 amps at 250 VAC.
        c) Programmable.
    4) Enclosure:
        a) As indicated in the datasheets.
        b) Non-hazardous area:
            (1) NEMA Type 4X.
    5) Mounting: As indicated in the Contract Documents.
    6) Operating temperature range from -5 to 122 degrees Fahrenheit (-20 to 50 degrees Celsius); relative humidity of 10 to 100 percent.
    7) Power supply shall be 90 to 253 VAC, or 10.5 to 32 VDC.
    8) Transmitter shall have automatic volume calculation for horizontal or vertical tanks with 32-point linearization; pre-programmed linearization tables for flumes and weirs; back water detection for submerged flow conditions; sludge detection; synchronization of pulses between 2 ultrasonic units used in same tank; automatic sensor detection; alternating pump control; rake/screen control.
    9) There shall be at least 3 integral totalizers and 3 daily counters with the ability for simultaneous measurement of level and flow in storm water overflow basin with only 1 sensor; EE prom memory backup; temperature compensation; average, difference, and sum calculations.

2.05 ACCESSORIES

A. Mounting brackets: As indicated on the Drawings.

B. Provide sunshades for outdoor installations.

2.06 FINISHES (NOT USED)

2.07 SOURCE QUALITY CONTROL

A. Factory calibrate each instrument with a minimum 3-point calibration or according to manufacturer's standard at a facility that is traceable to NIST.
    1. Submit calibration datasheets to the Engineer at least 30 days before shipment of the instruments to the project site.

B. FM approval certification or equal when installed in classified areas.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with trades to ensure that the mechanical system has necessary appurtenances including weld-o-lets, valves, etc., for proper installation of instruments.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.04 ADJUSTING

A. Turn on turbulent surface software feature for installations measuring surfaces lacking a placid surface. This would include but not be limited to level measurements in mixed media filters and potentially wet wells.

3.05 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be as indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - LEVEL MEASUREMENT: ULTRASONIC

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG LIT-3001 (LE-3001)

SPECIFICATION NUMBER 17206

DRAWING NUMBER 30N02

SERVICE N INFLUENT CHANNEL LEVEL

MEASURING PRINCIPLE ULTRASONIC

PLC RTU-ELEC1

TYPICAL DETAILS NL901, NA900

CONNECTION

PROCESS CONNECTION FLANGE MOUNT

FLUID

LEVEL RANGE 0-10 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-3001

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-3001

MOUNTING INT

POWER 24VDC-1P

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

NOTES

PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.

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PROJECT 202001

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GENERAL

TAG LIT-3002 (LE-3002)

SPECIFICATION NUMBER 17206

DRAWING NUMBER 30N01

SERVICE S INFLUENT CHANNEL LEVEL

MEASURING PRINCIPLE ULTRASONIC

PLC RTU-ELEC1

TYPICAL DETAILS NL901, NA900

CONNECTION

PROCESS CONNECTION FLANGE MOUNT

FLUID

LEVEL RANGE 0-10 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-3002

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-3002

MOUNTING INT

POWER 24VDC-1P

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

NOTES

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PROJECT 202001

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GENERAL

TAG LIT-3011 (LE-3011)

SPECIFICATION NUMBER 17206

DRAWING NUMBER 30N03

SERVICE FILTER 1 LEVEL

MEASURING PRINCIPLE ULTRASONIC

PLC RTU-NFL1

TYPICAL DETAILS NL181, NA900

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-12 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-3011

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-3011

MOUNTING [*]

POWER 24VDC-1P

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

NOTES

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GENERAL

TAG LIT-3021 (LE-3021)

SPECIFICATION NUMBER 17206

DRAWING NUMBER 30N04

SERVICE FILTER 2 LEVEL

MEASURING PRINCIPLE ULTRASONIC

PLC RTU-SFL2

TYPICAL DETAILS NL181, NA900

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-12 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-3021

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-3021

MOUNTING REM

POWER 24VDC-1P

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

NOTES

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GENERAL

TAG LIT-3031 (LE-3031)

SPECIFICATION NUMBER 17206

DRAWING NUMBER 30N05

SERVICE FILTER 3 LEVEL

MEASURING PRINCIPLE ULTRASONIC

PLC RTU-NFL3

TYPICAL DETAILS NL181, NA900

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-12 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-3031

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-3031

MOUNTING REM

POWER 24VDC-1P

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

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GENERAL

TAG LIT-3041 (LE-3041)

SPECIFICATION NUMBER 17206

DRAWING NUMBER 30N06

SERVICE FILTER 4 LEVEL

MEASURING PRINCIPLE ULTRASONIC

PLC RTU-SFL4

TYPICAL DETAILS NL181, NA900

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-12 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-3041

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-3041

MOUNTING REM

POWER 24VDC-1P

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

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GENERAL

TAG LIT-3051 (LE-3051)

SPECIFICATION NUMBER 17206

DRAWING NUMBER 30N07

SERVICE FILTER 5 LEVEL

MEASURING PRINCIPLE ULTRASONIC

PLC RTU-NFL5

TYPICAL DETAILS NL181, NA900

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-12 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-3051

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-3051

MOUNTING REM

POWER 24VDC-1P

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

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GENERAL

TAG LIT-3061 (LE-3061)
SPECIFICATION NUMBER 17206
DRAWING NUMBER 30N08
SERVICE FILTER 6 LEVEL
MEASURING PRINCIPLE ULTRASONIC
PLC RTU-SFL6
TYPICAL DETAILS NL181, NA900

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-12 FT
TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-3061
ELEMENT HAZ. MATERIALS N/A
SUBMERGENCE DETECTION NO
HEATED ELEMENT NO
ENCLOSURE CLASS NEMA 4X
ELEMENT MATERIAL MFR. STD.
TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-3061
MOUNTING REM
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
ENCLOSURE CLASS NEMA 4X
OUTPUT 4-20 MA
MEASUREMENT APPL LEVEL

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GENERAL

TAG LIT-3071 (LE-3071)

SPECIFICATION NUMBER 17206

DRAWING NUMBER 30N09

SERVICE FILTER 7 LEVEL

MEASURING PRINCIPLE ULTRASONIC

PLC RTU-NFL7

TYPICAL DETAILS NL181, NA900

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-12 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-3071

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-3071

MOUNTING REM

POWER 24VDC-1P

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

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GENERAL

TAG LIT-3081 (LE-3081)

SPECIFICATION NUMBER 17206

DRAWING NUMBER 30N10

SERVICE FILTER 8 LEVEL

MEASURING PRINCIPLE ULTRASONIC

PLC RTU-SFL8

TYPICAL DETAILS NL181, NA900

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-12 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-3081

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-3081

MOUNTING REM

POWER 24VDC-1P

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

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GENERAL

TAG LIT-3091 (LE-3091)

SPECIFICATION NUMBER 17206

DRAWING NUMBER 30N11

SERVICE FILTER 9 LEVEL

MEASURING PRINCIPLE ULTRASONIC

PLC RTU-NFL9

TYPICAL DETAILS NL181, NA900

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-12 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-3091

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-3091

MOUNTING REM

POWER 24VDC-1P

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

NOTES

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GENERAL

TAG LIT-3101 (LE-3101)

SPECIFICATION NUMBER 17206

DRAWING NUMBER 30N12

SERVICE FILTER 10 LEVEL

MEASURING PRINCIPLE ULTRASONIC

PLC RTU-SFL10

TYPICAL DETAILS NL181, NA900

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-12 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-3101

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-3101

MOUNTING REM

POWER 24VDC-1P

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

NOTES

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GENERAL

TAG LIT-3111 (LE-3111)

SPECIFICATION NUMBER 17206

DRAWING NUMBER 30N13

SERVICE FILTER 11 LEVEL

MEASURING PRINCIPLE ULTRASONIC

PLC RTU-NFL11

TYPICAL DETAILS NL181, NA900

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-12 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-3111

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-3111

MOUNTING REM

POWER 24VDC-1P

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

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PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.

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GENERAL

TAG LIT-3121 (LE-3121)
SPECIFICATION NUMBER 17206
DRAWING NUMBER 30N14
SERVICE FILTER 12 LEVEL
MEASURING PRINCIPLE ULTRASONIC
PLC RTU-SFL12
TYPICAL DETAILS NL181, NA900

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-12 FT
TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-3121
ELEMENT HAZ. MATERIALS N/A
SUBMERGENCE DETECTION NO
HEATED ELEMENT NO
ENCLOSURE CLASS NEMA 4X
ELEMENT MATERIAL MFR. STD.
TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-3121
MOUNTING REM
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
ENCLOSURE CLASS NEMA 4X
OUTPUT 4-20 MA
MEASUREMENT APPL LEVEL

NOTES

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GENERAL

TAG LIT-3131 (LE-3131)

SPECIFICATION NUMBER 17206

DRAWING NUMBER 30N15

SERVICE FILTER 13 LEVEL

MEASURING PRINCIPLE ULTRASONIC

PLC RTU-NFL13

TYPICAL DETAILS NL181, NA900

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-12 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-3131

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-3131

MOUNTING REM

POWER 24VDC-1P

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

NOTES

PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG LIT-3141 (LE-3141)

SPECIFICATION NUMBER 17206

DRAWING NUMBER 30N16

SERVICE FILTER 14 LEVEL

MEASURING PRINCIPLE ULTRASONIC

PLC RTU-SFL14

TYPICAL DETAILS NL181, NA900

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-12 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-3141

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-3141

MOUNTING REM

POWER 24VDC-1P

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

NOTES

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GENERAL

TAG LIT-3151 (LE-3151)

SPECIFICATION NUMBER 17206

DRAWING NUMBER 30N17

SERVICE FILTER 15 LEVEL

MEASURING PRINCIPLE ULTRASONIC

PLC RTU-NFL15

TYPICAL DETAILS NL181, NA900

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-12 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-3151

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-3151

MOUNTING REM

POWER 24VDC-1P

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

NOTES

PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.

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PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
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GENERAL

TAG LIT-3161 (LE-3161)
SPECIFICATION NUMBER 17206
DRAWING NUMBER 30N18
SERVICE FILTER 16 LEVEL
MEASURING PRINCIPLE ULTRASONIC
PLC RTU-SFL16
TYPICAL DETAILS NL181, NA900

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-12 FT
TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-3161
ELEMENT HAZ. MATERIALS N/A
SUBMERGENCE DETECTION NO
HEATED ELEMENT NO
ENCLOSURE CLASS NEMA 4X
ELEMENT MATERIAL MFR. STD.
TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-3161
MOUNTING REM
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
ENCLOSURE CLASS NEMA 4X
OUTPUT 4-20 MA
MEASUREMENT APPL LEVEL

NOTES

PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.

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GENERAL

TAG LIT-4122 (LE-4122)

SPECIFICATION NUMBER 17206

DRAWING NUMBER 30N20

SERVICE BACKWASH TANK NO. 2 LEVEL

MEASURING PRINCIPLE ULTRASONIC

PLC RTU-CS

TYPICAL DETAILS NL173

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-31.5 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-4122

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-4122

MOUNTING REM

POWER 24VDC-1P

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION YES

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

NOTES

PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.

SECTION 17208

LEVEL MEASUREMENT: RADAR PULSE TIME OF FLIGHT (PTOF)

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Non-contact radar (PTOF) level instruments.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Abbreviations
   1. PTOF: Pulse Time of Flight.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Furnish commissioning Submittals listed below, and as specified in this Section and Section 01756 - Commissioning:
   1. Manufacturer's representative qualifications.
   2. Owner Training.

1.04 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

C. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. One of the following, no equal:
   1. Endress+Hauser, Micropilot FMR51.
   2. Rosemount 3300 or 5400.
   3. Siemens Sitrans 250R.

2.04 MANUFACTURED UNITS

A. Pulse Time of Flight:
   1. General:
      a. Instrument emits radar pulses via a transmitter, with a frequency range of 6.3 GHz to 26 GHz.
      b. Pulses reflect from the surface being measured and are received back at the instrument via a sensor.
      c. Instrument measures the pulse travel time between the transmitter, surface, and receiver to calculate the level.
      d. Safety:
         1) Shall not generate frequency waves with power levels hazardous to humans.

2. Performance requirements:
    a. Accuracy: Level:
        1) 0.25-inch.
3. Element:
    a. Level element must conform to the process material compatibility as indicated in Attachment A - ISA Datasheet - Level Measurement: Radar Pulse Time of Flight (PTOF) or the Instrument Index.
    b. Connections:
        1) Process: Antenna design shall be suitable for mounting in a nozzle as indicated in Attachment A - ISA Datasheet - Level Measurement: Radar Pulse Time of Flight (PTOF) or the Instrument Index.
        2) Design shall be such that product condensation on the antenna shall not affect the performance of the gauge. It shall be possible to choose between parabolic-, cone-, or rod-shaped antennas.
4. Transmitter:
    a. Microprocessor-based signal converter/transmitter.
    b. Power supply:
        1) As indicated in the datasheets.
    c. Outputs:
        1) As indicated in the datasheets.
    d. Backlit digital display for level or volume.
    e. Self-diagnostics and automatic data checking.
    f. Signal integrity:
        1) Immune to radio frequency and electromagnetic interference with field strength of 15 volts/meter or less over a frequency range of 50 Hz to 460 MHz.
        2) Able to ignore momentary level spikes or momentary loss of echo and indicate loss of echo condition on indicating transmitter unit.
    g. Protected terminals and fuses in a separate compartment, which isolates field connection from electronics.
        1) Indication: Local - 5-digit display.
    h. Enclosure:
        1) As indicated in the datasheets.
    i. Electrical connection: 1/2-inch male NPT.

2.05 ACCESSORIES

A. Software: Provide Windows-based PC software for configuration and echo mapping.

B. Provide sun shield for outdoor installations.

2.06 FINISHES (NOT USED)

2.07 SOURCE QUALITY CONTROL

A. Factory calibrate each level transmitter at a facility traceable to NIST.

B. Provide complete documentation covering the traceability of calibration instruments.

C. FM approval certification or equal when installed in classified areas.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc., for proper installation of instruments.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Owner Training:
   1. Not required.

3.04 ADJUSTING

A. Verify factory calibration of instruments in accordance with the manufacturer's instructions:
   1. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.05 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - LEVEL MEASUREMENT: RADAR PULSE TIME OF FLIGHT (PTOF)

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG LIT-6211 (LE-6211)

SPECIFICATION NUMBER 17208

DRAWING NUMBER 62N02

SERVICE PRIMARY COAG DAY TANK LEVEL

MEASURING PRINCIPLE RADAR PTOF

PLC RTU-PEA

TYPICAL DETAILS NL150

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-7 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-6211

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-6211

MOUNTING INT

POWER [*]

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

NOTES

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PROJECT INFORMATION

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PROJECT 202001

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GENERAL

TAG LIT-6501 (LE-6501)

SPECIFICATION NUMBER 17208

DRAWING NUMBER 65N01

SERVICE CAUSTIC SODA TANK 1 LEVEL METER

MEASURING PRINCIPLE RADAR PTOF

PLC RTU-CS

TYPICAL DETAILS NL150

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-26 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-6501

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-6501

MOUNTING INT

POWER [*]

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

NOTES

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PROJECT INFORMATION

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GENERAL

TAG LIT-6502 (LE-6502)

SPECIFICATION NUMBER 17208

DRAWING NUMBER 65N01

SERVICE CAUSTIC SODA TANK 2 LEVEL METER

MEASURING PRINCIPLE RADAR PTOF

PLC RTU-CS

TYPICAL DETAILS NL150

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-26 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-6502

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-6502

MOUNTING INT

POWER [*]

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

NOTES

[*]

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PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

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GENERAL

TAG LIT-6503 (LE-6503)

SPECIFICATION NUMBER 17208

DRAWING NUMBER 65N01

SERVICE CAUSTIC SODA TANK 3 LEVEL METER

MEASURING PRINCIPLE RADAR PTOF

PLC RTU-CS

TYPICAL DETAILS NL150

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-26 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-6503

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-6503

MOUNTING INT

POWER [*]

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

NOTES

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GENERAL

TAG LIT-6531 (LE-6531)

SPECIFICATION NUMBER 17208

DRAWING NUMBER 65N02

SERVICE CS DAY TANK ULTRASONIC LEVEL

MEASURING PRINCIPLE RADAR PTOF

PLC RTU-CS

TYPICAL DETAILS NL150

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-8 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-6531

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-6531

MOUNTING INT

POWER [*]

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

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GENERAL

TAG LIT-7101 (LE-7101)
SPECIFICATION NUMBER 17208
DRAWING NUMBER 71N01
SERVICE PEC TANK 1 LEVEL
MEASURING PRINCIPLE RADAR PTOF
PLC RTU-PEA
TYPICAL DETAILS NL150

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-10 FT
TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-7101
ELEMENT HAZ. MATERIALS N/A
SUBMERGENCE DETECTION NO
HEATED ELEMENT NO
ENCLOSURE CLASS NEMA 4X
ELEMENT MATERIAL MFR. STD.
TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-7101
MOUNTING INT
POWER [*]
AMBIENT TEMPERATURE 0-95 DEG F
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
ENCLOSURE CLASS NEMA 4X
OUTPUT 4-20 MA
MEASUREMENT APPL LEVEL

NOTES

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GENERAL

TAG LIT-7102 (LE-7102)

SPECIFICATION NUMBER 17208

DRAWING NUMBER 71N01

SERVICE PEC TANK 2 LEVEL

MEASURING PRINCIPLE RADAR PTOF

PLC RTU-PEA

TYPICAL DETAILS NL150

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-10 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-7102

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-7102

MOUNTING INT

POWER [*]

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

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GENERAL

TAG LIT-7105 (LE-7105)

SPECIFICATION NUMBER 17208

DRAWING NUMBER 71N02

SERVICE PEC DAY TANK LEVEL

MEASURING PRINCIPLE RADAR PTOF

PLC RTU-PEA

TYPICAL DETAILS NL150

CONNECTION

PROCESS CONNECTION N/A

FLUID

LEVEL RANGE 0-7 FT

TEMPERATURE N/A

ELEMENT

ELEMENT TAG NO. LE-7105

ELEMENT HAZ. MATERIALS N/A

SUBMERGENCE DETECTION NO

HEATED ELEMENT NO

ENCLOSURE CLASS NEMA 4X

ELEMENT MATERIAL MFR. STD.

TEMPERATURE COMP. NO

TRANSMITTER

TRANSMITTER TAG NO. LIT-7105

MOUNTING INT

POWER [*]

AMBIENT TEMPERATURE 0-95 DEG F

SURGE PROTECTION NO

HAZARDOUS APPROVALS N/A

ENCLOSURE CLASS NEMA 4X

OUTPUT 4-20 MA

MEASUREMENT APPL LEVEL

NOTES

[*]

SECTION 17301

FLOW MEASUREMENT: SWITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Thermal dispersion flow switches.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide complete documentation covering the traceability of calibration instruments.

1.04 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

1.09 MAINTENANCE

A. Furnish parts, materials, fluids, etc., necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments identified in the Contract Drawings.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed site conditions, including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. The following, no equal:
   1. Thermal dispersion type:
      a. Fluid Components International LLC, FLT93F.

2.04 MANUFACTURED UNITS

A. As specified in this Section, including Attachment A - ISA Datasheet - Flow Measurement: Switches.

B. Thermal dispersion type:
   1. General:
      a. Instrument uses a heated probe and a reference probe.
         1) Deviation in the amount of heat measured by the reference probe deviates beyond the setpoint an adjustable relay closes.
         2) Switch:
            a) Micro-processor based with continuous self-diagnostics, "Smart Heater" to prevent sensor failure, no mechanical jumpers or trim pots, and a 3-year warranty.

2. Performance requirements:
    a. Accuracy:
        1) Liquids: Within 0.5 percent reading or within 0.04 fps or 0.012 mps.
        2) Gases: Within 0.5 percent reading or within 2 sfps or 0.06 nmps.
    b. Repeatability: Within 1 percent of setpoint range.
    c. Response time: 0.5 to 2.5 seconds.
    d. Adjustable bypass delay timer.
    e. Adjustable range.
3. Switch characteristics:
    a. Exposed parts: Powder coated aluminum housing.
    b. Wetted parts:
        1) Materials as recommended by the manufacturer and approved by the Engineer.
    c. Power supply:
        1) As indicated in the datasheets.
        2) 24 VDC.
    d. Operating temperature range:
        1) As indicated in the datasheets.
        2) -40 degrees Fahrenheit to 140 degrees Fahrenheit.
    e. Enclosure:
        1) As indicated in the datasheets.
        2) Non-hazardous area:
            a) NEMA Type 4X.

2.05 DATASHEET ACCESSORIES

A. Provide sunshades for outdoor installations.

2.06 FINISHES (NOT USED)

2.07 SOURCE QUALITY CONTROL

A. Factory calibrate each instrument with a minimum 3-point calibration or according to Manufacturer's standard at a facility that is traceable to the NIST.
    1. Submit calibration datasheets to the Engineer at least 30 days before shipment of the instruments to the project site.

B. Provide FM approval certification or equal when installed in classified areas.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.04 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - FLOW MEASUREMENT: SWITCHES

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Flow Switch

SPECIFICATION 17301

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID						
FSL-3911	30N25	**SERVICE**	FILTER DRAIN 1 FLOW LOW				
FE-3911		**FLUID**	WATER	**HAZARDOUS APP**	N/A	**POWER**	120VAC-1P
		MEASURING PRINCIPLE	THERMAL	**ELEM. ENC. CLASS**	NEMA 4X	**POWER LOCATION**	MCC BUCKET
		SET POINT	50 GPM OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**OUTPUT**	[*]
		PROCESS CONNECTION	M-NPT	**PRESSURE**	65 PSIG	**RELAY FORM**	SPDT
		CONNECTION MATERIAL	[*]	**TEMPERATURE**	60 DEG F	**PLC**	RTU-ELEC1
		INSERTION LENGTH	[*]	**VISCOSITY**	1.01	**SURGE PROTECTION**	NO
		TYPICAL DETAILS	NF111				
TAG	**P&ID**						
FSL-3921	30N25	**SERVICE**	FILTER DRAIN 2 FLOW LOW				
FE-3921		**FLUID**	WATER	**HAZARDOUS APP**	N/A	**POWER**	120VAC-1P
		MEASURING PRINCIPLE	THERMAL	**ELEM. ENC. CLASS**	NEMA 4X	**POWER LOCATION**	MCC BUCKET
		SET POINT	50 GPM OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**OUTPUT**	[*]
		PROCESS CONNECTION	M-NPT	**PRESSURE**	65 PSIG	**RELAY FORM**	SPDT
		CONNECTION MATERIAL	[*]	**TEMPERATURE**	60 DEG F	**PLC**	RTU-ELEC1
		INSERTION LENGTH	[*]	**VISCOSITY**	1.01	**SURGE PROTECTION**	NO
		TYPICAL DETAILS	NF111				
TAG	**P&ID**						
FSH-3942	30N24	**SERVICE**	THERMAL FLOW SWITCH				
FE-3942		**FLUID**	WATER	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
		MEASURING PRINCIPLE	THERMAL	**ELEM. ENC. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-FBW
		SET POINT	10 GPM	**SWITCH ENCL. CLASS**	NEMA 4X	**OUTPUT**	RELAY
		PROCESS CONNECTION	F-NPT	**PRESSURE**	N/A	**RELAY FORM**	SPDT
		CONNECTION MATERIAL	[*]	**TEMPERATURE**	N/A	**PLC**	RTU-ELEC1
		INSERTION LENGTH	[*]	**VISCOSITY**	N/A	**SURGE PROTECTION**	NO
		TYPICAL DETAILS	NF111				

Flow Switch

SPECIFICATION 17301

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID						
FSL-6391	63N14	**SERVICE**	THERMAL FLOW SWITCH				
FE-6391		**FLUID**	CL2 GAS/AIR	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
		MEASURING PRINCIPLE	THERMAL	**ELEM. ENC. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-CL
		SET POINT	2500 CFM	**SWITCH ENCL. CLASS**	NEMA 4X	**OUTPUT**	RELAY
		PROCESS CONNECTION	F-NPT	**PRESSURE**	N/A	**RELAY FORM**	DPDT
		CONNECTION MATERIAL	[*]	**TEMPERATURE**	N/A	**PLC**	RTU-CL
		INSERTION LENGTH	12-IN	**VISCOSITY**	N/A	**SURGE PROTECTION**	YES
		TYPICAL DETAILS	NF111, NA900				
		Notes	*PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.*				

TAG	P&ID						
FSL-6392	63N14	**SERVICE**	THERMAL FLOW SWITCH				
FE-6392		**FLUID**	CL2 GAS/AIR	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
		MEASURING PRINCIPLE	THERMAL	**ELEM. ENC. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-CL
		SET POINT	2500 CFM	**SWITCH ENCL. CLASS**	NEMA 4X	**OUTPUT**	RELAY
		PROCESS CONNECTION	F-NPT	**PRESSURE**	N/A	**RELAY FORM**	DPDT
		CONNECTION MATERIAL	[*]	**TEMPERATURE**	N/A	**PLC**	RTU-CL
		INSERTION LENGTH	12-IN	**VISCOSITY**	N/A	**SURGE PROTECTION**	YES
		TYPICAL DETAILS	NF111, NA900				
		Notes	*PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.*				

SECTION 17302

FLOW MEASUREMENT: MAGNETIC FLOWMETERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Full-body magnetic flowmeters.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Standards:
   1. International Organization for Standardization (ISO):
      a. 9000 - Quality management systems - Fundamentals and vocabulary.
      b. 17025 - General requirements for the competence of testing and calibration laboratories.
   2. National Institute of Standards and Technology (NIST).
   3. NSF International (NSF).

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Include sizing information from the manufacturer that includes:
   1. Chart of the measurement error from zero to maximum measured volumetric flow range indicated in datasheets.
   2. Indication of input parameters and their values used in the calculations.

C. Furnish commissioning Submittals listed below, as specified in this Section, and Section 01756 - Commissioning:
   1. Manufacturer's representative qualifications.
   2. Owner Training.

1.04 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.

b. Location within the process.
c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

C. Manufacture instrument facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation and Servicing.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed site conditions, including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. One of the following, no equal:
1. Emerson, Rosemount 8750W (Wall mount DA1 & DA2 Modbus, with Remote Transmitter).
2. Endress+Hauser 400W (Modbus).

2.04 MANUFACTURED UNITS

A. As specified in this Section, including Attachment A - ISA Datasheet - Flow Measurement: Magnetic Flowmeters.

B. Magnetic flowmeter:
   1. General:
      a. Magnetic flowmeters obtain the flow velocity by measuring the changes of induced voltage of the conductive fluid passing across a controlled magnetic field.
      b. Complete zero stability shall be an inherent characteristic of the flowmeter system.
      c. Include for each magnetic flow metering system:
         1) A metering tube with electrodes (sensor).
         2) Fully welded flanges that are rated for the full pressure class of the piping.
         3) Signal cable if remote mounted.
         4) Transmitter integral or remote as indicated on the Drawings.
         5) Flowmeter grounding rings.
   2. Performance requirements:
      a. Accuracy:
         1) 0.25 percent of flow rate from 10 to 100 percent of full-scale for velocities ranging between 1.9 to 10 feet per second.
      b. Repeatability:
         1) 0.25 percent of rate.
   3. Element:
      a. Metering tube:
         1) Constructed of Type 304 or 316 stainless steel (unless specifically noted otherwise in the instrument datasheet) with flanged connections to match with piping material.
            a) Carbon steel cannot be used when coils are on the outside of the metering tube, it will not pass the magnetic field.
            b) Coils that are embedded in the liner are not permitted.
         2) Liner material in conformance with:
            a) Manufacturer's recommendations for the intended service.
            b) NSF certified for drinking water applications.
         3) Electrodes type and material in conformance with:
            a) Manufacturer's recommendations for the intended service.
            b) Utilize a minimum of 2, self-cleaning electrodes.
         4) As indicated in the datasheets.
         5) Meter terminal housing NEMA Type 4X, unless installed in locations such as vaults that will experience submergence. In those applications NEMA 6P is required.
         6) Meter coating consisting of epoxy painted finish.
         7) Components:
            a) 2 grounding rings:
               (1) Which are in conformance with the manufacturer's bore and material recommendation for the meter's intended service.
   4. Transmitter:
      a. Power supply:
         1) As indicated in the datasheets.
      b. Outputs:
         1) As indicated in the instrument datasheet.
         2) For instruments with 4 to 20 mA HART or digital bus protocol, provide a Device Type Manager (DTM) certification by FDT group.
      c. Microprocessor-based signal converter/transmitter.

d. Utilize DC pulse technique to drive flux-producing coils.
e. Contain a 6-digit display for flow rate, percent of span, and totalizer.
f. Operator keypad interface.
g. Integral zero return to provide consistent zero output signals in response to an external dry contact closure.
h. Integral low flow cut-off zero return.
i. Programmable parameters including:
    1) Meter size.
    2) Full-scale flow rate.
    3) Magnetic field frequency.
    4) Time constant.
j. Data retention for a minimum of 5 years without auxiliary main or battery power.
k. Self-diagnostics and automatic data checking.
l. Protected terminals and fuses in a separate compartment which isolates field connection from electronics.
m. Ambient operating temperature limits of -5 to 140 degrees Fahrenheit (-20 to 60 degrees Celsius).
n. Enclosure:
    1) As indicated in the instrument datasheet.
    2) For more information, see Attachment A - ISA Datasheet - Flow Measurement: Magnetic Flowmeters.
o. Transmitter should retain all setup parameters and accumulated measurements internally in non-volatile memory in the event of power failure.
p. Device failure modes, self-monitoring characteristics and remedy diagnosis shall follow NAMUR standards NE 43 and NE 107.

2.05 ACCESSORIES

A. Provide stainless steel tags for each instrument. Tags shall be labeled as specified in the Contract Documents.

B. Provide sunshades for transmitters located outdoors.

C. Provide galvanic isolation gaskets, nylon/Teflon™ flange bolt insulation bushings, and nylon washers on meters installed on pipes with cathodic protection.

D. Furnish 1 spool piece for every size of magnetic flow tube being provided.

E. Electronic tester for calibration verification and diagnostics.
    1. Transmitter shall have continuous internal meter verification method comparing current meter system values to base line value.
    2. Should variance in readings be determined exceeding a preset limit the transmitter will provide an alarm condition via a configurable discrete output.

2.06 FINISHES (NOT USED)

2.07 SOURCE QUALITY CONTROL

A. Factory calibrate each flow metering system at a facility that is traceable to the NIST.
   1. ISO-17025 accredited test facility with certified accuracy traceable to NIST.
   2. Suggestion, the calibration facility be traceable to international standards and ILAC, International Laboratory Accreditation Committee MRA, Mutual Recognition Agreement.
   3. This ensures worldwide accreditation of calibration laboratories.

B. Evidence of accreditation shall originate from a national verification agency such as A2LA ILAC.

C. FM approval certification or equal when installed in classified areas.

D. A real-time computer-generated printout of the actual calibration date indication actual velocities and as read values of the flow tube.
   1. Flow calibration report of the manufacturers flow lab calibration procedure shall be shipped with the meter system.
   2. Minimum calibration shall be a 3 point calibration including 1, 3, and 10 feet per second velocities for every meter and transmitter system. 2 points at 15 to 20 percent and 80 to 100 percent are statistically proven to be sufficient calibration points.
   3. Manufacturer shall archive calibration reports for future reference.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. For instruments located outdoors or where instrument elements and transmitters are separated by conduit located outside the building envelope, provide surge protection devices at the transmitters.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.04 FIELD QUALITY CONTROL

A. Field Verification:
   1. Verify factory calibration of instruments in accordance with the manufacturer’s instructions.
   2. Verification should be traceable to factory calibration using a third-party, attested onboard system pursuant to ISO standards.
   3. Verification report should be compliant to common quality systems such as ISO 9000 to prove the reliability of the meter-specified accuracy.

4. Return factory-calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.05 SCHEDULES

A. Instrument datasheets are included in this Section.

B. The provided information does not necessarily include all required instruments.

C. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - FLOW MEASUREMENT: MAGNETIC FLOWMETERS

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Magnetic Flow Transmitter

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG FIT-3011 (FE-3011)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 30N03
SERVICE FILTER 1 EFFLUENT FLOW METER
MEASURING PRINCIPLE MAGNETIC
PLC RTU-NFL1
POWER LOCATION RTU-NFL1
TYPICAL DETAIL(S) NF130, NF135, NA900

CONNECTION

LINE SIZE 30-IN
LINE MATERIAL DUCTILE IRON
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL DUCTILE IRON

FLUID

FLUID WATER
NOMINAL FLOW 12390 GPM
FLOW RANGE 0-12,390 GPM
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY 1.01
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-3011
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 30-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-3011
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

PROVIDE HIGH ACCURACY, ZERO UPSTREAM/DOWNSTREAM FLOW METER/TRANSMITTERS. PROVIDE PHOENIX CONTACT RTU TO MODBUS TCP/IP CONVERTOR.

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG FIT-3021 (FE-3021)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 30N04
SERVICE FILTER 2 EFFLUENT FLOW METER
MEASURING PRINCIPLE MAGNETIC
PLC RTU-SFL2
POWER LOCATION RTU-SFL2
TYPICAL DETAIL(S) NF130, NF135, NA900

CONNECTION

LINE SIZE 30-IN
LINE MATERIAL DUCTILE IRON
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL DUCTILE IRON

FLUID

FLUID WATER
NOMINAL FLOW 12390 GPM
FLOW RANGE 0-12,390 GPM
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY 1.01
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-3021
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 30-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-3021
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

PROVIDE HIGH ACCURACY, ZERO UPSTREAM/DOWNSTREAM FLOW METER/TRANSMITTERS. PROVIDE PHOENIX CONTACT RTU TO MODBUS TCP/IP CONVERTOR.

Magnetic Flow Transmitter

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG FIT-3031 (FE-3031)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 30N05
SERVICE FILTER 3 EFFLUENT FLOW METER
MEASURING PRINCIPLE MAGNETIC
PLC RTU-NFL3
POWER LOCATION RTU-NFL3
TYPICAL DETAIL(S) NF130, NF135, NA900

CONNECTION

LINE SIZE 30-IN
LINE MATERIAL DUCTILE IRON
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL DUCTILE IRON

FLUID

FLUID WATER
NOMINAL FLOW 12390 GPM
FLOW RANGE 0-12,390 GPM
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY 1.01
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-3031
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 30-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-3031
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

PROVIDE HIGH ACCURACY, ZERO UPSTREAM/DOWNSTREAM FLOW METER/TRANSMITTERS. PROVIDE PHOENIX CONTACT RTU TO MODBUS TCP/IP CONVERTOR.

Magnetic Flow Transmitter

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
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GENERAL

TAG FIT-3041 (FE-3041)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 30N06
SERVICE FILTER 4 EFFLUENT FLOW METER
MEASURING PRINCIPLE MAGNETIC
PLC RTU-SFL4
POWER LOCATION RTU-SFL4
TYPICAL DETAIL(S) NF130, NF135, NA900

CONNECTION

LINE SIZE 30-IN
LINE MATERIAL DUCTILE IRON
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL DUCTILE IRON

FLUID

FLUID WATER
NOMINAL FLOW 12390 GPM
FLOW RANGE 0-12,390 GPM
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY 1.01
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-3041
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 30-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-3041
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

PROVIDE HIGH ACCURACY, ZERO UPSTREAM/DOWNSTREAM FLOW METER/TRANSMITTERS. PROVIDE PHOENIX CONTACT RTU TO MODBUS TCP/IP CONVERTOR.

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG FIT-3051 (FE-3051)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 30N07
SERVICE FILTER 5 EFFLUENT FLOW METER
MEASURING PRINCIPLE MAGNETIC
PLC RTU-NFL5
POWER LOCATION RTU-NFL5
TYPICAL DETAIL(S) NF130, NF135, NA900

CONNECTION

LINE SIZE 30-IN
LINE MATERIAL DUCTILE IRON
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL DUCTILE IRON

FLUID

FLUID WATER
NOMINAL FLOW 12390 GPM
FLOW RANGE 0-12,390 GPM
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY 1.01
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-3051
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 30-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-3051
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

PROVIDE HIGH ACCURACY, ZERO UPSTREAM/DOWNSTREAM FLOW METER/TRANSMITTERS. PROVIDE PHOENIX CONTACT RTU TO MODBUS TCP/IP CONVERTOR.

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG FIT-3061 (FE-3061)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 30N08
SERVICE FILTER 6 EFFLUENT FLOW METER
MEASURING PRINCIPLE MAGNETIC
PLC RTU-SFL6
POWER LOCATION RTU-SFL6
TYPICAL DETAIL(S) NF130, NF135, NA900

CONNECTION

LINE SIZE 30-IN
LINE MATERIAL DUCTILE IRON
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL DUCTILE IRON

FLUID

FLUID WATER
NOMINAL FLOW 12390 GPM
FLOW RANGE 0-12,390 GPM
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY 1.01
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-3061
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 30-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-3061
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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PROJECT INFORMATION

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PROJECT 202001
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LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG FIT-3071 (FE-3071)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 30N09
SERVICE FILTER 7 EFFLUENT FLOW METER
MEASURING PRINCIPLE MAGNETIC
PLC RTU-NFL7
POWER LOCATION RTU-NFL7
TYPICAL DETAIL(S) NF130, NF135, NA900

CONNECTION

LINE SIZE 30-IN
LINE MATERIAL DUCTILE IRON
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL DUCTILE IRON

FLUID

FLUID WATER
NOMINAL FLOW 12390 GPM
FLOW RANGE 0-12,390 GPM
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY 1.01
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-3071
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 30-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-3071
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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Magnetic Flow Transmitter

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GENERAL

TAG FIT-3081 (FE-3081)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 30N10
SERVICE FILTER 8 EFFLUENT FLOW METER
MEASURING PRINCIPLE MAGNETIC
PLC RTU-SFL8
POWER LOCATION RTU-SFL8
TYPICAL DETAIL(S) NF130, NF135, NA900

CONNECTION

LINE SIZE 30-IN
LINE MATERIAL DUCTILE IRON
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL DUCTILE IRON

FLUID

FLUID WATER
NOMINAL FLOW 12390 GPM
FLOW RANGE 0-12,390 GPM
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY 1.01
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-3081
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 30-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-3081
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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Magnetic Flow Transmitter

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GENERAL

TAG FIT-3091 (FE-3091)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 30N11
SERVICE FILTER 9 EFFLUENT FLOW METER
MEASURING PRINCIPLE MAGNETIC
PLC RTU-NFL9
POWER LOCATION RTU-NFL9
TYPICAL DETAIL(S) NF130, NF135, NA900

CONNECTION

LINE SIZE 30-IN
LINE MATERIAL DUCTILE IRON
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL DUCTILE IRON

FLUID

FLUID WATER
NOMINAL FLOW 12390 GPM
FLOW RANGE 0-12,390 GPM
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY 1.01
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-3091
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 30-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-3091
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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GENERAL

TAG FIT-3101 (FE-3101)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 30N12
SERVICE FILTER 10 EFFLUENT FLOW METER
MEASURING PRINCIPLE MAGNETIC
PLC RTU-SFL10
POWER LOCATION RTU-SFL10
TYPICAL DETAIL(S) NF130, NF135, NA900

CONNECTION

LINE SIZE 30-IN
LINE MATERIAL DUCTILE IRON
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL DUCTILE IRON

FLUID

FLUID WATER
NOMINAL FLOW 12390 GPM
FLOW RANGE 0-12,390 GPM
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY 1.01
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-3101
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 30-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-3101
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

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GENERAL

TAG FIT-3111 (FE-3111)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 30N13
SERVICE FILTER 11 EFFLUENT FLOW METER
MEASURING PRINCIPLE MAGNETIC
PLC RTU-NFL11
POWER LOCATION RTU-NFL11
TYPICAL DETAIL(S) NF130, NF135, NA900

CONNECTION

LINE SIZE 30-IN
LINE MATERIAL DUCTILE IRON
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL DUCTILE IRON

FLUID

FLUID WATER
NOMINAL FLOW 12390 GPM
FLOW RANGE 0-12,390 GPM
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY 1.01
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-3111
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 30-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-3111
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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PROJECT INFORMATION

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GENERAL

TAG FIT-3121 (FE-3121)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 30N14
SERVICE FILTER 12 EFFLUENT FLOW METER
MEASURING PRINCIPLE MAGNETIC
PLC RTU-SFL12
POWER LOCATION RTU-SFL12
TYPICAL DETAIL(S) NF130, NF135, NA900

CONNECTION

LINE SIZE 30-IN
LINE MATERIAL DUCTILE IRON
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL DUCTILE IRON

FLUID

FLUID WATER
NOMINAL FLOW 12390 GPM
FLOW RANGE 0-12,390 GPM
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY 1.01
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-3121
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 30-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-3121
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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PROJECT INFORMATION

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PROJECT 202001
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GENERAL

TAG FIT-3131 (FE-3131)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 30N15
SERVICE FILTER 13 EFFLUENT FLOW METER
MEASURING PRINCIPLE MAGNETIC
PLC RTU-NFL13
POWER LOCATION RTU-NFL13
TYPICAL DETAIL(S) NF130, NF135, NA900

CONNECTION

LINE SIZE 30-IN
LINE MATERIAL DUCTILE IRON
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL DUCTILE IRON

FLUID

FLUID WATER
NOMINAL FLOW 12390 GPM
FLOW RANGE 0-12,390 GPM
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY 1.01
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-3131
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 30-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-3131
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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PROJECT INFORMATION

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GENERAL

TAG FIT-3141 (FE-3141)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 30N16
SERVICE FILTER 14 EFFLUENT FLOW METER
MEASURING PRINCIPLE MAGNETIC
PLC RTU-SFL14
POWER LOCATION RTU-SFL14
TYPICAL DETAIL(S) NF130, NF135, NA900

CONNECTION

LINE SIZE 30-IN
LINE MATERIAL DUCTILE IRON
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL DUCTILE IRON

FLUID

FLUID WATER
NOMINAL FLOW 12390 GPM
FLOW RANGE 0-12,390 GPM
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY 1.01
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-3141
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 30-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-3141
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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PROJECT INFORMATION

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GENERAL

TAG FIT-3151 (FE-3151)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 30N17
SERVICE FILTER 15 EFFLUENT FLOW METER
MEASURING PRINCIPLE MAGNETIC
PLC RTU-NFL15
POWER LOCATION RTU-NFL15
TYPICAL DETAIL(S) NF130, NF135, NA900

CONNECTION

LINE SIZE 30-IN
LINE MATERIAL DUCTILE IRON
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL DUCTILE IRON

FLUID

FLUID WATER
NOMINAL FLOW 12390 GPM
FLOW RANGE 0-12,390 GPM
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY 1.01
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-3151
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 30-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-3151
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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GENERAL

TAG FIT-3161 (FE-3161)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 30N18
SERVICE FILTER 16 EFFLUENT FLOW METER
MEASURING PRINCIPLE MAGNETIC
PLC RTU-SFL16
POWER LOCATION RTU-SFL16
TYPICAL DETAIL(S) NF130, NF135, NA900

CONNECTION

LINE SIZE 30-IN
LINE MATERIAL DUCTILE IRON
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL DUCTILE IRON

FLUID

FLUID WATER
NOMINAL FLOW 12390 GPM
FLOW RANGE 0-12,390 GPM
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY 1.01
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-3161
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 30-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-3161
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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GENERAL

TAG FIT-4041 (FE-4041)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 30N21
SERVICE BACKWASH SUPPLY FLOW METER
MEASURING PRINCIPLE MAGNETIC
PLC RTU-ELEC2C
POWER LOCATION RTU-ELEC2C
TYPICAL DETAIL(S) NF130, NF135, NA900

CONNECTION

LINE SIZE 30-IN
LINE MATERIAL DUCTILE IRON
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL DUCTILE IRON

FLUID

FLUID WATER
NOMINAL FLOW 2500 GPM
FLOW RANGE 0-30000 GPM
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY 1.01
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-4041
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 30-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-4041
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT 4-20 MA
SURGE PROTECTION YES
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.

Magnetic Flow Transmitter

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG FIT-4135 (FE-4135)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 30N20
SERVICE FILTER BW FLOW 1
MEASURING PRINCIPLE MAGNETIC
PLC RTU-ELEC1
POWER LOCATION RTU-ELEC1
TYPICAL DETAIL(S) NF130, NF135, NA900

CONNECTION

LINE SIZE 20-IN
LINE MATERIAL DUCTILE IRON
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL DUCTILE IRON

FLUID

FLUID WATER
NOMINAL FLOW 8000 GPM
FLOW RANGE 0-12000 GPM
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY 1.01
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-4135
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 24-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-4135
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT 4-20 MA
SURGE PROTECTION YES
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW YES
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS YES
CATHODIC PROT. LINE NO

NOTES

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Magnetic Flow Transmitter

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
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LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG FIT-4136 (FE-4136)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 30N20
SERVICE FILTER BW FLOW 2
MEASURING PRINCIPLE MAGNETIC
PLC RTU-ELEC2C
POWER LOCATION RTU-ELEC2C
TYPICAL DETAIL(S) NF130, NF135, NA900

CONNECTION

LINE SIZE 12-IN
LINE MATERIAL DUCTILE IRON
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL DUCTILE IRON

FLUID

FLUID WATER
NOMINAL FLOW 2500 GPM
FLOW RANGE 0-4000 GPM
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY 1.01
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-4136
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 12-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-4136
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT 4-20 MA
SURGE PROTECTION YES
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW YES
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS YES
CATHODIC PROT. LINE NO

NOTES

PROVIDE SURGE PROTECTION FOR INSTRUMENTS LOCATED OUTDOORS.

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PROJECT INFORMATION

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PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
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GENERAL

TAG FIT-4411 (FE-4411)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 30N24
SERVICE FILTER TO WASTE FLOW
MEASURING PRINCIPLE MAGNETIC
PLC RTU-ELEC1
POWER LOCATION RTU-FBW
TYPICAL DETAIL(S) NF130, NF135, NA900

CONNECTION

LINE SIZE 24-IN
LINE MATERIAL DUCTILE IRON
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL DUCTILE IRON

FLUID

FLUID WATER
NOMINAL FLOW 80000 GPM
FLOW RANGE 0-13000 GPM
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY 1.01
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-4411
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 24-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-4411
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW YES
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

[*]

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PROJECT INFORMATION

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GENERAL

TAG FIT-6215 (FE-6215)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 62N04
SERVICE PC FEED DISCHARGE 1 FLOW
MEASURING PRINCIPLE MAGNETIC
PLC RTU-PEA
POWER LOCATION RTU-PEA
TYPICAL DETAIL(S) NF130, NF136, NA900

CONNECTION

LINE SIZE 1-IN
LINE MATERIAL PVC
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL NON-METALLIC

FLUID

FLUID PRIMARY COAGULANT
NOMINAL FLOW 20 GPH
FLOW RANGE 0-60 GPH
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY N/A
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-6215
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 5/16-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL PFA
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL HASTELOY

TRANSMITTER

TRANSMITTER TAG NO. FIT-6215
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

PROVIDE HIGH ACCURACY, ZERO UPSTREAM/DOWNSTREAM FLOW METER/TRANSMITTERS. PROVIDE PHOENIX CONTACT RTU TO MODBUS TCP/IP CONVERTOR.

Magnetic Flow Transmitter

PROJECT INFORMATION

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GENERAL

TAG FIT-6216 (FE-6216)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 62N04
SERVICE PC FEED DISCHARGE 2 FLOW
MEASURING PRINCIPLE MAGNETIC
PLC RTU-PEA
POWER LOCATION RTU-PEA
TYPICAL DETAIL(S) NF130, NF136, NA900

CONNECTION

LINE SIZE 2-IN
LINE MATERIAL PVC
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL NON-METALLIC

FLUID

FLUID PRIMARY COAGULANT
NOMINAL FLOW 70 GPH
FLOW RANGE 0-300 GPH
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY N/A
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-6216
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 1/2-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL PFA
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL HASTELOY

TRANSMITTER

TRANSMITTER TAG NO. FIT-6216
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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Magnetic Flow Transmitter

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GENERAL

TAG FIT-6563 (FE-6563)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 65N03
SERVICE CS SMALL PMPS FLOW
MEASURING PRINCIPLE MAGNETIC
PLC RTU-CS
POWER LOCATION RTU-CS
TYPICAL DETAIL(S) NF130, NF136, NA900

CONNECTION

LINE SIZE 1-IN
LINE MATERIAL CPVC
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL NON-METALLIC

FLUID

FLUID CAUSTIC SODA
NOMINAL FLOW 30 GPH
FLOW RANGE 0.3-52 GPH
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY N/A
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-6563
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 5/16-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL PTFE
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL TITANIUM

TRANSMITTER

TRANSMITTER TAG NO. FIT-6563
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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PROJECT INFORMATION

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GENERAL

TAG FIT-6583 (FE-6583)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 65N04
SERVICE CS FLOW METER
MEASURING PRINCIPLE MAGNETIC
PLC RTU-CS
POWER LOCATION RTU-CS
TYPICAL DETAIL(S) NF130, NF136, NA900

CONNECTION

LINE SIZE 2-IN
LINE MATERIAL CPVC
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL NON-METALLIC

FLUID

FLUID CAUSTIC SODA
NOMINAL FLOW 175 GPH
FLOW RANGE 52-450 GPH
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY N/A
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-6583
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 1-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL PTFE
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL TITANIUM

TRANSMITTER

TRANSMITTER TAG NO. FIT-6583
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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Magnetic Flow Transmitter

PROJECT INFORMATION

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GENERAL

TAG FIT-6691 (FE-6691)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 66N01
SERVICE FL CARRIER WATER
MEASURING PRINCIPLE MAGNETIC
PLC RTU-FL
POWER LOCATION RTU-FL
TYPICAL DETAIL(S) NF130, NF136, NA900

CONNECTION

LINE SIZE [*]
LINE MATERIAL [*]
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL [*]

FLUID

FLUID WATER
NOMINAL FLOW 25 GPH
FLOW RANGE 0-50 GPM
PRESSURE 125 PSI
TEMPERATURE N/A
VISCOSITY N/A
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-6691
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 2-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL HARD RUBBER
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-6691
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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PROJECT INFORMATION

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GENERAL

TAG FIT-6918 (FE-6918)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 69N04
SERVICE PEA FILT AID SMALL DISCHARGE 1 FLOW
MEASURING PRINCIPLE MAGNETIC
PLC RTU-PEA
POWER LOCATION RTU-PEA
TYPICAL DETAIL(S) NF130, NF136, NA900

CONNECTION

LINE SIZE 3/4-IN
LINE MATERIAL PVC
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL NON-METALLIC

FLUID

FLUID POLYMER
NOMINAL FLOW 25 GPH
FLOW RANGE 2-40 GPH
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY N/A
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-6918
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 5/16-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL PTFE
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-6918
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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PROJECT INFORMATION

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GENERAL

TAG FIT-6919 (FE-6919)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 69N04
SERVICE PEA FILT AID SMALL DISCHARGE 1 FLOW
MEASURING PRINCIPLE MAGNETIC
PLC RTU-PEA
POWER LOCATION RTU-PEA
TYPICAL DETAIL(S) NF130, NF136, NA900

CONNECTION

LINE SIZE 3/4-IN
LINE MATERIAL PVC
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL NON-METALLIC

FLUID

FLUID POLYMER
NOMINAL FLOW 25 GPH
FLOW RANGE 0-40 GPH
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY N/A
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-6919
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 5/16-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL PTFE
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-6919
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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PROJECT INFORMATION

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GENERAL

TAG FIT-6928 (FE-6928)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 69N06
SERVICE PEA FILT AID LARGE 1 FLOW
MEASURING PRINCIPLE MAGNETIC
PLC RTU-PEA
POWER LOCATION RTU-PEA
TYPICAL DETAIL(S) NF130, NF136, NA900

CONNECTION

LINE SIZE 1-1/2-IN
LINE MATERIAL PVC
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL NON-METALLIC

FLUID

FLUID POLYMER
NOMINAL FLOW 60 GPH
FLOW RANGE 40-150 GPH
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY N/A
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-6928
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 1/2-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL PTFE
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-6928
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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PROJECT INFORMATION

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GENERAL

TAG FIT-6929 (FE-6929)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 69N06
SERVICE PEA FILT AID LARGE 2 FLOW
MEASURING PRINCIPLE MAGNETIC
PLC RTU-PEA
POWER LOCATION RTU-PEA
TYPICAL DETAIL(S) NF130, NF136, NA900

CONNECTION

LINE SIZE 1-1/2-IN
LINE MATERIAL PVC
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL NON-METALLIC

FLUID

FLUID POLYMER
NOMINAL FLOW 60 GPH
FLOW RANGE 40-150 GPH
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY N/A
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-6929
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 1/2-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL PTFE
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-6929
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

PROVIDE HIGH ACCURACY, ZERO UPSTREAM/DOWNSTREAM FLOW METER/TRANSMITTERS. PROVIDE PHOENIX CONTACT RTU TO MODBUS TCP/IP CONVERTOR.

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Magnetic Flow Transmitter

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG FIT-6937 (FE-6937)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 69N08
SERVICE PEA FLOC AID FEED 1 FLOW
MEASURING PRINCIPLE MAGNETIC
PLC RTU-PEA
POWER LOCATION RTU-PEA
TYPICAL DETAIL(S) NF130, NF136, NA900

CONNECTION

LINE SIZE 2-IN
LINE MATERIAL PVC
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL NON-METALLIC

FLUID

FLUID POLYMER
NOMINAL FLOW 100 GPH
FLOW RANGE 10-700 GPH
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY N/A
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-6937
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 1-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL PTFE
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-6937
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG FIT-6938 (FE-6938)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 69N08
SERVICE PEA FLOC AID FEED 2 FLOW
MEASURING PRINCIPLE MAGNETIC
PLC RTU-PEA
POWER LOCATION RTU-PEA
TYPICAL DETAIL(S) NF130, NF136, NA900

CONNECTION

LINE SIZE 2-IN
LINE MATERIAL PVC
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL NON-METALLIC

FLUID

FLUID POLYMER
NOMINAL FLOW 100 GPH
FLOW RANGE 10-700 GPH
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY N/A
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-6938
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 1-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL PTFE
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-6938
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG FIT-6948 (FE-6948)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 69N10
SERVICE PEA FLOC AID FEED 3 FLOW
MEASURING PRINCIPLE MAGNETIC
PLC RTU-PEA
POWER LOCATION RTU-PEA
TYPICAL DETAIL(S) NF130, NF136, NA900

CONNECTION

LINE SIZE 2-IN
LINE MATERIAL PVC
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL NON-METALLIC

FLUID

FLUID POLYMER
NOMINAL FLOW 100 GPH
FLOW RANGE 10-700 GPH
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY N/A
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-6948
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 1-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL PTFE
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-6948
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG FIT-6949 (FE-6949)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 69N10
SERVICE PEA FLOC AID FEED 4 FLOW
MEASURING PRINCIPLE MAGNETIC
PLC RTU-PEA
POWER LOCATION RTU-PEA
TYPICAL DETAIL(S) NF130, NF136, NA900

CONNECTION

LINE SIZE 2-IN
LINE MATERIAL PVC
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL NON-METALLIC

FLUID

FLUID POLYMER
NOMINAL FLOW 100 GPH
FLOW RANGE 10-700 GPH
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY N/A
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-6949
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 1-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL PTFE
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-6949
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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PROJECT INFORMATION

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PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG FIT-6958 (FE-6958)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 69N12
SERVICE PEA FILT AID DOSING FLOW
MEASURING PRINCIPLE MAGNETIC
PLC RTU-PEA
POWER LOCATION RTU-PEA
TYPICAL DETAIL(S) NF130, NF136, NA900

CONNECTION

LINE SIZE 3/4-IN
LINE MATERIAL PVC
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL NON-METALLIC

FLUID

FLUID POLYMER
NOMINAL FLOW 8 GPH
FLOW RANGE 0.3-40 GPH
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY N/A
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-6958
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 5/16-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL PTFE
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-6958
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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PROJECT INFORMATION

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PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
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GENERAL

TAG FIT-7108 (FE-7108)
SPECIFICATION NUMBER 17302
DRAWING NUMBER 71N03
SERVICE PEC FEED DISCHARGE FLOW
MEASURING PRINCIPLE MAGNETIC
PLC RTU-PEA
POWER LOCATION RTU-PEA
TYPICAL DETAIL(S) NF130, NF136, NA900

CONNECTION

LINE SIZE 3/4-IN
LINE MATERIAL PVC
PROCESS CONNECTION ANSI 150
PROCESS CONN. MATERIAL NON-METALLIC

FLUID

FLUID PEC
NOMINAL FLOW 6 GPH
FLOW RANGE 0.1-25 GPH
PRESSURE 125 PSI
TEMPERATURE 45-65 DEG F
VISCOSITY N/A
CONDUCTIVITY N/A

ELEMENT

ELEMENT TAG NO. FE-7108
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
TUBE SIZE 5/16-IN
TUBE MATERIAL MFR. STD.
PROCESS CONNECTION ANSI 150
LINER MATERIAL PTFE
VACUUM POSSIBILITY NO
ELECTRODE TYPE MFR. STD.
ELECTRODE MATERIAL 316 SST

TRANSMITTER

TRANSMITTER TAG NO. FIT-7108
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
POWER 24VDC-1P
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT MODBUS RTU
SURGE PROTECTION NO
HAZARDOUS APPROVALS N/A
EMPTY PIPE DETECTION YES
BI DIRECTIONAL FLOW NO
PULSE OUTPUT NO
RELAY OPTIONS YES
POTTED ELECTRONICS NO
CATHODIC PROT. LINE NO

NOTES

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SECTION 17316

FLOW MEASUREMENT: ROTAMETERS (VARIABLE AREA FLOWMETERS)

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Rotameters (variable area flowmeters).

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.04 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the instrument manufacturer’s recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. Dwyer, Series FS flowmeter with flow limit switch.
   2. Tecfluid.
   3. Core Instruments.

2.04 MANUFACTURED UNITS

A. Rotameters:
   1. General:
      a. Variable area type flowmeters with local flow indication.
      b. Material Construction:
         1) As indicated in the datasheet.
         2) Use Glass tube type for all non-chemical areas.
      c. Use Metal tube type for all Chemical Areas:
         a) For applications above 100 pounds per square inch gauge, with hazardous fluids, or with opaque liquids, provide a metal meter tube.
   2. Performance requirements:
      a. Flow range:
         1) As specified in instrument datasheets or instrument index.
      b. Accuracy:
         1) Glass tube: Within 2.0 percent of range.
         2) Metal tube: Within 5.0 percent of range.
         3) Repeatability: 0.50 percent of range.
   3. Element:
      a. Flow tube:
         1) Glass tube: Borosilicate glass, or as required to be compatible with the process conditions.
      b. Metal tube with magnetic follower:
         1) Type 316 stainless steel.
      c. Turndown: 10 to 1.

d. Process temperature:
    1) As indicated in the datasheet.
    2) Glass tube: 32 to 200 degrees Fahrenheit.
    3) Metal tube: -20 to 320 degrees Fahrenheit.
e. Maximum process pressure:
    1) As indicated in the datasheet.
    2) Glass tube: 100 pounds per square inch gauge.
    3) Metal tube: 450 pounds per square inch gauge.
    4) Range:
        a) As indicated in the datasheet.
    5) Polycarbonate operator protection shield.
f. Float:
    1) Design to provide the widest possible immunity band change for lowest pressure loss for all non-chemical fluids.
    2) Design to provide the widest possible immunity band change in viscosity for all chemical fluids.
    3) Metal tube rotameters: Float with encapsulated magnet.

4. Components:
    a. Seals: O-rings or packing glands fully compatible with process fluid.
    b. Integral needle valve for flow control.
5. Scale:
    a. Metal tube: Dial indicator with rotatable magnet coupled to magnet encapsulated in rotameter float.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with trades to ensure that the mechanical system has necessary appurtenances including weld-o-lets, valves, etc., for proper installation of instruments.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.04 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
    1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - ROTAMETERS: VARIABLE AREA FLOWMETERS

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Rotameter

SPECIFICATION 17316

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID	SERVICE					
FI-3010	30N03	FILTER 1 SAMPLE ROTAMETER					
		FLUID	WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	100-1000 ML/MIN
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	[*]	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				
		Notes: PROVIDE ROTAMETERS WITH INTEGRAL LOW FLOW SWITCH.					
TAG	**P&ID**	**SERVICE**	FILTER 2 SAMPLE ROTAMETER				
FI-3020	30N04						
		FLUID	WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	100-1000 ML/MIN
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	[*]	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				
		Notes: PROVIDE ROTAMETERS WITH INTEGRAL LOW FLOW SWITCH.					
TAG	**P&ID**	**SERVICE**	FILTER 3 SAMPLE ROTAMETER				
FI-3030	30N05						
		FLUID	WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	100-1000 ML/MIN
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	[*]	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				
		Notes: PROVIDE ROTAMETERS WITH INTEGRAL LOW FLOW SWITCH.					
TAG	**P&ID**	**SERVICE**	FILTER 4 SAMPLE ROTAMETER				
FI-3040	30N06						
		FLUID	WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	100-1000 ML/MIN
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	[*]	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				
		Notes: PROVIDE ROTAMETERS WITH INTEGRAL LOW FLOW SWITCH.					

Rotameter

SPECIFICATION 17316

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID	SERVICE					
FI-3050	30N07	FILTER 5 SAMPLE ROTAMETER					
		FLUID	WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	100-1000 ML/MIN
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	[*]	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				
		Notes: PROVIDE ROTAMETERS WITH INTEGRAL LOW FLOW SWITCH.					
TAG	**P&ID**	**SERVICE**	FILTER 6 SAMPLE ROTAMETER				
FI-3060	30N08	**FLUID**	WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	100-1000 ML/MIN
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	[*]	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				
		Notes: PROVIDE ROTAMETERS WITH INTEGRAL LOW FLOW SWITCH.					
TAG	**P&ID**	**SERVICE**	FILTER 7 SAMPLE ROTAMETER				
FI-3070	30N09	**FLUID**	WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	100-1000 ML/MIN
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	[*]	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				
		Notes: PROVIDE ROTAMETERS WITH INTEGRAL LOW FLOW SWITCH.					
TAG	**P&ID**	**SERVICE**	FILTER 8 SAMPLE ROTAMETER				
FI-3080	30N10	**FLUID**	WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	100-1000 ML/MIN
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	[*]	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				
		Notes: PROVIDE ROTAMETERS WITH INTEGRAL LOW FLOW SWITCH.					

Rotameter

SPECIFICATION 17316

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID	SERVICE					
FI-3090	30N11	FILTER 9 SAMPLE ROTAMETER					
		FLUID	WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	100-1000 ML/MIN
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	[*]	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				
		Notes: PROVIDE ROTAMETERS WITH INTEGRAL LOW FLOW SWITCH.					
TAG	**P&ID**	**SERVICE**	FILTER 10 SAMPLE ROTAMETER				
FI-3100	30N12	**FLUID**	WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	100-1000 ML/MIN
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	[*]	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				
		Notes: PROVIDE ROTAMETERS WITH INTEGRAL LOW FLOW SWITCH.					
TAG	**P&ID**	**SERVICE**	FILTER 11 SAMPLE ROTAMETER				
FI-3110	30N13	**FLUID**	WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	100-1000 ML/MIN
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	[*]	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				
		Notes: PROVIDE ROTAMETERS WITH INTEGRAL LOW FLOW SWITCH.					
TAG	**P&ID**	**SERVICE**	FILTER 12 SAMPLE ROTAMETER				
FI-3120	30N14	**FLUID**	WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	100-1000 ML/MIN
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	[*]	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				
		Notes: PROVIDE ROTAMETERS WITH INTEGRAL LOW FLOW SWITCH.					

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SPECIFICATION 17316

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID	SERVICE					
FI-3130	30N15	FILTER 13 SAMPLE ROTAMETER					
		FLUID	WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	100-1000 ML/MIN
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	[*]	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				
		Notes: PROVIDE ROTAMETERS WITH INTEGRAL LOW FLOW SWITCH.					
TAG	**P&ID**	**SERVICE**	FILTER 14 SAMPLE ROTAMETER				
FI-3140	30N16						
		FLUID	WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	100-1000 ML/MIN
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	[*]	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				
		Notes: PROVIDE ROTAMETERS WITH INTEGRAL LOW FLOW SWITCH.					
TAG	**P&ID**	**SERVICE**	FILTER 15 SAMPLE ROTAMETER				
FI-3150	30N17						
		FLUID	WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	100-1000 ML/MIN
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	[*]	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				
		Notes: PROVIDE ROTAMETERS WITH INTEGRAL LOW FLOW SWITCH.					
TAG	**P&ID**	**SERVICE**	FILTER 16 SAMPLE ROTAMETER				
FI-3160	30N18						
		FLUID	WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	100-1000 ML/MIN
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	[*]	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				
		Notes: PROVIDE ROTAMETERS WITH INTEGRAL LOW FLOW SWITCH.					

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SPECIFICATION 17316

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID	SERVICE					
FI-6341	63N09	ROTAMETER					
		FLUID	WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	0-150 GPM
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	2"	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				

TAG	P&ID	SERVICE					
FI-6342	63N09	ROTAMETER					
		FLUID	WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	0-150 GPM
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	2"	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				

TAG	P&ID	SERVICE					
FI-6343	63N10	ROTAMETER					
		FLUID	WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	0-150 GPM
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	2"	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				

TAG	P&ID	SERVICE					
FI-6344	63N10	ROTAMETER					
		FLUID	WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	0-150 GPM
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	2"	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				

TAG	P&ID	SERVICE					
FI-6345	63N10	ROTAMETER					
		FLUID	WATER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	0-150 GPM
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	2"	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				

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SPECIFICATION 17316

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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TAG	P&ID	SERVICE		TYPICAL DETAILS		
FI-6346	63N09	ROTAMETER		[*]		
		FLUID	WATER	PRESSURE	125 PSI	FLOW RANGE 0-150 GPM
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	TEMPERATURE	N/A	VISCOSITY N/A
		LINE SIZE	2"	PROCESS CONN.	F-NPT	SEAL MATERIAL EPDM
		LINE MATERIAL	PVC			TUBE MATERIAL BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL			
TAG	P&ID	SERVICE		TYPICAL DETAILS		
FI-6347	63N11	ROTAMETER		[*]		
		FLUID	WATER	PRESSURE	125 PSI	FLOW RANGE 0-150 GPM
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	TEMPERATURE	N/A	VISCOSITY N/A
		LINE SIZE	2"	PROCESS CONN.	F-NPT	SEAL MATERIAL EPDM
		LINE MATERIAL	PVC			TUBE MATERIAL BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL			
TAG	P&ID	SERVICE		TYPICAL DETAILS		
FI-6348	63N11	ROTAMETER		[*]		
		FLUID	WATER	PRESSURE	125 PSI	FLOW RANGE 0-150 GPM
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	TEMPERATURE	N/A	VISCOSITY N/A
		LINE SIZE	2"	PROCESS CONN.	F-NPT	SEAL MATERIAL EPDM
		LINE MATERIAL	PVC			TUBE MATERIAL BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL			
TAG	P&ID	SERVICE		TYPICAL DETAILS		
FI-6584	65N04	ROTAMETER		[*]		
		FLUID	CAUSTIC SODA	PRESSURE	125 PSI	FLOW RANGE 0-40 GPM
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	TEMPERATURE	N/A	VISCOSITY N/A
		LINE SIZE	2"	PROCESS CONN.	F-NPT	SEAL MATERIAL EPDM
		LINE MATERIAL	CPVC			TUBE MATERIAL BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL			
TAG	P&ID	SERVICE		TYPICAL DETAILS		
FI-6927	69N06	ROTAMETER		[*]		
		FLUID	POLYMER	PRESSURE	125 PSI	FLOW RANGE 0-10 GPM
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	TEMPERATURE	N/A	VISCOSITY N/A
		LINE SIZE	1"	PROCESS CONN.	F-NPT	SEAL MATERIAL EPDM
		LINE MATERIAL	PVC			TUBE MATERIAL BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL			

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SPECIFICATION 17316

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID	SERVICE					
FI-6928	69N06	ROTAMETER					
		FLUID	POLYMER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	0-10 GPM
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	1"	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				

TAG	P&ID	SERVICE					
FI-6934	69N08	ROTAMETER					
		FLUID	POLYMER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	0-10 GPM
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	1"	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				

TAG	P&ID	SERVICE					
FI-6935	69N08	ROTAMETER					
		FLUID	POLYMER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	0-10 GPM
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	1"	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				

TAG	P&ID	SERVICE					
FI-6940	69N10	ROTAMETER					
		FLUID	POLYMER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	0-10 GPM
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	1"	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				

TAG	P&ID	SERVICE					
FI-6941	69N10	ROTAMETER					
		FLUID	POLYMER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	0-10 GPM
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	1"	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				

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SPECIFICATION 17316

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID						
FI-6957	69N12	**SERVICE**	ROTAMETER				
		FLUID	POLYMER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	0-10 GPM
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	1"	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				
TAG	**P&ID**						
FI1-6948	69N10	**SERVICE**	ROTAMETER				
		FLUID	POLYMER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	0-20 GPM
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	2"	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				
TAG	**P&ID**						
FI1-6949	69N10	**SERVICE**	ROTAMETER				
		FLUID	POLYMER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	0-20 GPM
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	2"	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				
TAG	**P&ID**						
FI2-6948	69N10	**SERVICE**	ROTAMETER				
		FLUID	POLYMER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	0-20 GPM
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	2"	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				
TAG	**P&ID**						
FI2-6949	69N10	**SERVICE**	ROTAMETER				
		FLUID	POLYMER	**TYPICAL DETAILS**	[*]	**FLOW RANGE**	0-20 GPM
		MEASURING PRINCIPLE	VARIABLE AREA FLOW	**PRESSURE**	125 PSI	**VISCOSITY**	N/A
		LINE SIZE	2"	**TEMPERATURE**	N/A	**SEAL MATERIAL**	EPDM
		LINE MATERIAL	PVC	**PROCESS CONN.**	F-NPT	**TUBE MATERIAL**	BOROSILICATE GLASS
		PROCESS CONN. MAT'L	STEEL				

SECTION 17401

PRESSURE/VACUUM MEASUREMENT: DIAPHRAGM AND ANNULAR SEALS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Diaphragm seals.
   2. Annular seals.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Standards:
   1. American National Standards Institute (ANSI).

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Additional requirements:
   1. Product data:
      a. Manufacturer’s installation instructions.
      b. Seal type.
      c. Body materials.
      d. Diaphragm material.
      e. Fill fluid type.
      f. Seal size.
      g. Options.
      h. Process connection.

1.04 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify the compatibility with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.

c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the manufacturer's recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

1.09 MAINTENANCE

A. Furnish a spare annular seal for every size provided in the project.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide seals identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. Diaphragm seals:
   1. For chemical applications, liquids containing solids, and liquids with pulsating flow having pressures less than or equal to 15 pounds per square inch gauge: One of the following or equal:
      a. Ashcroft:
         1) Flushing connection: Type 741.
         2) Without flushing connection: Type 740.
      b. Mansfield and Green:
         1) Flushing connection: Type SGT.
         2) Without flushing connection: Type SBT.
      c. Wika, Type L990.40.

2. For chemical applications, liquids containing solids, and liquids with pulsating flow having pressures greater than or equal to 15 pounds per square inch gauge: One of the following or equal:
    a. Ashcroft:
        1) Flushing connection: Type 201.
        2) Without flushing connection: Type 200.
    b. Mansfield and Green:
        1) Flushing connection: Type SG.
        2) Without flushing connection: Type SB.
    c. Wika:
        1) Type L990.10.

2.04 MANUFACTURED UNITS

A. Diaphragm seals:
    1. General:
        a. Diaphragm seal and pressure instrument shall be assembled by pressure instrument manufacturer and shipped as an assembly.
    2. Requirements:
        a. Seal type:
            1) Metallic diaphragm: Welded to upper housing.
            2) Elastomer diaphragm: Bonded to upper housing.
        b. Process connection:
            1) As indicated in the instrument datasheets.
            2)
        c. Instrument connection: 1/2-inch NPT.
        d. Material Construction:
            1) As indicated in the instrument datasheets.
        e.
        f. Provide fill/bleed connection.
        g. Mounting: As indicated in the Contract Documents.
        h. Provide Type 316 stainless steel armored capillary for remote installations.
        i. Nuts and bolts: Type 316 stainless steel.
        j. Materials of construction:
            1) Sewage, sludge, liquids containing solids, and liquids with pulsating flow having pressures less than or equal to 15 pounds per square inch:
                a) Diaphragm: Type 316 stainless steel.
                b) Lower housing: Type 316 stainless steel.
                c) Upper housing: Manufacturer’s standard.
                d) Fill fluid: Silicone oil.
            2) Sewage, sludge, liquids containing solids, and liquids with pulsating flow having pressures greater than 15 pounds per square inch:
                a) Diaphragm: Type 316 stainless steel.
                b) Lower housing: Type 316 stainless steel.
                c) Upper housing: Manufacturer’s standard.
                d) Fill fluid: Silicone oil.
            3) Chlorine:
                a) Diaphragm: Tantalum.
                b) Lower housing: Hastelloy C.

c) Upper housing: Manufacturer's standard.
d) Fill fluid: Halocarbon.

4) Ferric chloride:
   a) Diaphragm: PTFE or tantalum.
   b) Lower housing: PVC or titanium.
   c) Upper housing: Manufacturer's standard.
   d) Fill fluid: Silicone oil.
5) Fluorosilicic acid:
   a) Diaphragm: Viton™.
   b) Lower housing: PVC.
   c) Upper housing: Manufacturer's standard.
   d) Fill fluid: Silicone oil.
6) Hydrochloric acid:
   a) Diaphragm: PVDF or tantalum.
   b) Lower housing: Hastelloy B2.
   c) Upper housing: Manufacturer's Standard.
   d) Fill fluid: Fluorolube.
7) Ozone:
   a) Diaphragm: Type 316 stainless steel.
   b) Lower housing: Type 316 stainless steel.
   c) Upper housing: Manufacturer's standard.
   d) Fill fluid: Halocarbon.
8) Potassium permanganate:
   a) Diaphragm: PTFE or tantalum.
   b) Lower housing: PVDF or titanium.
   c) Upper housing: Manufacturer's standard.
   d) Fill fluid: Halocarbon.
9) Sodium permanganate:
   a) Diaphragm: PTFE.
   b) Lower housing: PVDF.
   c) Upper housing: Manufacturer's standard.
   d) Fill fluid: Halocarbon.
10) Sodium bisulfite:
   a) Diaphragm: Tantalum.
   b) Lower housing: Titanium.
   c) Upper housing: Manufacturer's standard.
   d) Fill fluid: Silicone oil.
11) Sodium hydroxide:
   a) Diaphragm: Monel.
   b) Lower housing: Monel.
   c) Upper housing: Manufacturer's standard.
   d) Fill fluid: Silicone oil.
12) Sodium hypochlorite:
   a) Diaphragm: Tantalum.
   b) Lower Housing: Titanium.
   c) Upper Housing: Manufacturer's standard.
   d) Fill Fluid: Halocarbon.
13) Sulfur dioxide:
   a) Diaphragm: PTFE or tantalum.
   b) Lower housing: PVDF or titanium.
   c) Upper housing: Manufacturer's standard.

d) Fill fluid: Halocarbon.
14) Sulfuric acid:
a) Diaphragm: PTFE or tantalum.
b) Lower housing: Hastelloy B2.
c) Upper housing: Manufacturer's Standard.
d) Fill fluid: Halocarbon.
15) Engineer's approval.

B. Annular seals:
1. General:
a. Inside diameter of annular seal shall provide uninterrupted flow:
1) There shall be no dead ends or crevices.
2) Process flow shall be sufficient to make the annular seal self-cleaning.
b. The pressure sensing flexible cylinder shall measure pressure around the full inside circumference of the pipeline.
2. Requirements:
a. Pressure rating: Equivalent to the ANSI flanges.
b. Materials of construction:
1) Inner flexible cylinder: Manufacturer's standard.
2) Body:
a) As indicated in the instrument datasheets.
3) Assembly flanges: To match adjacent piping.
4) Fill fluid: Silicone oil.
c. Process connection:
1) As indicated in the instrument datasheets.
d. Instrument connection: 1/2-inch NPT.

2.05 ACCESSORIES

A. Provide field fill kits for all liquid-filled gauges.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation System.

B. Coordinate the installation with trades to ensure that the mechanical system has necessary appurtenances, including weld-o-lets, valves, etc., for proper instrument installation.

C. Do not use Teflon™ thread seal tape on pressure instruments with silicone oil fill fluid.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

END OF SECTION

SECTION 17402

PRESSURE/VACUUM MEASUREMENT: INSTRUMENT VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Valve manifolds and instrument valves.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.03 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Additional requirements:
   1. Product data:
      a. Valve type.
      b. Body material.
      c. Size.
      d. Options.
   2. Shop drawings:
      a. Mounting details for all manifold valves.

1.04 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the valves are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Provide valves manufactured at facilities certified to the quality standards of ISO 9001.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Protect valve manifolds and protective coatings from damage during handling and installation. Repair coating where damaged.

1.06 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 01850 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the valve manufacturer's recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

1.09 MAINTENANCE

A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide all valves identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide valves suitable for the installed site conditions including, but not limited to, material compatibility, process, and ambient temperatures.

2.03 MANUFACTURERS

A. Valve manifold:
   1. One of the following or equal:
      a. Anderson Greenwood.
      b. Hex Valve.
      c. Noshok.
      d. Emerson, Rosemount.

B. Block and bleed valve:
   1. One of the following or equal:
      a. Anderson Greenwood.
      b. Hex Valve.

C. Gauge valve:
   1. One of the following or equal:
      a. Anderson Greenwood.
      b. Hex Valve.

D. Level sensor isolation valve:
   1. One of the following or equal:
      a. Indu-Tech, Level Sensor Isolation Valve.
      b. DeZURIK, Level Sensor Isolation Valve.
      c. Tyco, Rovalve Isolation Knife Gate Valve.

2.04 MANUFACTURED UNITS

A. Valve manifolds:
   1. General:
      a. Provide 2-valve, 3-valve, blowdown type 5-valve, or metering type 5-valve manifolds as indicated on the Drawings.
      b. Valve manifolds shall have one piece bonnet with a metal-to-metal seal to the valve body below the bonnet threads.
   2. Requirements:
      a. Bonnet lock pin to prevent accidental loosening.
      b. Gas leak tested metal-to-metal hard seat design for hard seat valves.
      c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
      d. Manifold valves shall have straight through portion for bi-directional flow and easy roddable cleaning.
      e. Manifold valves shall allow for direct or remote instrument mounting.
      f. Shall be able to withstand pressures up to 6,000 psi for soft seat valves and 10,000 psi for hard seat valves at maximum 200 degrees Fahrenheit.
      g. Materials of construction:
         1) Body material: Type 316 stainless steel.
         2) O-ring: Teflon™.
      h. 2-Valve manifolds:
         1) 1 isolation valve and 1 drain/vent and calibration valve.
      i. 3-Valve manifolds:
         1) 2 isolation valves and 1 equalizing valve for differential pressure applications.
         2) Plugged vent connections used for vent/drain or calibration.
      j. Blowdown 5-valve manifold:
         1) 2 isolation valves, 1 equalizing valve, 2 blowdown valves for differential pressure applications.
      k. Metering 5-valve manifold:
         1) 2 isolation valves, 2 equalizing valves, 1 vent/drain and calibration valve for differential pressure applications.

B. Block and bleed valves:
   1. General:
      a. Valve shall provide process isolation and venting/draining capabilities.
      b. Gas leak tested metal-to-metal hard seat design for hard seat valves.
      c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
      d. Valve shall not be used with fluids with high solids content, such as raw wastewater or sludge.

2. Requirements:
    a. Materials of construction:
        1) Body material: Type 316 stainless steel.
        2) O-ring: Teflon™.

C. Gauge valves:
1. General:
    a. Valve shall provide process isolation from pressure instrument.
    b. Gas leak tested, metal-to-metal hard seat design for hard seat valves.
    c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
2. Requirements:
    a. Materials of construction:
        1) Body material: Type 316 stainless steel.
        2) O-ring: Teflon™.

D. Level sensor isolation valves:
1. General:
    a. Valve shall provide process isolation from level diaphragm.
    b. Gas leak tested, metal-to-metal hard seat design for hard seat valves.
    c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
2. Requirements:
    a. Materials of construction:
        1) Body material: Type 316 stainless steel.
        2) Flange diameter size: 3 inches.

2.05 ACCESSORIES

A. Provide tube fitting, female NPT, or pipe butt weld connections if necessary.

B. Provide stainless steel concentric or eccentric pipe nipples when necessary.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location and verify the valve will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of all valves.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

END OF SECTION

SECTION 17403

PRESSURE/VACUUM MEASUREMENT: SWITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Pressure/vacuum switches.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Product data:
   1. Accessories.

1.04 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 01850 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

1.09 MAINTENANCE

A. Furnish parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments specified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed site conditions, including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. Electronic type pressure switch: The following, or equal:
   1. Ashcroft, NPI Series.

2.04 MANUFACTURED UNITS

A. As specified in this Section including Attachment A - ISA Datasheet - Pressure/Vacuum Measurement: Switches.

B. Electronic indicating type pressure switches:
   1. General:
      a. Pressure switch shall utilize ceramic or polysilicon thin film pressure transducer.
   2. Performance requirements:
      a. Pressure range:
         1) As specified in datasheets.
      b. Accuracy:
         1) Within 1.0 percent of range.
      c. Repeatability:
         1) Within 1.0 percent of range.
   3. Element:
      a. Type: Ceramic or polysilicon thin film.

b. Overpressure:
    1) Minimum 130 percent of maximum range pressure without damage to switch or sensing element.
    2) Minimum 400 percent of nominal range without leakage or rupture.
c. Sensing element shall not require ambient temperature compensation.
d. Wetted materials:
    1) As indicated in the datasheets.
    2) Stainless steel.

4. Transmitter:
    a. Setpoint:
        1) As indicated in the datasheets.
        2) Dual.
        3) Switch shall activate at setpoint on increasing pressure for high-pressure alarm applications and on decreasing pressure for low-pressure alarm applications.
    b. Deadband:
        1) Adjustable deadband.
    c. Switch elements:
        1) Snap acting.
            a) As indicated in the datasheets.
            b) 2 single-pole double-throw (SPDT).
        2) Resets:
            a) Automatic reset.
    d. Enclosure: Epoxy-coated.
        1) As indicated in the datasheets.
    e. Local display:
        1) 4-digit LCD or LED.
        2) Scaled in engineering units.
    f. Switch mounting:
        1) Process connection: 1/2-inch NPT.
    g. Power supply:
        1) As indicated in the datasheets.
    h. Outputs:
        1) As indicated in the datasheets.
        2) Isolated 4 to 20 mA DC with HART communication protocol.
    i. Relay outputs:
        1) As indicated in the datasheets.
        2) Form C contacts: 2.
    j. Rated 5 amps at 120 VAC.
    k. Components:
        1) Provide necessary hardware for pressure switch mounting.

2.05 ACCESSORIES

A. Pulsation dampeners and snubbers:
    1. Provide pulsation dampener or snubber with each pressure switch installed on discharge of positive displacement type pump.
    2. Materials: Stainless steel.
    3. Mount pulsation dampener or snubber integrally to the pressure switch.
    4. Connection: 1/2-inch NPT.

B. Provide diaphragm seals as specified in datasheets or as indicated on the Drawings and as specified in Section 17401 - Pressure/Vacuum Measurement: Diaphragm and Annular Seals:
   1. Diaphragm seal and pressure switch shall be assembled by manufacturer and shipped as an assembly.

C. Furnish block and bleed valves as specified in Section 17402 - Pressure/Vacuum Measurement: Instrument Valves.

D. Furnish gauge valves as specified in Section 17402 - Pressure/Vacuum Measurement: Instrument Valves.

E. Provide stainless steel tags for each instrument. Tags shall be labeled as specified in the Contract Documents.

2.06 FINISHES (NOT USED)

2.07 SOURCE QUALITY CONTROL

A. Factory calibrate each instrument with a minimum 3-point calibration or according to Manufacturer's standard at a facility that is traceable to the NIST.
   1. Submit calibration datasheets to the Engineer at least 30 days before shipment of the instruments to the project site.

B. FM approval certification or equal when installed in classified areas.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with trades to ensure that the mechanical system has necessary appurtenances including weld-o-lets, valves, etc., for proper installation of instruments.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.04 ADJUSTING

A. Verify factory calibration of instruments in accordance with the manufacturer's instructions:
   1. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.05 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments specified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - PRESSURE/VACUUM MEASUREMENT: SWITCHES

Pressure Switch

SPECIFICATION 17403

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID	SERVICE	PC TRANSFER 1 PRESS HIGH				
PISH-6201	62N02	**FLUID**	PRIMARY COAGULANT	**HAZARDOUS APP**	N/A	**POWER**	[*]
PE-6201		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	LOOP
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	25 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	DPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-CDX
		TYPICAL DETAILS	NP502	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

TAG	P&ID	SERVICE	PC TRANSFER 2 PRESS HIGH				
PISH-6202	62N02	**FLUID**	PRIMARY COAGULANT	**HAZARDOUS APP**	N/A	**POWER**	[*]
PE-6202		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	LOOP
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	25 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	DPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-CDX
		TYPICAL DETAILS	NP502	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

Pressure Switch

SPECIFICATION 17403

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID	SERVICE	PC FEED 1 PRESS HIGH				
PISH-6204	62N03	**FLUID**	PRIMARY COAGULANT	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
PE-6204		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	PP-PEA
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	55 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	DPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-PEA
		TYPICAL DETAILS	NP502	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

TAG	P&ID	SERVICE	PC FEED 2 PRESS HIGH				
PISH-6205	62N03	**FLUID**	PRIMARY COAGULANT	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
PE-6205		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	PP-PEA
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	55 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	DPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-PEA
		TYPICAL DETAILS	NP502	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

Pressure Switch

SPECIFICATION 17403

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID	SERVICE	PC FEED 3 PRESS HIGH				
PISH-6211	62N04	**FLUID**	PRIMARY COAGULANT	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
PE-6211		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-PEA
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	55 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	DPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-PEA
		TYPICAL DETAILS	NP502	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

TAG	P&ID	SERVICE	PC FEED 4 PRESS HIGH				
PISH-6221	62N04	**FLUID**	PRIMARY COAGULANT	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
PE-6221		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-PEA
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	55 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	DPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-PEA
		TYPICAL DETAILS	NP502	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID	SERVICE	PW PRESS LOW 1				
PISL-6350	63N09	**FLUID**	WATER	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
PE-6350		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-CL
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	25 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	DPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-CL
		TYPICAL DETAILS	NP502	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	N/A
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

TAG	P&ID	SERVICE	PW PRESS LOW 3				
PISL-6352	63N10	**FLUID**	WATER	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
PE-6352		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-CL
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	25 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	SPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-CL
		TYPICAL DETAILS	NP502	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	N/A
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

Pressure Switch

SPECIFICATION 17403

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID	SERVICE	CS TRANSFER PMP 1 PRESS SWITCH HIGH				
PISH-6511	65N02	**FLUID**	CAUSTIC SODA	**HAZARDOUS APP**	N/A	**POWER**	[*]
PE-6511		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	LOOP
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	25 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	DPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-CS
		TYPICAL DETAILS	NP502	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

TAG	P&ID	SERVICE	CS TRANSFER PMP 2 PRESS SWITCH HIGH				
PISH-6521	65N02	**FLUID**	CAUSTIC SODA	**HAZARDOUS APP**	N/A	**POWER**	[*]
PE-6521		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	LOOP
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	25 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	DPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-CS
		TYPICAL DETAILS	NP502	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

Pressure Switch

SPECIFICATION 17403

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID	SERVICE	CS SMALL FEED PMP 1 PRESS SWITCH HIGH				
PISH-6541	65N03	**FLUID**	CAUSTIC SODA	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
PE-6541		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-CS
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	60 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	DPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-CS
		TYPICAL DETAILS	NP502	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

TAG	P&ID	SERVICE	CS SMALL FEED PMP 2 PRESS SWITCH HIGH				
PISH-6562	65N03	**FLUID**	CAUSTIC SODA	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
PE-6562		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-CS
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	60 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	DPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-CS
		TYPICAL DETAILS	NP502	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

Pressure Switch

SPECIFICATION 17403

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID	SERVICE	CS LARGE FEED PMP 3 PRESS SWITCH HIGH				
PISH-6572	65N04		**FLUID** CAUSTIC SODA	**HAZARDOUS APP** N/A		**POWER** [*]
PE-6572			**FLUID TEMPERATURE** N/A	**ELEM. ENCL. CLASS** NEMA 4X		**POWER LOCATION** LOOP
			MEASURING PRINCIPLE PRESS SW	**ELEMENT MATERIAL** MFR. STD.		**OUTPUT** RELAY
			SET POINT 60 PSIG OPEN	**SWITCH ENCL. CLASS** NEMA 4X		**RELAY FORM** DPDT
			ADJUSTABLE RANGE [*]	**ENCL. MATERIAL** MFR. STD.		**PLC** RTU-CS
			TYPICAL DETAILS NP502	**SURGE PROTECTION** NO		**MANUAL RESET** NO
			CONN. MOUNTING BOTTOM	**BOTT. HOUSING MAT.** MFR. STD.		**SEAL TYPE** DIAPHRAGM
			CONNECTON TYPE M-NPT	**INSTRUMENT VALVES** INSTRUMENT VALVE TREE		**DIAPHRAGM/WET MAT** MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

TAG	P&ID	SERVICE	CS LARGE FEED PMP 4 PRESS SWITCH HIGH				
PISH-6582	65N04		**FLUID** CAUSTIC SODA	**HAZARDOUS APP** N/A		**POWER** [*]
PE-6582			**FLUID TEMPERATURE** N/A	**ELEM. ENCL. CLASS** NEMA 4X		**POWER LOCATION** LOOP
			MEASURING PRINCIPLE PRESS SW	**ELEMENT MATERIAL** MFR. STD.		**OUTPUT** RELAY
			SET POINT 60 PSIG OPEN	**SWITCH ENCL. CLASS** NEMA 4X		**RELAY FORM** DPDT
			ADJUSTABLE RANGE [*]	**ENCL. MATERIAL** MFR. STD.		**PLC** RTU-CS
			TYPICAL DETAILS NP502	**SURGE PROTECTION** NO		**MANUAL RESET** NO
			CONN. MOUNTING BOTTOM	**BOTT. HOUSING MAT.** MFR. STD.		**SEAL TYPE** DIAPHRAGM
			CONNECTON TYPE M-NPT	**INSTRUMENT VALVES** INSTRUMENT VALVE TREE		**DIAPHRAGM/WET MAT** MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID	SERVICE	PEA FILT AID SMALL 1 PRESS HIGH				
PISH-6911	69N04	**FLUID**	POLYMER	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
PE-6911		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-PEA
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	55 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	DPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-PEA
		TYPICAL DETAILS	NP501	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

TAG	P&ID	SERVICE	PEA FILT AID SMALL 2 PRESS HIGH				
PISH-6916	69N04	**FLUID**	POLYMER	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
PE-6916		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-PEA
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	55 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	DPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-PEA
		TYPICAL DETAILS	NP501	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

Pressure Switch

SPECIFICATION 17403

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID	SERVICE	PEA FILT AID LARGE 1 PRESSURE HIGH				
PISH-6921	69N05		**FLUID** POLYMER	**HAZARDOUS APP** N/A		**POWER** [*]
PE-6921			**FLUID TEMPERATURE** N/A	**ELEM. ENCL. CLASS** NEMA 4X		**POWER LOCATION** LOOP
			MEASURING PRINCIPLE PRESS SW	**ELEMENT MATERIAL** MFR. STD.		**OUTPUT** RELAY
			SET POINT 55 PSIG OPEN	**SWITCH ENCL. CLASS** NEMA 4X		**RELAY FORM** DPDT
			ADJUSTABLE RANGE [*]	**ENCL. MATERIAL** MFR. STD.		**PLC** RTU-PEA
			TYPICAL DETAILS NP501	**SURGE PROTECTION** NO		**MANUAL RESET** NO
			CONN. MOUNTING BOTTOM	**BOTT. HOUSING MAT.** MFR. STD.		**SEAL TYPE** DIAPHRAGM
			CONNECTON TYPE M-NPT	**INSTRUMENT VALVES** INSTRUMENT VALVE TREE		**DIAPHRAGM/WET MAT** MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

TAG	P&ID	SERVICE	PEA FILT AID LARGE 2 PRESSURE HIGH				
PISH-6926	69N05		**FLUID** POLYMER	**HAZARDOUS APP** N/A		**POWER** [*]
PE-6926			**FLUID TEMPERATURE** N/A	**ELEM. ENCL. CLASS** NEMA 4X		**POWER LOCATION** LOOP
			MEASURING PRINCIPLE PRESS SW	**ELEMENT MATERIAL** MFR. STD.		**OUTPUT** RELAY
			SET POINT 55 PSIG OPEN	**SWITCH ENCL. CLASS** NEMA 4X		**RELAY FORM** DPDT
			ADJUSTABLE RANGE [*]	**ENCL. MATERIAL** MFR. STD.		**PLC** RTU-PEA
			TYPICAL DETAILS NP501	**SURGE PROTECTION** NO		**MANUAL RESET** NO
			CONN. MOUNTING BOTTOM	**BOTT. HOUSING MAT.** MFR. STD.		**SEAL TYPE** DIAPHRAGM
			CONNECTON TYPE M-NPT	**INSTRUMENT VALVES** INSTRUMENT VALVE TREE		**DIAPHRAGM/WET MAT** MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID	SERVICE	PEA FLOC AID FEED 1 PRESS HIGH				
PISH-6931	69N07	**FLUID**	POLYMER	**HAZARDOUS APP**	N/A	**POWER**	[*]
PE-6931		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	LOOP
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	55 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	DPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-PEA
		TYPICAL DETAILS	NP501	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

TAG	P&ID	SERVICE	PEA FLOC AID FEED 2 PRESS HIGH				
PISH-6936	69N07	**FLUID**	POLYMER	**HAZARDOUS APP**	N/A	**POWER**	[*]
PE-6936		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	LOOP
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	55 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	DPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-PEA
		TYPICAL DETAILS	NP501	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

Pressure Switch

SPECIFICATION 17403

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID	SERVICE	PEA FLOC AID FEED 3 PRESS HIGH				
PISH-6941	69N09	**FLUID**	POLYMER	**HAZARDOUS APP**	N/A	**POWER**	[*]
PE-6941		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	LOOP
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	55 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	DPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-PEA
		TYPICAL DETAILS	NP501	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

TAG	P&ID	SERVICE	PEA FLOC AID FEED 4 PRESS HIGH				
PISH-6946	69N09	**FLUID**	POLYMER	**HAZARDOUS APP**	N/A	**POWER**	[*]
PE-6946		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	LOOP
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	55 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	DPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-PEA
		TYPICAL DETAILS	NP501	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID	SERVICE	PEA STANDBY FEED PRESS HIGH				
PISH-6951	69N11		**FLUID** POLYMER	**HAZARDOUS APP** N/A		**POWER**	[*]
PE-6951			**FLUID TEMPERATURE** N/A	**ELEM. ENCL. CLASS** NEMA 4X		**POWER LOCATION**	LOOP
			MEASURING PRINCIPLE PRESS SW	**ELEMENT MATERIAL** MFR. STD.		**OUTPUT**	RELAY
			SET POINT 55 PSIG OPEN	**SWITCH ENCL. CLASS** NEMA 4X		**RELAY FORM**	DPDT
			ADJUSTABLE RANGE [*]	**ENCL. MATERIAL** MFR. STD.		**PLC**	RTU-PEA
			TYPICAL DETAILS NP501	**SURGE PROTECTION** NO		**MANUAL RESET**	NO
			CONN. MOUNTING BOTTOM	**BOTT. HOUSING MAT.** MFR. STD.		**SEAL TYPE**	DIAPHRAGM
			CONNECTON TYPE M-NPT	**INSTRUMENT VALVES** INSTRUMENT VALVE TREE		**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

TAG	P&ID	SERVICE	PEA FILT AID DOSING PRESS HIGH				
PISH-6956	69N12		**FLUID** POLYMER	**HAZARDOUS APP** N/A		**POWER**	24VDC-1P
PE-6956			**FLUID TEMPERATURE** N/A	**ELEM. ENCL. CLASS** NEMA 4X		**POWER LOCATION**	RTU-PEA
			MEASURING PRINCIPLE PRESS SW	**ELEMENT MATERIAL** MFR. STD.		**OUTPUT**	RELAY
			SET POINT 55 PSIG OPEN	**SWITCH ENCL. CLASS** NEMA 4X		**RELAY FORM**	DPDT
			ADJUSTABLE RANGE [*]	**ENCL. MATERIAL** MFR. STD.		**PLC**	RTU-PEA
			TYPICAL DETAILS NP501	**SURGE PROTECTION** NO		**MANUAL RESET**	NO
			CONN. MOUNTING BOTTOM	**BOTT. HOUSING MAT.** MFR. STD.		**SEAL TYPE**	DIAPHRAGM
			CONNECTON TYPE M-NPT	**INSTRUMENT VALVES** INSTRUMENT VALVE TREE		**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

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LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID	SERVICE	PEC TRANSFER 1 PRESS HIGH				
PISH-7103	71N02	**FLUID**	PEC	**HAZARDOUS APP**	N/A	**POWER**	[*]
PE-7103		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	LOOP
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	25 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	DPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-PEA
		TYPICAL DETAILS	NP501	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

TAG	P&ID	SERVICE	PEC TRANSFER 2 PRESS HIGH				
PISH-7104	71N02	**FLUID**	PEC	**HAZARDOUS APP**	N/A	**POWER**	[*]
PE-7104		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	LOOP
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	25 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	DPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-PEA
		TYPICAL DETAILS	NP501	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID	SERVICE	PEC FEED PRESS 1 HIGH				
PISH-7106	71N03	**FLUID**	PEC	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
PE-7106		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-PEA
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	55 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	DPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-PEA
		TYPICAL DETAILS	NP501	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

TAG	P&ID	SERVICE	PEC FEED PRESS 2 HIGH				
PISH-7107	71N03	**FLUID**	PEC	**HAZARDOUS APP**	N/A	**POWER**	24VDC-1P
PE-7107		**FLUID TEMPERATURE**	N/A	**ELEM. ENCL. CLASS**	NEMA 4X	**POWER LOCATION**	RTU-PEA
		MEASURING PRINCIPLE	PRESS SW	**ELEMENT MATERIAL**	MFR. STD.	**OUTPUT**	RELAY
		SET POINT	55 PSIG OPEN	**SWITCH ENCL. CLASS**	NEMA 4X	**RELAY FORM**	DPDT
		ADJUSTABLE RANGE	[*]	**ENCL. MATERIAL**	MFR. STD.	**PLC**	RTU-PEA
		TYPICAL DETAILS	NP501	**SURGE PROTECTION**	NO	**MANUAL RESET**	NO
		CONN. MOUNTING	BOTTOM	**BOTT. HOUSING MAT.**	MFR. STD.	**SEAL TYPE**	DIAPHRAGM
		CONNECTON TYPE	M-NPT	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE	**DIAPHRAGM/WET MAT**	MFR. STD.

Notes: PROVIDE POWERED INDICATING SWITCH ASHCROFT NPI SERIES.

SECTION 17404

PRESSURE/VACUUM MEASUREMENT: GAUGES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Pressure/vacuum gauges.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B40.100 - Pressure Gauges and Gauge Attachments.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Product data:
   1. Accessories.

1.04 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments specified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed site conditions, including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. One of the following, no equal:
   1. Ashcroft:
      a. Maximum pressure less than 10 pounds per square inch: Model 1188 or 1189.
         1) If a stainless steel dial casing is required:
            a) Model 1009.
      b. Maximum pressure greater than or equal to 10 pounds per square inch: Model 1279 or 1379.
         1) If a stainless steel dial casing is required:
            a) Model 1009.
   2. Wika, Model XSEL type 232.34.
   3. Ametek U.S. Gauge (4 Performance Plus or Equal).

2.04 MANUFACTURED UNITS

A. General:
   1. Pressure gauge assembly shall include pressure sensing element, gauge case, and dial mechanism.

B. Performance requirements:
   1. Pressure range:
      a. As specified in the Contract Documents.

2. Accuracy:
    a. Grade 2A, as defined by ASME B40.100.
    b. Within 1.0 percent of span after friction errors are eliminated by tapping or vibration.
    c. Maximum allowable friction inaccuracy: Within 1.0 percent of span.
3. Element:
    a. Where the maximum pressure is less than 10 pounds per square inch, provide socket and bellows; for all other pressure ranges, employ a Bourdon® tube.
    b. Socket tips for bellows and Bourdon® tube:
        1) Materials: Type 316 stainless steel.
    c. Overpressure: Minimum 130 percent of maximum range pressure without damage to gauge or sensing element.
    d. Wetted materials:
        1) As indicated in the datasheets.
        2) Type 316 stainless steel.
4. Dial gauge:
    a. Dial size: 4-1/2 inches.
    b. Dial case material:
        1) As indicated in the datasheets.
        2) Maximum pressure less than 10 pounds per square inch:
            a) Phenolic.
        3) Maximum pressure greater than or equal to 10 pounds per square inch:
            a) Phenolic.
    c. Provide safety gauge with safety blow out through the back or top of the unit.
    d. Dial face: Gasketed shatterproof glass or polycarbonate.
    e. Provide gauge locks on pressure gauges directly connected to diaphragm seals.
    f. Provide gauge locks where possible.
    g. Hermetically sealed.
    h. Connection and mounting:
        1) Direct mounted and suitable for outdoor installation.
        2) 1/2-inch NPT.
        3) Connection material:
            a) As indicated in the datasheets.
            b) Stainless steel.
    i. Pointer: Externally adjustable.

2.05 ACCESSORIES

A. Pulsation dampeners and snubbers:
    1. As indicated in the datasheets.
    2. Provide pulsation dampener or snubber with each pressure gauge installed on discharge of positive displacement type pump.
    3. Provide piston-type snubber if pressure spikes will exceed 130 percent of gauge maximum range.
    4. Mount pulsation dampener or snubber integrally to the pressure gauge.
    5. Connection: 1/2-inch NPT.

6. Provide diaphragm seals as specified in the Contract Documents and/or as indicated in the datasheets.
7. Diaphragm seal and pressure gauge shall be assembled by manufacturer and shipped as an assembly.

B. Provide means for gauge isolation as specified in Section 17402 - Pressure/Vacuum Measurement: Instrument Valves:
1. Mount valve manifold integrally to the gauge.
2. Valve manifold and pressure gauge shall be assembled by manufacturer and shipped as an assembly.

C. Provide stainless steel tags for each instrument. Tags shall be labeled as specified in the Contract Documents.

2.06 FINISHES (NOT USED)

2.07 SOURCE QUALITY CONTROL

A. Factory calibrate each pressure gauge at a facility that is traceable to the NIST.

B. Provide complete documentation covering the traceability of calibration instruments.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with trades to ensure that the mechanical system has necessary appurtenances including weld-o-lets, valves, etc., for proper installation of instruments.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.04 ADJUSTING

A. Verify factory calibration of instruments in accordance with the manufacturer’s instructions:
1. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.05 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - PRESSURE/VACUUM MEASUREMENT: GAUGES

Pressure Gauge

SPECIFICATION 17404

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID						
PI-3011	30N03	**SERVICE**	FILTER 1 PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0-10	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI-3021	30N04	**SERVICE**	FILTER 2 PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0-10	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI-3031	30N05	**SERVICE**	FILTER 3 PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0-10	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI-3041	30N06	**SERVICE**	FILTER 4 PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0-10	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F

Pressure Gauge

SPECIFICATION 17404

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID						
PI-3051	30N07	**SERVICE**	FILTER 5 PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0-10	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI-3061	30N08	**SERVICE**	FILTER 6 PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0-10	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI-3071	30N09	**SERVICE**	FILTER 7 PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0-10	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI-3081	30N10	**SERVICE**	FILTER 8 PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0-10	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F

Pressure Gauge

SPECIFICATION 17404

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID						
PI-3091	30N11	**SERVICE**	FILTER 9 PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0-10	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI-3101	30N12	**SERVICE**	FILTER 10 PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0-10	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI-3111	30N13	**SERVICE**	FILTER 11 PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0-10	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI-3121	30N14	**SERVICE**	FILTER 12 PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0-10	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F

Pressure Gauge

SPECIFICATION 17404

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID						
PI-3131	30N15	**SERVICE**	FILTER 13 PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0-10	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI-3141	30N16	**SERVICE**	FILTER 14 PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0-10	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI-3151	30N17	**SERVICE**	FILTER 15 PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0-10	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI-3161	30N18	**SERVICE**	FILTER 16 PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0-10	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID						
PI-6215	62N04	**SERVICE**	PC FEED DISCHARGE 1 PRESS INDICATOR				
		FLUID	PRIMARY COAGULANT	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0-30 PSIG	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-60 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI-6216	62N04	**SERVICE**	PC FEED DISCHARGE 2 PRESS INDICATOR				
		FLUID	PRIMARY COAGULANT	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0-30 PSIG	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-60 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI-6331	63N06	**SERVICE**	FW CLG PRESS INDICATOR				
		FLUID	CHLORINE GAS	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	HASTELLOY C
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	TANTALUM
		PRESSURE RANGE:	30" HG VAC TO 15 PSI	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	30" HG VAC TO 15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
		Notes: PROVIDE SOCKET AND BELLOWS.					
TAG	**P&ID**						
PI-6332	63N06	**SERVICE**	RW CLG PRESS INDICATOR				
		FLUID	CHLORINE GAS	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	HASTELLOY C
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	TANTALUM
		PRESSURE RANGE:	30" HG VAC TO 15 PSI	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	30" HG VAC TO 15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
		Notes: PROVIDE SOCKET AND BELLOWS.					

Pressure Gauge

SPECIFICATION 17404

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID						
PI-6333	63N06	**SERVICE**	RW CLG PRESS INDICATOR				
		FLUID	CHLORINE GAS	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	HASTELLOY C
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	TANTALUM
		PRESSURE RANGE:	30" HG VAC TO 15 PSI	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	30" HG VAC TO 15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
	Notes: PROVIDE SOCKET AND BELLOWS.						
TAG	**P&ID**						
PI-6540	65N03	**SERVICE**	UTILITY WATER PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0-160 PSIG	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-160 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI-6563	65N03	**SERVICE**	CS SMALL PMPS PRESS INDICATOR				
		FLUID	CAUSTIC SODA	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MONEL 400
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	K-MONEL
		PRESSURE RANGE:	0 - 60 PSIG	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-100 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI-6584	65N04	**SERVICE**	PRESS INDICATOR				
		FLUID	CAUSTIC SODA	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MONEL 400
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	K-MONEL
		PRESSURE RANGE:	0 - 60 PSIG	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-100 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F

Pressure Gauge

SPECIFICATION 17404

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID						
PI-6918	69N04	**SERVICE**	PEA FILT AID SMALL 1 PRESS INDICATOR				
		FLUID	POLYMER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0 - 50 PSIG	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-100 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI-6919	69N04	**SERVICE**	PEA FILT AID SMALL 2 PRESS INDICATOR				
		FLUID	POLYMER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0 - 50 PSIG	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-100 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI-6928	69N06	**SERVICE**	PEA FILT AID LARGE 1 PRESS INDICATOR				
		FLUID	POLYMER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0 - 50 PSIG	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-100 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI-6929	69N06	**SERVICE**	PEA FILT AID LARGE 2 PRESS INDICATOR				
		FLUID	POLYMER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0 - 50 PSIG	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-100 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F

Pressure Gauge

SPECIFICATION 17404

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID						
PI1-6341	63N09	**SERVICE**	PRESS INDICATOR				
		FLUID	CHLORINE SOLUTION	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	HASTELLOY C
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	TANTALUM
		PRESSURE RANGE:	0 - 75 PSIG	**TYPICAL DETAILS**	NP503	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-160 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI1-6342	63N09	**SERVICE**	PRESS INDICATOR				
		FLUID	CHLORINE SOLUTION	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	HASTELLOY C
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	TANTALUM
		PRESSURE RANGE:	0 - 75 PSIG	**TYPICAL DETAILS**	NP503	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-160 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI1-6343	63N10	**SERVICE**	PRESS INDICATOR				
		FLUID	CHLORINE SOLUTION	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	HASTELLOY C
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	TANTALUM
		PRESSURE RANGE:	0 - 75 PSIG	**TYPICAL DETAILS**	NP503	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-160 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI1-6344	63N10	**SERVICE**	PRESS INDICATOR				
		FLUID	CHLORINE SOLUTION	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	HASTELLOY C
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	TANTALUM
		PRESSURE RANGE:	0 - 75 PSIG	**TYPICAL DETAILS**	NP503	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-160 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F

Pressure Gauge

SPECIFICATION 17404

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID						
PI1-6345	63N10	**SERVICE**	PRESS INDICATOR				
		FLUID	CHLORINE SOLUTION	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	HASTELLOY C
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	TANTALUM
		PRESSURE RANGE:	0 - 75 PSIG	**TYPICAL DETAILS**	NP503	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-160 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI1-6346	63N09	**SERVICE**	PRESS INDICATOR				
		FLUID	CHLORINE SOLUTION	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	HASTELLOY C
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	TANTALUM
		PRESSURE RANGE:	0 - 75 PSIG	**TYPICAL DETAILS**	NP503	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-160 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI1-6937	69N08	**SERVICE**	PEA FLOC AID FEED 1 PRESS INDICATOR				
		FLUID	POLYMER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0 - 50 PSIG	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-100 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI1-6938	69N08	**SERVICE**	PEA FLOC AID FEED 2 PRESS INDICATOR				
		FLUID	POLYMER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0 - 50 PSIG	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-100 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F

Pressure Gauge

SPECIFICATION 17404

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID						
PI1-6948	69N10	**SERVICE**	PEA FLOC AID FEED 3 PRESS INDICATOR				
		FLUID	POLYMER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0 - 50 PSIG	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-100 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI1-6949	69N10	**SERVICE**	PEA FLOC AID FEED 4 PRESS INDICATOR				
		FLUID	POLYMER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0 - 50 PSIG	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-100 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI1-6958	69N12	**SERVICE**	PEA FILT AID DOSING PRESS INDICATOR				
		FLUID	POLYMER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0 - 50 PSIG	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-100 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI1-7108	71N03	**SERVICE**	PEC FEED DISCHARGE PRESS INDICATOR				
		FLUID	PEC	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0 - 30 PSIG	**TYPICAL DETAILS**	NP501	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-60 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F

Pressure Gauge

SPECIFICATION 17404

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID						
PI2-6341	63N09	**SERVICE**	PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0 - 75 PSIG	**TYPICAL DETAILS**	NP503	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-160 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI2-6342	63N09	**SERVICE**	PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0 - 75 PSIG	**TYPICAL DETAILS**	NP503	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-160 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI2-6343	63N10	**SERVICE**	PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0 - 75 PSIG	**TYPICAL DETAILS**	NP503	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-160 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI2-6344	63N10	**SERVICE**	PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0 - 75 PSIG	**TYPICAL DETAILS**	NP503	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-160 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F

Pressure Gauge

SPECIFICATION 17404

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID						
PI2-6345	63N10	**SERVICE**	PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0 - 75 PSIG	**TYPICAL DETAILS**	NP503	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-160 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI2-6346	63N09	**SERVICE**	PRESS INDICATOR				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0 - 75 PSIG	**TYPICAL DETAILS**	NP503	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-160 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI3-3911	30N25	**SERVICE**	FILTER DRAIN 1 PRESSURE				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0-15 PSIG	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI3-3921	30N25	**SERVICE**	FILTER DRAIN 2 PRESSURE				
		FLUID	WATER	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	MFR. STD.
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	N/A	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	MFR. STD.
		PRESSURE RANGE:	0-15 PSIG	**TYPICAL DETAILS**	[*]	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	0-15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F

Pressure Gauge

SPECIFICATION 17404

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

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TAG	P&ID						
PI3-6341	63N09	**SERVICE**	PRESS INDICATOR				
		FLUID	CHLORINE GAS	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	HASTELLOY C
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	TANTALUM
		PRESSURE RANGE:	30" HG VAC TO 15 PSI	**TYPICAL DETAILS**	NP503	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	30" HG VAC TO 15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI3-6342	63N09	**SERVICE**	PRESS INDICATOR				
		FLUID	CHLORINE GAS	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	HASTELLOY C
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	TANTALUM
		PRESSURE RANGE:	30" HG VAC TO 15 PSI	**TYPICAL DETAILS**	NP503	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	30" HG VAC TO 15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI3-6343	63N10	**SERVICE**	PRESS INDICATOR				
		FLUID	CHLORINE GAS	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	HASTELLOY C
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	TANTALUM
		PRESSURE RANGE:	30" HG VAC TO 15 PSI	**TYPICAL DETAILS**	NP503	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	30" HG VAC TO 15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F
TAG	**P&ID**						
PI3-6344	63N10	**SERVICE**	PRESS INDICATOR				
		FLUID	CHLORINE GAS	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	HASTELLOY C
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	TANTALUM
		PRESSURE RANGE:	30" HG VAC TO 15 PSI	**TYPICAL DETAILS**	NP503	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	30" HG VAC TO 15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F

Pressure Gauge

SPECIFICATION 17404

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

TAG	P&ID						
PI3-6345	63N10	**SERVICE**	PRESS INDICATOR				
		FLUID	CHLORINE GAS	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	HASTELLOY C
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	TANTALUM
		PRESSURE RANGE:	30" HG VAC TO 15 PSI	**TYPICAL DETAILS**	NP503	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	30" HG VAC TO 15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F

TAG	P&ID						
PI3-6346	63N09	**SERVICE**	PRESS INDICATOR				
		FLUID	CHLORINE GAS	**CONNECTION TYPE**	1/2 IN NPT	**BOTT. HOUSING MAT.**	HASTELLOY C
		TEMPERATURE	50-95 DEG F	**ISOLATION SEALS**	DIAPHRAGM	**INSTRUMENT VALVES**	INSTRUMENT VALVE TREE
		MEASURING PRINCIPLE	DIRECT	**CASE MATERIAL**	PHENOLIC	**DIAPHRAGM MAT.**	TANTALUM
		PRESSURE RANGE:	30" HG VAC TO 15 PSI	**TYPICAL DETAILS**	NP503	**DIAL SIZE**	4-1/2"
		GAUGE RANGE	30" HG VAC TO 15 PSI	**OPTIONS**	[*]	**AMBIENT TEMP**	0-95 DEG F

SECTION 17405

PRESSURE/VACUUM MEASUREMENT: DIRECT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Pressure transmitters and indicators.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Calibrated range: The range that the pressure transmitter is configured to measure.
      a. The low end of the calibrated range must be greater than the lower range value (LRV) of the transmitter.
      b. The high end of the calibrated range must be less than or equal to the upper range value (URV).
      c. The calibrated range corresponds to the flow signal sent from the transmitter.
   2. Lower range value (LRV): Lowest pressure that the pressure transmitter is capable of measuring.
   3. Upper range value (URV): Highest pressure that the pressure transmitter is capable of measuring.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide complete documentation covering the traceability of calibration instruments.

1.05 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials etc.

2. Physical conditions:
    a. Installation and mounting requirements.
    b. Location within the process.
    c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

C. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
    1. Notify the Engineer if any installation condition does not meet the instrument manufacturer’s recommendations or specifications.

1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

1.10 MAINTENANCE

A. Furnish parts, materials, fluids, etc., necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. The following, no equal:
    1. Emerson, Rosemount 3051 Series.
        a. Coplanar 3051CD2A02A1AS5.

b. Rosemount 305 Integral Manifold 0305RC32B11B4.

2.04 MANUFACTURED UNITS

A. Pressure transmitters - direct:
   1. General:
      a. Pressure transmitter assembly shall include a diaphragm type pressure transducer and microprocessor-based transmitter for measurement of gauge, vacuum, or absolute pressure.
   2. Performance requirements:
      a. Maximum ratio of total instrument range to calibrated span: 10 to 1.
      b. Accuracy:
         1) Reference accuracy: Plus or minus 0.075 percent of calibrated span, including effects of hysteresis, nonlinearity, and repeatability.
         2) Total performance accuracy: Plus or minus 0.30 percent of calibrated span, including reference accuracy effects, static pressure and ambient temperature effects.
         3) Stability: Plus or minus 0.15 percent of upper range limit over 5 years.
   3. Element:
      a. Diaphragm type transducer integral to pressure transmitter.
      b. Diaphragm material: Stainless steel or ceramic.
      c. Process material compatibility:
         1) Verify material compatibilities with the instrument manufacturer.
      d. Process connection: As specified in Attachment A - ISA Datasheet - Pressure/Vacuum Measurement: Direct.
   4. Transmitter:
      a. Power supply:
         1) As indicated in the datasheets.
      b. Outputs:
         1) As indicated in the datasheets.
         2) Isolated 4-20 mA DC with HART communication protocol.
      c. Provided with electronic microprocessor.
      d. Adjustments: Adjustable electronic zero and span, with elevated or suppressed zero as required by application. Adjustment shall be possible without mechanical fulcrum points or a handheld configurator.
      e. Local display:
         1) 5-digit LCD.
         2) Scaled in engineering units.
      f. Enclosure:
         1) As indicated in the datasheets.
         2) Non-hazardous area:
            a) NEMA Type 4X.
      g. Over range protection: To maximum process line pressure.
      h. Conduit: 1/2-inch male NPT.
   5. Components:
      a. Transmitter mounting:
         1) As indicated in the datasheets.
         2) Provide necessary hardware for transmitter mounting.

2.05 ACCESSORIES

A. Provide valve manifolds as specified in Section 17402 - Pressure/Vacuum Measurement: Instrument Valves:
   1. Mount valve manifold integrally to the transmitter.
   2. Valve manifold and transmitter shall be assembled by Manufacturer and shipped as an assembly.
   3. Provide remote or integral diaphragm seals as indicated on the Drawings or as indicated in the datasheets.

B. Provide sunshades for outdoor installations.

C. Provide stainless steel tags for each instrument. Tags shall be labeled as specified in the Contract Documents.

2.06 FINISHES (NOT USED)

2.07 SOURCE QUALITY CONTROL

A. Factory calibrate each instrument with a minimum 3-point calibration or according to Manufacturer's standard at a facility that is traceable to the NIST.
   1. Submit calibration datasheets to the Engineer at least 30 days before shipment of the instruments to the project site.

B. FM approval certification or equal when installed in classified areas.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with trades to ensure that the mechanical system has necessary appurtenances including weld-o-lets, valves, etc., for proper installation of instruments.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.04 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - PRESSURE/VACUUM MEASUREMENT: DIRECT

Pressure Transmitter

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG PIT-3011 (PE-3011)
SPECIFICATION NUMBER 17405
DRAWING NUMBER 30N03
SERVICE FILTER 1 PRESSURE TRANSMITTER
MEASURING PRINCIPLE DIRECT
PLC RTU-NFL1
TYPICAL DETAILS NP501

CONNECTION

CONNECTION TYPE M-NPT
INSTRUMENT VALVES INSTRUMENT VALVE TREE

FLUID

FLUID [*]
TEMPERATURE 50-65 DEG F
PRESSURE RANGE 0-10 PSIG

ELEMENT

ELEMENT TAG NO. PE-3011
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
SEAL TYPE N/A
DIAPHRAGM MATERIAL MFR. STD.
BOTTOM HOUSING MAT. MFR. STD.

TRANSMITTER

TRANSMITTER TAG NO. PIT-3011
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT 4-20 MA
SURGE PROTECTION NO

NOTES

[*]

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

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GENERAL

TAG PIT-3021 (PE-3021)

SPECIFICATION NUMBER 17405

DRAWING NUMBER 30N04

SERVICE FILTER 2 PRESSURE TRANSMITTER

MEASURING PRINCIPLE DIRECT

PLC RTU-SFL2

TYPICAL DETAILS NP501

CONNECTION

CONNECTION TYPE M-NPT

INSTRUMENT VALVES INSTRUMENT VALVE TREE

FLUID

FLUID [*]

TEMPERATURE 50-65 DEG F

PRESSURE RANGE 0-10 PSIG

ELEMENT

ELEMENT TAG NO. PE-3021

ENCLOSURE CLASS NEMA 4X

HAZARDOUS APPROVALS N/A

SEAL TYPE N/A

DIAPHRAGM MATERIAL MFR. STD.

BOTTOM HOUSING MAT. MFR. STD.

TRANSMITTER

TRANSMITTER TAG NO. PIT-3021

MOUNTING INT

ENCLOSURE CLASS NEMA 4X

AMBIENT TEMPERATURE 0-95 DEG F

OUTPUT 4-20 MA

SURGE PROTECTION NO

NOTES

[*]

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PROJECT INFORMATION

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GENERAL

TAG PIT-3031 (PE-3031)
SPECIFICATION NUMBER 17405
DRAWING NUMBER 30N05
SERVICE FILTER 3 PRESSURE TRANSMITTER
MEASURING PRINCIPLE DIRECT
PLC RTU-NFL3
TYPICAL DETAILS NP501

CONNECTION

CONNECTION TYPE M-NPT
INSTRUMENT VALVES INSTRUMENT VALVE TREE

FLUID

FLUID [*]
TEMPERATURE 50-65 DEG F
PRESSURE RANGE 0-10 PSIG

ELEMENT

ELEMENT TAG NO. PE-3031
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
SEAL TYPE N/A
DIAPHRAGM MATERIAL MFR. STD.
BOTTOM HOUSING MAT. MFR. STD.

TRANSMITTER

TRANSMITTER TAG NO. PIT-3031
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT 4-20 MA
SURGE PROTECTION NO

NOTES

[*]

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

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GENERAL

TAG PIT-3041 (PE-3041)

SPECIFICATION NUMBER 17405

DRAWING NUMBER 30N06

SERVICE FILTER 4 PRESSURE TRANSMITTER

MEASURING PRINCIPLE DIRECT

PLC RTU-SFL4

TYPICAL DETAILS NP501

CONNECTION

CONNECTION TYPE M-NPT

INSTRUMENT VALVES INSTRUMENT VALVE TREE

FLUID

FLUID [*]

TEMPERATURE 50-65 DEG F

PRESSURE RANGE 0-10 PSIG

ELEMENT

ELEMENT TAG NO. PE-3041

ENCLOSURE CLASS NEMA 4X

HAZARDOUS APPROVALS N/A

SEAL TYPE N/A

DIAPHRAGM MATERIAL MFR. STD.

BOTTOM HOUSING MAT. MFR. STD.

TRANSMITTER

TRANSMITTER TAG NO. PIT-3041

MOUNTING INT

ENCLOSURE CLASS NEMA 4X

AMBIENT TEMPERATURE 0-95 DEG F

OUTPUT 4-20 MA

SURGE PROTECTION NO

NOTES

[*]

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG PIT-3051 (PE-3051)

SPECIFICATION NUMBER 17405

DRAWING NUMBER 30N07

SERVICE FILTER 5 PRESSURE TRANSMITTER

MEASURING PRINCIPLE DIRECT

PLC RTU-NFL5

TYPICAL DETAILS NP501

CONNECTION

CONNECTION TYPE M-NPT

INSTRUMENT VALVES INSTRUMENT VALVE TREE

FLUID

FLUID [*]

TEMPERATURE 50-65 DEG F

PRESSURE RANGE 0-10 PSIG

ELEMENT

ELEMENT TAG NO. PE-3051

ENCLOSURE CLASS NEMA 4X

HAZARDOUS APPROVALS N/A

SEAL TYPE N/A

DIAPHRAGM MATERIAL MFR. STD.

BOTTOM HOUSING MAT. MFR. STD.

TRANSMITTER

TRANSMITTER TAG NO. PIT-3051

MOUNTING INT

ENCLOSURE CLASS NEMA 4X

AMBIENT TEMPERATURE 0-95 DEG F

OUTPUT 4-20 MA

SURGE PROTECTION NO

NOTES

[*]

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

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GENERAL

TAG PIT-3061 (PE-3061)

SPECIFICATION NUMBER 17405

DRAWING NUMBER 30N08

SERVICE FILTER 6 PRESSURE TRANSMITTER

MEASURING PRINCIPLE DIRECT

PLC RTU-SFL6

TYPICAL DETAILS NP501

CONNECTION

CONNECTION TYPE M-NPT

INSTRUMENT VALVES INSTRUMENT VALVE TREE

FLUID

FLUID [*]

TEMPERATURE 50-65 DEG F

PRESSURE RANGE 0-10 PSIG

ELEMENT

ELEMENT TAG NO. PE-3061

ENCLOSURE CLASS NEMA 4X

HAZARDOUS APPROVALS N/A

SEAL TYPE N/A

DIAPHRAGM MATERIAL MFR. STD.

BOTTOM HOUSING MAT. MFR. STD.

TRANSMITTER

TRANSMITTER TAG NO. PIT-3061

MOUNTING INT

ENCLOSURE CLASS NEMA 4X

AMBIENT TEMPERATURE 0-95 DEG F

OUTPUT 4-20 MA

SURGE PROTECTION NO

NOTES

[*]

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

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GENERAL

TAG PIT-3071 (PE-3071)

SPECIFICATION NUMBER 17405

DRAWING NUMBER 30N09

SERVICE FILTER 7 PRESS TRANSMITTER

MEASURING PRINCIPLE DIRECT

PLC RTU-NFL7

TYPICAL DETAILS NP501

CONNECTION

CONNECTION TYPE M-NPT

INSTRUMENT VALVES INSTRUMENT VALVE TREE

FLUID

FLUID [*]

TEMPERATURE 50-65 DEG F

PRESSURE RANGE 0-10 PSIG

ELEMENT

ELEMENT TAG NO. PE-3071

ENCLOSURE CLASS NEMA 4X

HAZARDOUS APPROVALS N/A

SEAL TYPE N/A

DIAPHRAGM MATERIAL MFR. STD.

BOTTOM HOUSING MAT. MFR. STD.

TRANSMITTER

TRANSMITTER TAG NO. PIT-3071

MOUNTING INT

ENCLOSURE CLASS NEMA 4X

AMBIENT TEMPERATURE 0-95 DEG F

OUTPUT 4-20 MA

SURGE PROTECTION NO

NOTES

[*]

Pressure Transmitter

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
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GENERAL

TAG PIT-3081 (PE-3081)
SPECIFICATION NUMBER 17405
DRAWING NUMBER 30N10
SERVICE FILTER 8 PRESS TRANSMITTER
MEASURING PRINCIPLE DIRECT
PLC RTU-SFL8
TYPICAL DETAILS NP501

CONNECTION

CONNECTION TYPE M-NPT
INSTRUMENT VALVES INSTRUMENT VALVE TREE

FLUID

FLUID [*]
TEMPERATURE 50-65 DEG F
PRESSURE RANGE 0-10 PSIG

ELEMENT

ELEMENT TAG NO. PE-3081
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
SEAL TYPE N/A
DIAPHRAGM MATERIAL MFR. STD.
BOTTOM HOUSING MAT. MFR. STD.

TRANSMITTER

TRANSMITTER TAG NO. PIT-3081
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT 4-20 MA
SURGE PROTECTION NO

NOTES

[*]

Pressure Transmitter

PROJECT INFORMATION

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GENERAL

TAG PIT-3091 (PE-3091)
SPECIFICATION NUMBER 17405
DRAWING NUMBER 30N11
SERVICE FILTER 9 PRESS TRANSMITTER
MEASURING PRINCIPLE DIRECT
PLC RTU-NFL9
TYPICAL DETAILS NP501

CONNECTION

CONNECTION TYPE M-NPT
INSTRUMENT VALVES INSTRUMENT VALVE TREE

FLUID

FLUID [*]
TEMPERATURE 50-65 DEG F
PRESSURE RANGE 0-10 PSIG

ELEMENT

ELEMENT TAG NO. PE-3091
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
SEAL TYPE N/A
DIAPHRAGM MATERIAL MFR. STD.
BOTTOM HOUSING MAT. MFR. STD.

TRANSMITTER

TRANSMITTER TAG NO. PIT-3091
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT 4-20 MA
SURGE PROTECTION NO

NOTES

[*]

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PROJECT INFORMATION

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GENERAL

TAG PIT-3101 (PE-3101)
SPECIFICATION NUMBER 17405
DRAWING NUMBER 30N12
SERVICE FILTER 10 PRESS TRANSMITTER
MEASURING PRINCIPLE DIRECT
PLC RTU-SFL10
TYPICAL DETAILS NP501

CONNECTION

CONNECTION TYPE M-NPT
INSTRUMENT VALVES INSTRUMENT VALVE TREE

FLUID

FLUID [*]
TEMPERATURE 50-65 DEG F
PRESSURE RANGE 0-10 PSIG

ELEMENT

ELEMENT TAG NO. PE-3101
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
SEAL TYPE N/A
DIAPHRAGM MATERIAL MFR. STD.
BOTTOM HOUSING MAT. MFR. STD.

TRANSMITTER

TRANSMITTER TAG NO. PIT-3101
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT 4-20 MA
SURGE PROTECTION NO

NOTES

[*]

Pressure Transmitter

PROJECT INFORMATION

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GENERAL

TAG PIT-3111 (PE-3111)
SPECIFICATION NUMBER 17405
DRAWING NUMBER 30N13
SERVICE FILTER 11 PRESS TRANSMITTER
MEASURING PRINCIPLE DIRECT
PLC RTU-NFL11
TYPICAL DETAILS NP501

CONNECTION

CONNECTION TYPE M-NPT
INSTRUMENT VALVES INSTRUMENT VALVE TREE

FLUID

FLUID [*]
TEMPERATURE 50-65 DEG F
PRESSURE RANGE 0-10 PSIG

ELEMENT

ELEMENT TAG NO. PE-3111
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
SEAL TYPE N/A
DIAPHRAGM MATERIAL MFR. STD.
BOTTOM HOUSING MAT. MFR. STD.

TRANSMITTER

TRANSMITTER TAG NO. PIT-3111
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT 4-20 MA
SURGE PROTECTION NO

NOTES

[*]

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Pressure Transmitter

RESERVOIR

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG PIT-3121 (PE-3121)

SPECIFICATION NUMBER 17405

DRAWING NUMBER 30N14

SERVICE FILTER 12 PRESS TRANSMITTER

MEASURING PRINCIPLE DIRECT

PLC RTU-SFL12

TYPICAL DETAILS NP501

CONNECTION

CONNECTION TYPE M-NPT

INSTRUMENT VALVES INSTRUMENT VALVE TREE

FLUID

FLUID [*]

TEMPERATURE 50-65 DEG F

PRESSURE RANGE 0-10 PSIG

ELEMENT

ELEMENT TAG NO. PE-3121

ENCLOSURE CLASS NEMA 4X

HAZARDOUS APPROVALS N/A

SEAL TYPE N/A

DIAPHRAGM MATERIAL MFR. STD.

BOTTOM HOUSING MAT. MFR. STD.

TRANSMITTER

TRANSMITTER TAG NO. PIT-3121

MOUNTING INT

ENCLOSURE CLASS NEMA 4X

AMBIENT TEMPERATURE 0-95 DEG F

OUTPUT 4-20 MA

SURGE PROTECTION NO

NOTES

[*]

Pressure Transmitter

PROJECT INFORMATION

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PROJECT 202001
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LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG PIT-3131 (PE-3131)
SPECIFICATION NUMBER 17405
DRAWING NUMBER 30N15
SERVICE FILTER 13 PRESS TRANSMITTER
MEASURING PRINCIPLE DIRECT
PLC RTU-NFL13
TYPICAL DETAILS NP501

CONNECTION

CONNECTION TYPE M-NPT
INSTRUMENT VALVES INSTRUMENT VALVE TREE

FLUID

FLUID [*]
TEMPERATURE 50-65 DEG F
PRESSURE RANGE 0-10 PSIG

ELEMENT

ELEMENT TAG NO. PE-3131
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
SEAL TYPE N/A
DIAPHRAGM MATERIAL MFR. STD.
BOTTOM HOUSING MAT. MFR. STD.

TRANSMITTER

TRANSMITTER TAG NO. PIT-3131
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT 4-20 MA
SURGE PROTECTION NO

NOTES

[*]

Pressure Transmitter

PROJECT INFORMATION

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GENERAL

TAG PIT-3141 (PE-3141)
SPECIFICATION NUMBER 17405
DRAWING NUMBER 30N16
SERVICE FILTER 14 PRESS TRANSMITTER
MEASURING PRINCIPLE DIRECT
PLC RTU-SFL14
TYPICAL DETAILS NP501

CONNECTION

CONNECTION TYPE M-NPT
INSTRUMENT VALVES INSTRUMENT VALVE TREE

FLUID

FLUID [*]
TEMPERATURE 50-65 DEG F
PRESSURE RANGE 0-10 PSIG

ELEMENT

ELEMENT TAG NO. PE-3141
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
SEAL TYPE N/A
DIAPHRAGM MATERIAL MFR. STD.
BOTTOM HOUSING MAT. MFR. STD.

TRANSMITTER

TRANSMITTER TAG NO. PIT-3141
MOUNTING INT
ENCLOSURE CLASS NEMA 4X
AMBIENT TEMPERATURE 0-95 DEG F
OUTPUT 4-20 MA
SURGE PROTECTION NO

NOTES

[*]

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PROJECT INFORMATION

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PROJECT 202001

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GENERAL

TAG PIT-3151 (PE-3151)

SPECIFICATION NUMBER 17405

DRAWING NUMBER 30N17

SERVICE FILTER 15 PRESS TRANSMITTER

MEASURING PRINCIPLE DIRECT

PLC RTU-NFL15

TYPICAL DETAILS NP501

CONNECTION

CONNECTION TYPE M-NPT

INSTRUMENT VALVES INSTRUMENT VALVE TREE

FLUID

FLUID [*]

TEMPERATURE 50-65 DEG F

PRESSURE RANGE 0-10 PSIG

ELEMENT

ELEMENT TAG NO. PE-3151

ENCLOSURE CLASS NEMA 4X

HAZARDOUS APPROVALS N/A

SEAL TYPE N/A

DIAPHRAGM MATERIAL MFR. STD.

BOTTOM HOUSING MAT. MFR. STD.

TRANSMITTER

TRANSMITTER TAG NO. PIT-3151

MOUNTING INT

ENCLOSURE CLASS NEMA 4X

AMBIENT TEMPERATURE 0-95 DEG F

OUTPUT 4-20 MA

SURGE PROTECTION NO

NOTES

[*]

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PROJECT INFORMATION

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GENERAL

TAG PIT-3161 (PE-3161)

SPECIFICATION NUMBER 17405

DRAWING NUMBER 30N18

SERVICE FILTER 16 PRESS TRANSMITTER

MEASURING PRINCIPLE DIRECT

PLC RTU-SFL16

TYPICAL DETAILS NP501

CONNECTION

CONNECTION TYPE M-NPT

INSTRUMENT VALVES INSTRUMENT VALVE TREE

FLUID

FLUID [*]

TEMPERATURE 50-65 DEG F

PRESSURE RANGE 0-10 PSIG

ELEMENT

ELEMENT TAG NO. PE-3161

ENCLOSURE CLASS NEMA 4X

HAZARDOUS APPROVALS N/A

SEAL TYPE N/A

DIAPHRAGM MATERIAL MFR. STD.

BOTTOM HOUSING MAT. MFR. STD.

TRANSMITTER

TRANSMITTER TAG NO. PIT-3161

MOUNTING INT

ENCLOSURE CLASS NEMA 4X

AMBIENT TEMPERATURE 0-95 DEG F

OUTPUT 4-20 MA

SURGE PROTECTION NO

NOTES

[*]

SECTION 17406

PRESSURE/VACUUM MEASUREMENT: DIFFERENTIAL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Differential pressure transmitters and indicators.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Calibrated range: The range that the pressure transmitter is configured to measure.
      a. The low end of the calibrated range must be greater than the lower range value (LRV) of the transmitter.
      b. The high end of the calibrated range must be less than the upper range value (URV).
      c. The calibrated range corresponds to the pressure signal sent from the transmitter.
      d. When a Low-Flow Cut-Off is considered, the calibration set points need to be 10 percent, 25 percent, 50 percent, 75 percent, and 100 percent of the output flowrate rather than starting form 0 percent.
   2. Lower range value (LRV): Lowest pressure that the pressure transmitter is capable of measuring.
   3. Upper range value (URV): Highest pressure that the pressure transmitter is capable of measuring.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Product data:
   1. Accessories.

C. Provide complete documentation covering the traceability of calibration instruments.

1.05 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT CONDITIONS

A. Project environmental conditions as specified in Section 01850 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the instrument manufacturer’s recommendations or specifications.

1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

1.10 MAINTENANCE

A. Furnish parts, materials, fluids, etc., necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments specified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed site conditions, including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. One of the following, no equal:
   1. Emerson, Rosemount 3051S Series.
   2. Endress + Hauser, Deltabar S Series.
   3. SMAR, LD300 Series.

2.04 MANUFACTURED UNITS

A. As specified in this Section including Attachment A - ISA Datasheet - Pressure/Vacuum Measurement: Differential.

B. Pressure transmitters - differential:
   1. General:
      a. Differential pressure transmitter assembly shall include a diaphragm-type pressure transducer and microprocessor-based transmitter for measurement of differential pressure.
      b. Differential pressure transmitters shall be used for differential pressure, flow, or liquid level measurement as indicated on the Drawings.
   2. Performance requirements:
      a. Maximum ratio of total instrument range to calibrated span: 10 to 1.
      b. Accuracy:
         1) Reference accuracy: Plus or minus 0.075 percent of calibrated span, including effects of hysteresis, nonlinearity, and repeatability.
         2) Stability: Plus or minus 0.30 percent of upper range limit over 5 years.
   3. Element:
      a. Diaphragm-type transducer integral to differential pressure transmitter.
      b. Diaphragm/wetted material: As indicated in Attachment A - ISA Datasheet - Pressure/Vacuum Measurement: Differential.
      c. Wetted materials: As indicated in the instrument datasheet.
      d. Process connection: As indicated in the instrument datasheets.
      e. Process material compatibility:
         1) Verify material compatibilities with the instrument manufacturer.

   4. Transmitter:
      a. Power supply:
         1) As indicated in the datasheets.
      b. Outputs:
         1) As indicated in the datasheets.
         2) Isolated 4-20 mA DC with HART communications protocol.
         3) Pressure/Vacuum Measurement: Differential.
      c. Provided with electronic microprocessor.
      d. Adjustments: Adjustable electronic zero and span, with elevated or suppressed zero as required by application. Adjustment shall be possible without mechanical fulcrum points or handheld configurator.
      e. Square root extraction for flow calculation.
      f. Local display:
         1) 5-digit LCD.
         2) Scaled in engineering units.
      g. Enclosure:
         1) As indicated in the datasheets.

2) Non-hazardous area:
a) NEMA Type 4X.
h. Overrange protection: To maximum process line pressure.
i. Conduit connection: 1/2-inch male NPT.
5. Components:
a. Transmitter mounting:
1) As indicated in the instrument datasheet.
2) Provide necessary hardware for transmitter mounting.

2.05 ACCESSORIES

A. Provide manifold as indicated on the Drawings, or as indicated in the datasheets.

B. Mount valve manifold integrally to the transmitter.
1. The valve manifold and transmitter shall be assembled by the manufacturer and shipped as an assembly.

C. Provide seals as indicated on the Drawings, as indicated in Attachment A - ISA Datasheet - Pressure/Vacuum Measurement: Differential, and as specified in Section 17402 - Pressure/Vacuum Measurement: Instrument Valves:
1. The diaphragm seal and transmitter shall be assembled by the manufacturer and shipped as an assembly.

D. Provide flanged diaphragm for tank or vessel level measurement:
1. The flanged diaphragm and transmitter shall be assembled by the manufacturer and shipped as an assembly.

E. Provide sunshades for outdoor installations.

F. Provide stainless steel tags for each instrument. Tags shall be labeled as specified in the Contract Documents.

G. Sensing (impulse) lines:
1. Provide sensing lines for each instrument.
2. Seamless stainless steel.
3. Pressure rated for the actual field service conditions.
4. Diameter based on the overall length.
a. Up to 10 feet: 3/8-inch.
b. From 10 feet to 20 feet: 1/2-inch.
c. From 20 feet to 40 feet: 1-inch.
d. Increase the diameter 1 increment for medium to heavy viscosity fluids, very dirty fluids and sludges.

2.06 FINISHES (NOT USED)

2.07 SOURCE QUALITY CONTROL

A. Each differential pressure transmitter shall be factory calibrated with 5-point calibration at a facility that is traceable to the NIST.

B. Provide complete documentation covering the traceability of calibration instruments.

C. FM approval certification or equal when installed in classified areas.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with trades to ensure that the mechanical system has necessary appurtenances including weld-o-lets, valves, etc., for proper installation of instruments.

C. Install sensing lines in accordance with the Contract Documents and the line manufacturer.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.04 ADJUSTING

A. Verify factory calibration of instruments by the manufacturer's instructions:
   1. Return factory-calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.05 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

SECTION 17504

ANALYZERS: GAS MONITORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Combustible and toxic gas monitors.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. LEL: Lower explosive limit is the lowest concentration of vapor in air, which will burn or explode upon contact with a source of ignition.
   2. Multi-channel gas monitor: A multi-channel gas monitor facilitates monitoring of 2 or more sensor modules.
   3. Sensor module: A module formed using the combination of a sensor and a transmitter is called a sensor module.
   4. Single-channel gas monitor: A single-channel gas monitor is used to monitor a single type of gas.
   5. STEL: Short-term exposure limit is the maximum permissible concentration of a material for duration of 15 minutes.
   6. TWA: Time-weighted-average concentration is the average concentration of a chemical to which it is permissible to expose a worker for a period of 8 hours.
   7. Wet stack sensor: A sensor designed for monitoring reactive gas concentrations in moisture saturated air streams.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide complete documentation covering the traceability of calibration instruments.

C. Furnish commissioning Submittals listed below and as specified in this Section and Section 01756 - Commissioning:
   1. Manufacturer’s representative qualifications.
   2. Owner training.

1.05 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

C. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 01850 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the instrument manufacturer’s recommendations or specifications.

1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

1.10 MAINTENANCE

A. Furnish parts, materials, fluids, etc., necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver these supplies before project substantial completion.

B. Furnish the following spare parts:
   1. Duct-mount fitting with calibration gas delivery fitting for each scrubber.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. The following, no equal:
   1. Single-channel gas monitor:
      a. CROWCON TXgard-IS+
   2. Wet stack:
      a. ATI, Series B12 Wet Gas Monitoring System.
      b. Boreal, GasFinder3 Single Channel SDX Gas Monitor.

2.04 MANUFACTURED UNITS

A. As specified in this Section, including Attachment A - ISA Datasheet - Analyzers: Gas Monitors.

B. Single-channel gas monitor:
   1. General:
      a. Monitor a single type of gas and produce an analog output signal which is directly proportional to the gas concentration.
      b. A single-channel gas monitoring system consists of:
         1) Gas sensor module(s) integral or remote to the gas transmitter.
         2) Gas transmitter.
         3) Cable between gas sensor and gas transmitter (for remote applications).
   2. Performance requirements:
      a. Repeatability: Within 1 percent full-scale.
      b. Accuracy: Within- 5 percent of full-scale.
      c. Calibrated range: As indicated in Attachment A - ISA Datasheet - Analyzers: Gas Monitors.
   3. Sensor module:
      a. Gas type: Toxic or Combustible as indicated in Attachment A - ISA Datasheet - Analyzers: Gas Monitors.
      b. Sensor type:
         1) Toxic gases: Electrochemical sensors.
         2) Combustible gases: Infrared or Catalytic bead sensors as indicated in Attachment A - ISA Datasheet - Analyzers: Gas Monitors.
      c. Integral or remote as indicated on the Drawings.
      d. Corrosion resistant.
   4. Transmitter:
      a. Microprocessor-based transmitter.

b. Programming and setup: Non-intrusive.
c. Enclosure rating:
    1) NEMA Type 4X when installed in non-hazardous areas.
    2) Explosion-proof or NEMA 4X with intrinsic safe circuits when installed in Class I Division 2 areas.
    3) Explosion-proof rating when installed in Class I Division 1 areas.
d. For more information, see Attachment A - ISA Datasheet - Analyzers: Gas Monitors.
e. Mounting: As indicated in Attachment A - ISA Datasheet - Analyzers: Gas Monitors.
f. Power requirements: As indicated in Attachment A - ISA Datasheet - Analyzers: Gas Monitors.
g. LCD or LED display.
h. Outputs: As indicated in Attachment A - ISA Datasheet - Analyzers: Gas Monitors.
i. Operating temperature range: As indicated in Attachment A - ISA Datasheet - Analyzers: Gas Monitors.

5. Cable between sensor and transmitter for remote applications: Manufacturer's standard for the intended application.

2.05 ACCESSORIES

A. Provide manufacturer's flow cell and sampling system for applications indicated in Attachment A - ISA Datasheet - Analyzers: Gas Monitors.

B. Calibration equipment:
1. Provide calibration kit including appropriate gas with necessary hardware to calibrate the gas monitoring/indication units for a 2-year period.
2. Furnish carrying case.

C. For outdoor installations, provide sunshield for transmitters/controllers, sensor flow cap and rain shield.

D. Manufacturer's battery backup option for transmitter.

E. Manufacturer's reflector plate heater and required element mounting accessories for open path applications in high humidity environments where condensation is possible.

F. Provide Manufacturer's sunshield for transmitters located outdoors.

2.06 FINISHES (NOT USED)

2.07 SOURCE QUALITY CONTROL

A. Factory-calibrate each instrument with a minimum 3-point calibration or according to Manufacturer's standard at a facility that is traceable to the NIST.
1. Submit calibration datasheets to the Engineer at least 30 days before shipment of the instruments to the project site.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.04 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - ANALYZERS: GAS MONITORS

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Gas Monitor

RESERVOIR

PROJECT INFORMATION

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GENERAL

TAG AIT-6311 (AE-6311)
SPECIFICATION NUMBER 17504
DRAWING NUMBER 63N01
SERVICE CL2 TOXIC GAS
POWER LOCATION RTU-CLIP
MEASURING PRINCIPLE ELECTROCHEMICAL
PLC RTU-CLIP
TYPICAL DETAILS NA001, NA900

GAS

GAS CL2
MEASUREMENT RANGE 0-5 PPM
HUMIDITY [*]
PRESSURE [*]
TEMPERATURE [*]

ELEMENT

ELEMENT TAG NO. AE-6311
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING AMBIENT

TRANSMITTER

TRANSMITTER TAG NO. AIT-6311
ENCLOSURE CLASS NEMA 4X
TRANSMITTER MOUNTING REM
TRANS. POWER 24VDC-1P
SURGE PROTECTION NO
TRANS. SIGNAL OUTPUT AI
TRANS. OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

CONTROLLER

CONTROLLER TAG NO [*]
CONTROLLER ENCL CLASS NEMA 4X
CONTROLLER INPUT TYPE [*]
 # INPUT CHANNELS 1
CONTROLLER OUTPUT 4-20 MA
CONTROLLER POWER 24VDC-1P
HAZARDOUS APPROVALS N/A
RELAY OPTIONS YES
SURGE PROTECTION NO
CONTROLLER MOUNTING WALL

NOTES

[*]

Gas Monitor

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GENERAL

TAG AIT-6312 (AE-6312)
SPECIFICATION NUMBER 17504
DRAWING NUMBER 63N01
SERVICE CL2 TOXIC GAS
POWER LOCATION RTU-CLIP
MEASURING PRINCIPLE ELECTROCHEMICAL
PLC RTU-CLIP
TYPICAL DETAILS NA001, NA900

GAS

GAS CL2
MEASUREMENT RANGE 0-5 PPM
HUMIDITY [*]
PRESSURE [*]
TEMPERATURE [*]

ELEMENT

ELEMENT TAG NO. AE-6312
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING AMBIENT

TRANSMITTER

TRANSMITTER TAG NO. AIT-6312
ENCLOSURE CLASS NEMA 4X
TRANSMITTER MOUNTING REM
TRANS. POWER 24VDC-1P
SURGE PROTECTION NO
TRANS. SIGNAL OUTPUT AI
TRANS. OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

CONTROLLER

CONTROLLER TAG NO [*]
CONTROLLER ENCL CLASS NEMA 4X
CONTROLLER INPUT TYPE [*]
 # INPUT CHANNELS 1
CONTROLLER OUTPUT 4-20 MA
CONTROLLER POWER 24VDC-1P
HAZARDOUS APPROVALS N/A
RELAY OPTIONS YES
SURGE PROTECTION NO
CONTROLLER MOUNTING WALL

NOTES

[*]

PROJECT INFORMATION

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GENERAL

TAG AIT-6313 (AE-6313)
SPECIFICATION NUMBER 17504
DRAWING NUMBER 63N02
SERVICE CL2 TOXIC GAS
POWER LOCATION RTU-CLIP
MEASURING PRINCIPLE ELECTROCHEMICAL
PLC RTU-CLIP
TYPICAL DETAILS NA001, NA900

GAS

GAS CL2
MEASUREMENT RANGE 0-5 PPM
HUMIDITY [*]
PRESSURE [*]
TEMPERATURE [*]

ELEMENT

ELEMENT TAG NO. AE-6313
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING AMBIENT

TRANSMITTER

TRANSMITTER TAG NO. AIT-6313
ENCLOSURE CLASS NEMA 4X
TRANSMITTER MOUNTING REM
TRANS. POWER 24VDC-1P
SURGE PROTECTION NO
TRANS. SIGNAL OUTPUT AI
TRANS. OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

CONTROLLER

CONTROLLER TAG NO [*]
CONTROLLER ENCL CLASS NEMA 4X
CONTROLLER INPUT TYPE [*]
 # INPUT CHANNELS 1
CONTROLLER OUTPUT 4-20 MA
CONTROLLER POWER 24VDC-1P
HAZARDOUS APPROVALS N/A
RELAY OPTIONS YES
SURGE PROTECTION NO
CONTROLLER MOUNTING WALL

NOTES

[*]

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG AIT-6314 (AE-6314)
SPECIFICATION NUMBER 17504
DRAWING NUMBER 63N02
SERVICE CL2 TOXIC GAS
POWER LOCATION RTU-CLIP
MEASURING PRINCIPLE ELECTROCHEMICAL
PLC RTU-CLIP
TYPICAL DETAILS NA001, NA900

GAS

GAS CL2
MEASUREMENT RANGE 0-5 PPM
HUMIDITY [*]
PRESSURE [*]
TEMPERATURE [*]

ELEMENT

ELEMENT TAG NO. AE-6314
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING AMBIENT

TRANSMITTER

TRANSMITTER TAG NO. AIT-6314
ENCLOSURE CLASS NEMA 4X
TRANSMITTER MOUNTING REM
TRANS. POWER 24VDC-1P
SURGE PROTECTION NO
TRANS. SIGNAL OUTPUT AI
TRANS. OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

CONTROLLER

CONTROLLER TAG NO [*]
CONTROLLER ENCL CLASS NEMA 4X
CONTROLLER INPUT TYPE [*]
 # INPUT CHANNELS 1
CONTROLLER OUTPUT 4-20 MA
CONTROLLER POWER 24VDC-1P
HAZARDOUS APPROVALS N/A
RELAY OPTIONS YES
SURGE PROTECTION NO
CONTROLLER MOUNTING WALL

NOTES

[*]

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PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
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CUSTOMER JORDAN VALLEY WATER
LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG AIT-6315 (AE-6315)
SPECIFICATION NUMBER 17504
DRAWING NUMBER 63N04
SERVICE CL2 TOXIC GAS
POWER LOCATION RTU-CLIP
MEASURING PRINCIPLE ELECTROCHEMICAL
PLC RTU-CLIP
TYPICAL DETAILS NA001, NA900

GAS

GAS CL2
MEASUREMENT RANGE 0-5 PPM
HUMIDITY [*]
PRESSURE [*]
TEMPERATURE [*]

ELEMENT

ELEMENT TAG NO. AE-6315
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING AMBIENT

TRANSMITTER

TRANSMITTER TAG NO. AIT-6315
ENCLOSURE CLASS NEMA 4X
TRANSMITTER MOUNTING REM
TRANS. POWER 24VDC-1P
SURGE PROTECTION NO
TRANS. SIGNAL OUTPUT AI
TRANS. OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

CONTROLLER

CONTROLLER TAG NO [*]
CONTROLLER ENCL CLASS NEMA 4X
CONTROLLER INPUT TYPE [*]
 # INPUT CHANNELS 1
CONTROLLER OUTPUT 4-20 MA
CONTROLLER POWER 24VDC-1P
HAZARDOUS APPROVALS N/A
RELAY OPTIONS YES
SURGE PROTECTION NO
CONTROLLER MOUNTING WALL

NOTES

[*]

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PROJECT INFORMATION

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GENERAL

TAG AIT-6316 (AE-6316)
SPECIFICATION NUMBER 17504
DRAWING NUMBER 63N04
SERVICE CL2 TOXIC GAS
POWER LOCATION RTU-CLIP
MEASURING PRINCIPLE ELECTROCHEMICAL
PLC RTU-CLIP
TYPICAL DETAILS NA001, NA900

GAS

GAS CL2
MEASUREMENT RANGE 0-5 PPM
HUMIDITY [*]
PRESSURE [*]
TEMPERATURE [*]

ELEMENT

ELEMENT TAG NO. AE-6316
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING AMBIENT

TRANSMITTER

TRANSMITTER TAG NO. AIT-6316
ENCLOSURE CLASS NEMA 4X
TRANSMITTER MOUNTING REM
TRANS. POWER 24VDC-1P
SURGE PROTECTION NO
TRANS. SIGNAL OUTPUT AI
TRANS. OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

CONTROLLER

CONTROLLER TAG NO [*]
CONTROLLER ENCL CLASS NEMA 4X
CONTROLLER INPUT TYPE [*]
 # INPUT CHANNELS 1
CONTROLLER OUTPUT 4-20 MA
CONTROLLER POWER 24VDC-1P
HAZARDOUS APPROVALS N/A
RELAY OPTIONS YES
SURGE PROTECTION NO
CONTROLLER MOUNTING WALL

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[*]

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GENERAL

TAG AIT-6317 (AE-6317)
SPECIFICATION NUMBER 17504
DRAWING NUMBER 63N05
SERVICE CL2 TOXIC GAS
POWER LOCATION RTU-CLIP
MEASURING PRINCIPLE ELECTROCHEMICAL
PLC RTU-CLIP
TYPICAL DETAILS NA001, NA900

GAS

GAS CL2
MEASUREMENT RANGE 0-5 PPM
HUMIDITY [*]
PRESSURE [*]
TEMPERATURE [*]

ELEMENT

ELEMENT TAG NO. AE-6317
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING AMBIENT

TRANSMITTER

TRANSMITTER TAG NO. AIT-6317
ENCLOSURE CLASS NEMA 4X
TRANSMITTER MOUNTING REM
TRANS. POWER 24VDC-1P
SURGE PROTECTION NO
TRANS. SIGNAL OUTPUT AI
TRANS. OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

CONTROLLER

CONTROLLER TAG NO [*]
CONTROLLER ENCL CLASS NEMA 4X
CONTROLLER INPUT TYPE [*]
 # INPUT CHANNELS 1
CONTROLLER OUTPUT 4-20 MA
CONTROLLER POWER 24VDC-1P
HAZARDOUS APPROVALS N/A
RELAY OPTIONS YES
SURGE PROTECTION NO
CONTROLLER MOUNTING WALL

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GENERAL

TAG AIT-6318 (AE-6318)
SPECIFICATION NUMBER 17504
DRAWING NUMBER 63N05
SERVICE CL2 TOXIC GAS
POWER LOCATION RTU-CLIP
MEASURING PRINCIPLE ELECTROCHEMICAL
PLC RTU-CLIP
TYPICAL DETAILS NA001, NA900

GAS

GAS CL2
MEASUREMENT RANGE 0-5 PPM
HUMIDITY [*]
PRESSURE [*]
TEMPERATURE [*]

ELEMENT

ELEMENT TAG NO. AE-6318
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING AMBIENT

TRANSMITTER

TRANSMITTER TAG NO. AIT-6318
ENCLOSURE CLASS NEMA 4X
TRANSMITTER MOUNTING REM
TRANS. POWER 24VDC-1P
SURGE PROTECTION NO
TRANS. SIGNAL OUTPUT AI
TRANS. OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

CONTROLLER

CONTROLLER TAG NO [*]
CONTROLLER ENCL CLASS NEMA 4X
CONTROLLER INPUT TYPE [*]
 # INPUT CHANNELS 1
CONTROLLER OUTPUT 4-20 MA
CONTROLLER POWER 24VDC-1P
HAZARDOUS APPROVALS N/A
RELAY OPTIONS YES
SURGE PROTECTION NO
CONTROLLER MOUNTING WALL

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[*]

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GENERAL

TAG AIT-6321 (AE-6321)
SPECIFICATION NUMBER 17504
DRAWING NUMBER 63N06
SERVICE CL2 TOXIC GAS
POWER LOCATION RTU-CLIP
MEASURING PRINCIPLE ELECTROCHEMICAL
PLC RTU-CLIP
TYPICAL DETAILS NA001, NA900

GAS

GAS CL2
MEASUREMENT RANGE 0-5 PPM
HUMIDITY [*]
PRESSURE [*]
TEMPERATURE [*]

ELEMENT

ELEMENT TAG NO. AE-6321
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING AMBIENT

TRANSMITTER

TRANSMITTER TAG NO. AIT-6321
ENCLOSURE CLASS NEMA 4X
TRANSMITTER MOUNTING REM
TRANS. POWER 24VDC-1P
SURGE PROTECTION NO
TRANS. SIGNAL OUTPUT AI
TRANS. OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

CONTROLLER

CONTROLLER TAG NO [*]
CONTROLLER ENCL CLASS NEMA 4X
CONTROLLER INPUT TYPE [*]
 # INPUT CHANNELS 1
CONTROLLER OUTPUT 4-20 MA
CONTROLLER POWER 24VDC-1P
HAZARDOUS APPROVALS N/A
RELAY OPTIONS YES
SURGE PROTECTION NO
CONTROLLER MOUNTING WALL

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[*]

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GENERAL

TAG AIT-6322 (AE-6322)
SPECIFICATION NUMBER 17504
DRAWING NUMBER 63N06
SERVICE CL2 TOXIC GAS
POWER LOCATION RTU-CLIP
MEASURING PRINCIPLE ELECTROCHEMICAL
PLC RTU-CLIP
TYPICAL DETAILS NA001, NA900

GAS

GAS CL2
MEASUREMENT RANGE 0-5 PPM
HUMIDITY [*]
PRESSURE [*]
TEMPERATURE [*]

ELEMENT

ELEMENT TAG NO. AE-6322
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING AMBIENT

TRANSMITTER

TRANSMITTER TAG NO. AIT-6322
ENCLOSURE CLASS NEMA 4X
TRANSMITTER MOUNTING REM
TRANS. POWER 24VDC-1P
SURGE PROTECTION NO
TRANS. SIGNAL OUTPUT AI
TRANS. OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

CONTROLLER

CONTROLLER TAG NO [*]
CONTROLLER ENCL CLASS NEMA 4X
CONTROLLER INPUT TYPE [*]
 # INPUT CHANNELS 1
CONTROLLER OUTPUT 4-20 MA
CONTROLLER POWER 24VDC-1P
HAZARDOUS APPROVALS N/A
RELAY OPTIONS YES
SURGE PROTECTION NO
CONTROLLER MOUNTING WALL

NOTES

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PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
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GENERAL

TAG AIT-6323 (AE-6323)
SPECIFICATION NUMBER 17504
DRAWING NUMBER 63N06
SERVICE CO CARBON MONOXIDE
POWER LOCATION RTU-CLIP
MEASURING PRINCIPLE ELECTROCHEMICAL
PLC RTU-CLIP
TYPICAL DETAILS NA001, NA900

GAS

GAS CO
MEASUREMENT RANGE 0-50 PPM
HUMIDITY [*]
PRESSURE [*]
TEMPERATURE [*]

ELEMENT

ELEMENT TAG NO. AE-6323
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING AMBIENT

TRANSMITTER

TRANSMITTER TAG NO. AIT-6323
ENCLOSURE CLASS NEMA 4X
TRANSMITTER MOUNTING REM
TRANS. POWER 24VDC-1P
SURGE PROTECTION NO
TRANS. SIGNAL OUTPUT AI
TRANS. OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

CONTROLLER

CONTROLLER TAG NO [*]
CONTROLLER ENCL CLASS NEMA 4X
CONTROLLER INPUT TYPE [*]
 # INPUT CHANNELS 1
CONTROLLER OUTPUT 4-20 MA
CONTROLLER POWER 24VDC-1P
HAZARDOUS APPROVALS N/A
RELAY OPTIONS YES
SURGE PROTECTION NO
CONTROLLER MOUNTING WALL

NOTES

[*]

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GENERAL

TAG AIT-6324 (AE-6324)
SPECIFICATION NUMBER 17504
DRAWING NUMBER 63N06
SERVICE CO CARBON MONOXIDE
POWER LOCATION RTU-CLIP
MEASURING PRINCIPLE ELECTROCHEMICAL
PLC RTU-CLIP
TYPICAL DETAILS NA001, NA900

GAS

GAS CO
MEASUREMENT RANGE 0-50 PPM
HUMIDITY [*]
PRESSURE [*]
TEMPERATURE [*]

ELEMENT

ELEMENT TAG NO. AE-6324
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING AMBIENT

TRANSMITTER

TRANSMITTER TAG NO. AIT-6324
ENCLOSURE CLASS NEMA 4X
TRANSMITTER MOUNTING REM
TRANS. POWER 24VDC-1P
SURGE PROTECTION NO
TRANS. SIGNAL OUTPUT AI
TRANS. OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

CONTROLLER

CONTROLLER TAG NO [*]
CONTROLLER ENCL CLASS NEMA 4X
CONTROLLER INPUT TYPE [*]
 # INPUT CHANNELS 1
CONTROLLER OUTPUT 4-20 MA
CONTROLLER POWER 24VDC-1P
HAZARDOUS APPROVALS N/A
RELAY OPTIONS YES
SURGE PROTECTION NO
CONTROLLER MOUNTING WALL

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[*]

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GENERAL

TAG AIT-6331 (AE-6331)
SPECIFICATION NUMBER 17504
DRAWING NUMBER 63N07
SERVICE CL2 TOXIC GAS
POWER LOCATION RTU-CLIP
MEASURING PRINCIPLE ELECTROCHEMICAL
PLC RTU-CLIP
TYPICAL DETAILS NA001, NA900

GAS

GAS CL2
MEASUREMENT RANGE 0-5 PPM
HUMIDITY [*]
PRESSURE [*]
TEMPERATURE [*]

ELEMENT

ELEMENT TAG NO. AE-6331
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING AMBIENT

TRANSMITTER

TRANSMITTER TAG NO. AIT-6331
ENCLOSURE CLASS NEMA 4X
TRANSMITTER MOUNTING REM
TRANS. POWER 24VDC-1P
SURGE PROTECTION NO
TRANS. SIGNAL OUTPUT AI
TRANS. OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

CONTROLLER

CONTROLLER TAG NO [*]
CONTROLLER ENCL CLASS NEMA 4X
CONTROLLER INPUT TYPE [*]
 # INPUT CHANNELS 1
CONTROLLER OUTPUT 4-20 MA
CONTROLLER POWER 24VDC-1P
HAZARDOUS APPROVALS N/A
RELAY OPTIONS YES
SURGE PROTECTION NO
CONTROLLER MOUNTING WALL

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[*]

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PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
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GENERAL

TAG AIT-6342 (AE-6342)
SPECIFICATION NUMBER 17504
DRAWING NUMBER 63N14
SERVICE CL2 TOXIC GAS
POWER LOCATION RTU-CLIP
MEASURING PRINCIPLE ELECTROCHEMICAL
PLC RTU-CLIP
TYPICAL DETAILS NA001, NA900

GAS

GAS CL2
MEASUREMENT RANGE 0-2 PPM
HUMIDITY [*]
PRESSURE [*]
TEMPERATURE [*]

ELEMENT

ELEMENT TAG NO. AE-6342
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING WET STACK

TRANSMITTER

TRANSMITTER TAG NO. AIT-6342
ENCLOSURE CLASS NEMA 4X
TRANSMITTER MOUNTING REM
TRANS. POWER 24VDC-1P
SURGE PROTECTION NO
TRANS. SIGNAL OUTPUT AI
TRANS. OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

CONTROLLER

CONTROLLER TAG NO [*]
CONTROLLER ENCL CLASS NEMA 4X
CONTROLLER INPUT TYPE [*]
 # INPUT CHANNELS 1
CONTROLLER OUTPUT 4-20 MA
CONTROLLER POWER 24VDC-1P
HAZARDOUS APPROVALS N/A
RELAY OPTIONS YES
SURGE PROTECTION NO
CONTROLLER MOUNTING WALL

NOTES

PROVIDE SURGE PROTECTION ON ALL OUTDOOR INSTRUMENTS

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GENERAL

TAG AIT-6391 (AE-6391)
SPECIFICATION NUMBER 17504
DRAWING NUMBER 63N14
SERVICE CL2 TOXIC GAS
POWER LOCATION RTU-CLIP
MEASURING PRINCIPLE ELECTROCHEMICAL
PLC RTU-CLIP
TYPICAL DETAILS NA001, NA900

GAS

GAS CL2
MEASUREMENT RANGE 0-2 PPM
HUMIDITY [*]
PRESSURE [*]
TEMPERATURE [*]

ELEMENT

ELEMENT TAG NO. AE-6391
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING WET STACK

TRANSMITTER

TRANSMITTER TAG NO. AIT-6391
ENCLOSURE CLASS NEMA 4X
TRANSMITTER MOUNTING REM
TRANS. POWER 24VDC-1P
SURGE PROTECTION NO
TRANS. SIGNAL OUTPUT AI
TRANS. OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

CONTROLLER

CONTROLLER TAG NO [*]
CONTROLLER ENCL CLASS NEMA 4X
CONTROLLER INPUT TYPE [*]
 # INPUT CHANNELS 1
CONTROLLER OUTPUT 4-20 MA
CONTROLLER POWER 24VDC-1P
HAZARDOUS APPROVALS N/A
RELAY OPTIONS YES
SURGE PROTECTION NO
CONTROLLER MOUNTING WALL

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PROVIDE SURGE PROTECTION ON ALL OUTDOOR INSTRUMENTS

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GENERAL

TAG AIT-6392 (AE-6392)
SPECIFICATION NUMBER 17504
DRAWING NUMBER 63N14
SERVICE CL2 TOXIC GAS
POWER LOCATION RTU-CLIP
MEASURING PRINCIPLE ELECTROCHEMICAL
PLC RTU-CLIP
TYPICAL DETAILS NA001, NA900

GAS

GAS CL2
MEASUREMENT RANGE 0-2 PPM
HUMIDITY [*]
PRESSURE [*]
TEMPERATURE [*]

ELEMENT

ELEMENT TAG NO. AE-6392
ENCLOSURE CLASS NEMA 4X
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING WET STACK

TRANSMITTER

TRANSMITTER TAG NO. AIT-6392
ENCLOSURE CLASS NEMA 4X
TRANSMITTER MOUNTING REM
TRANS. POWER 24VDC-1P
SURGE PROTECTION NO
TRANS. SIGNAL OUTPUT AI
TRANS. OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

CONTROLLER

CONTROLLER TAG NO [*]
CONTROLLER ENCL CLASS NEMA 4X
CONTROLLER INPUT TYPE [*]
 # INPUT CHANNELS 1
CONTROLLER OUTPUT 4-20 MA
CONTROLLER POWER 24VDC-1P
HAZARDOUS APPROVALS N/A
RELAY OPTIONS YES
SURGE PROTECTION NO
CONTROLLER MOUNTING WALL

NOTES

PROVIDE SURGE PROTECTION ON ALL OUTDOOR INSTRUMENTS

SECTION 17509

ANALYZERS: TURBIDITY

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Turbidity analyzers (turbidimeters).

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Standards:
   1. United States Environmental Protection Agency (USEPA):
      a. Federal Register Vol. 82 No. 143.
         1) 40 CFR Part 141 - National Primary Drinking Water Regulations.
      b. Method 180.1 - Determination of Turbidity by 360-degree Nephelometry.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide complete documentation covering the traceability of calibration instruments.

C. Furnish commissioning Submittals listed below, as specified in this Section, and Section 01756 - Commissioning:
   1. Manufacturer's representative qualifications.
   2. Owner training.

1.04 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

C. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 01850 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

1.09 MAINTENANCE

A. Furnish parts, materials, fluids, etc., necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

B. Sensor probe and transmitter must be from the same manufacturer.

2.03 MANUFACTURERS

A. Probe (The following, no equal):
   1. HACH-TU5400.

B. Transmitter:
   1. As specified in Section 17525 - Process Analyzer Transmitters.

2.04 MANUFACTURED UNITS

A. As specified in this Section, including Attachment A - ISA Datasheet - Analyzers: Turbidity.

B. Low range turbidimeters:
   1. General:
      a. The turbidimeter shall be a microprocessor-based, continuous-reading, online nephelometric instrument utilizing a 4-beam radiometric measurement. Each turbidity system shall consist of a 1 sensor and 1 transmitter.
   2. Performance requirements:
      a. Accuracy:
         1) Within 2 percent of reading or within 0.012 NTU (whichever is greater) over the range of regulation.
      b. Resolution:
         1) 0.0001 NTU.
      c. Repeatability:
         1) Better than 1 percent at 1 NTU.
      d. Response time:
         1) Initial response in 30 seconds.
         2) 9.5 seconds with internal bubble trap.
      e. Sample flow:
         1) Required flow: 30 to 500 mL/min (0.5 to 8 gallons per hour).
         2) Optimal flow: 50 to 80 mL/min.
      f. Storage temperature:
         1) -20 degrees Celsius to 60 degrees Celsius.
      g. Operating temperature:
         1) 0 degrees Celsius to 50 degrees Celsius.
      h. Operating humidity:
         1) 5 to 95 percent non-condensing.
      i. Communication:
         1) Modbus TCP.
   3. Element:
      a. Light sources shall be emitted by a LED source.
      b. The method of measuring turbidity will be nephelometric.
      c. Light will be directed into the sample in the turbidimeter body.
      d. The light scattered at 90 degrees will be sensed by a submerged detector in the measuring chamber.

C. Low range, high precision turbidimeters:
   1. General:
      a. The turbidimeter shall be a microprocessor-based, continuous-reading, on-line nephelometric instrument with predictive diagnostics, meeting design and performance criteria in accordance with acceptable USEPA testing methods for contaminants listed at 40 CFR 141.74(a)(1). Each turbidity system shall consist of a 1 sensor and 1 transmitter.
      b. Optical components shall be mounted in a sealed head assembly that can be removed easily for calibration/service.
      c. The turbidimeter body shall be corrosion-resistant and shall include an internal bubble trap to vent entrained air from the sample stream.

2. Performance requirements:
    a. Range: As indicated in the instrument datasheets.
    b. Accuracy:
        1) Within 2 percent of reading within 0.01 NTU from 0 to 40 NTU based on Formazin primary standard at 25 degrees Celsius.
        2) Within 10 percent of reading from 40 to 1,000 NTU based on Formazin primary standard at 25 degrees Celsius.
    c. Resolution: 0.0001 NTU.
    d. Repeatability: Within 1 percent of reading or 0.002 NTU, whichever is greater based on Formazin primary standard at 25 degrees Celsius.
3. Element:
    a. The low range online laser turbidimeter consists of a Class 1 650 nanometer (EPA) laser light source and 360 degrees by 90 degrees detection system with predictive diagnostics designed to continuously monitor turbidity in a sample stream.
4. Power Supply: 24VDC.
5. Communication:
    1) As indicated in the Instrument data sheets.

2.05 ACCESSORIES

A. Mounting brackets as required or as indicated on the Drawings.

B. Provide sunshades for outdoor installations.

C. Flushing solenoids to clean the probe as recommended by the manufacturer.

2.06 FINISHES (NOT USED)

2.07 SOURCE QUALITY CONTROL

A. Factory calibrate each instrument with a minimum 3-point calibration or according to manufacturer's standard at a facility that is traceable to the NIST.
    1. Submit calibration datasheets to the Engineer at least 30 days before the instruments are shipped to the project site.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with trades to ensure that the mechanical system has necessary appurtenances including weld-o-lets, valves, etc., for proper installation of instruments.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.04 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - ANALYZERS: TURBIDITY

Engineers...Working Wonders With Water®

Analyzer Transmitter

RESERVOIR

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

TAG AIT-3010 (AE-3010)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N03
SERVICE FILTER 1 EFF TURBIDITY
POWER LOCATION RTU-NFL1
MEASURING PRINCIPLE [*]
PLC RTU-NFL1
TYPICAL DETAILS NA030, NA090, NA900

FLUID

FLUID WATER
MEASUREMENT RANGE 0-1 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3010
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION INSERTION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3010
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT MBTCP
OUTPUT MODBUS TCP/IP
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

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GENERAL

TAG AIT-3011 (AE-3011)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N03
SERVICE BW 1 EXPANSION
POWER LOCATION RTU-NFL1
MEASURING PRINCIPLE [*]
PLC RTU-NFL1
TYPICAL DETAILS NA902, NA900, NA900

FLUID

FLUID WATER
MEASUREMENT RANGE 0-50 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3011
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION SUBMERSION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3011
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

Analyzer Transmitter

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
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GENERAL

TAG AIT-3020 (AE-3020)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N04
SERVICE FILTER 2 EFF TURBIDITY
POWER LOCATION RTU-SFL2
MEASURING PRINCIPLE [*]
PLC RTU-SFL2
TYPICAL DETAILS NA030, NA090

FLUID

FLUID WATER
MEASUREMENT RANGE 0-1 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3020
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION INSERTION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3020
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT MBTCP
OUTPUT MODBUS TCP/IP
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

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GENERAL

TAG AIT-3021 (AE-3021)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N04
SERVICE BW 2 EXPANSION
POWER LOCATION RTU-SFL2
MEASURING PRINCIPLE [*]
PLC RTU-SFL2
TYPICAL DETAILS NA902, NA900, NA900

FLUID

FLUID WATER
MEASUREMENT RANGE 0-50 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3021
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION SUBMERSION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3021
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

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GENERAL

TAG AIT-3030 (AE-3030)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N05
SERVICE FILTER 3 EFF TURBIDITY
POWER LOCATION RTU-NFL3
MEASURING PRINCIPLE [*]
PLC RTU-NFL3
TYPICAL DETAILS NA030, NA090

FLUID

FLUID WATER
MEASUREMENT RANGE 0-1 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3030
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION INSERTION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3030
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT MBTCP
OUTPUT MODBUS TCP/IP
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

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GENERAL

TAG AIT-3031 (AE-3031)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N05
SERVICE BW 3 EXPANSION
POWER LOCATION RTU-NFL3
MEASURING PRINCIPLE [*]
PLC RTU-NFL3
TYPICAL DETAILS NA902, NA900, NA900

FLUID

FLUID WATER
MEASUREMENT RANGE 0-50 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3031
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION SUBMERSION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3031
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

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GENERAL

TAG AIT-3040 (AE-3040)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N06
SERVICE FILTER 4 EFF TURBIDITY
POWER LOCATION RTU-SFL4
MEASURING PRINCIPLE [*]
PLC RTU-SFL4
TYPICAL DETAILS NA030, NA090

FLUID

FLUID WATER
MEASUREMENT RANGE 0-1 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3040
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION INSERTION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3040
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT MBTCP
OUTPUT MODBUS TCP/IP
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

Analyzer Transmitter

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GENERAL

TAG AIT-3041 (AE-3041)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N06
SERVICE BW 4 EXPANSION
POWER LOCATION RTU-SFL4
MEASURING PRINCIPLE [*]
PLC RTU-SFL4
TYPICAL DETAILS NA902, NA900, NA900

FLUID

FLUID WATER
MEASUREMENT RANGE 0-50 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3041
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION SUBMERSION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3041
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

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GENERAL

TAG AIT-3050 (AE-3050)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N07
SERVICE FILTER 5 EFF TURBIDITY
POWER LOCATION RTU-NFL5
MEASURING PRINCIPLE [*]
PLC RTU-NFL5
TYPICAL DETAILS NA030, NA090

FLUID

FLUID WATER
MEASUREMENT RANGE 0-1 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3050
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION INSERTION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3050
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT MBTCP
OUTPUT MODBUS TCP/IP
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

Analyzer Transmitter

PROJECT INFORMATION

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GENERAL

TAG AIT-3051 (AE-3051)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N07
SERVICE BW 5 EXPANSION
POWER LOCATION RTU-NFL5
MEASURING PRINCIPLE [*]
PLC RTU-NFL5
TYPICAL DETAILS NA902, NA900, NA900

FLUID

FLUID WATER
MEASUREMENT RANGE 0-50 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3051
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION SUBMERSION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3051
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
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GENERAL

TAG AIT-3060 (AE-3060)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N08
SERVICE FILTER 6 EFF TURBIDITY
POWER LOCATION RTU-SFL6
MEASURING PRINCIPLE [*]
PLC RTU-SFL6
TYPICAL DETAILS NA030, NA090

FLUID

FLUID WATER
MEASUREMENT RANGE 0-1 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3060
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION INSERTION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3060
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT MBTCP
OUTPUT MODBUS TCP/IP
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

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GENERAL

TAG AIT-3061 (AE-3061)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N08
SERVICE BW 6 EXPANSION
POWER LOCATION RTU-SFL6
MEASURING PRINCIPLE [*]
PLC RTU-SFL6
TYPICAL DETAILS NA902, NA900, NA900

FLUID

FLUID WATER
MEASUREMENT RANGE 0-50 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3061
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION SUBMERSION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3061
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG AIT-3070 (AE-3070)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N09
SERVICE FILTER 7 EFF TURBIDITY
POWER LOCATION RTU-NFL7
MEASURING PRINCIPLE [*]
PLC RTU-NFL7
TYPICAL DETAILS NA030, NA090

FLUID

FLUID WATER
MEASUREMENT RANGE 0-1 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3070
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION INSERTION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3070
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT MBTCP
OUTPUT MODBUS TCP/IP
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG AIT-3071 (AE-3071)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N09
SERVICE BW 7 EXPANSION
POWER LOCATION RTU-NFL7
MEASURING PRINCIPLE [*]
PLC RTU-NFL7
TYPICAL DETAILS NA902, NA900, NA900

FLUID

FLUID WATER
MEASUREMENT RANGE 0-50 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3071
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION SUBMERSION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3071
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG AIT-3080 (AE-3080)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N10
SERVICE FILTER 8 EFF TURBIDITY
POWER LOCATION RTU-SFL8
MEASURING PRINCIPLE [*]
PLC RTU-SFL8
TYPICAL DETAILS NA030, NA090

FLUID

FLUID WATER
MEASUREMENT RANGE 0-1 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3080
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION INSERTION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3080
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT MBTCP
OUTPUT MODBUS TCP/IP
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG AIT-3081 (AE-3081)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N10
SERVICE BW 8 EXPANSION
POWER LOCATION RTU-SFL8
MEASURING PRINCIPLE [*]
PLC RTU-SFL8
TYPICAL DETAILS NA902, NA900, NA900

FLUID

FLUID WATER
MEASUREMENT RANGE 0-50 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3081
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION SUBMERSION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3081
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
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GENERAL

TAG AIT-3090 (AE-3090)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N11
SERVICE FILTER 9 EFF TURBIDITY
POWER LOCATION RTU-NFL9
MEASURING PRINCIPLE [*]
PLC RTU-NFL9
TYPICAL DETAILS NA030, NA090

FLUID

FLUID WATER
MEASUREMENT RANGE 0-1 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3090
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION INSERTION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3090
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT MBTCP
OUTPUT MODBUS TCP/IP
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
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GENERAL

TAG AIT-3091 (AE-3091)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N11
SERVICE BW 9 EXPANSION
POWER LOCATION RTU-NFL9
MEASURING PRINCIPLE [*]
PLC RTU-NFL9
TYPICAL DETAILS NA902, NA900, NA900

FLUID

FLUID WATER
MEASUREMENT RANGE 0-50 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3091
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION SUBMERSION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3091
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

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GENERAL

TAG AIT-3100 (AE-3100)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N12
SERVICE FILTER 10 EFF TURBIDITY
POWER LOCATION RTU-SFL10
MEASURING PRINCIPLE [*]
PLC RTU-SFL10
TYPICAL DETAILS NA030, NA090

FLUID

FLUID WATER
MEASUREMENT RANGE 0-1 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3100
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION INSERTION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3100
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT MBTCP
OUTPUT MODBUS TCP/IP
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

Analyzer Transmitter

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
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GENERAL

TAG AIT-3101 (AE-3101)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N12
SERVICE BW 10 EXPANSION
POWER LOCATION RTU-SFL10
MEASURING PRINCIPLE [*]
PLC RTU-SFL10
TYPICAL DETAILS NA902, NA900, NA900

FLUID

FLUID WATER
MEASUREMENT RANGE 0-50 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3101
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION SUBMERSION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3101
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

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GENERAL

TAG AIT-3110 (AE-3110)

SPECIFICATION NUMBER 17509

DRAWING NUMBER 30N13

SERVICE FILTER 11 EFF TURBIDITY

POWER LOCATION RTU-NFL11

MEASURING PRINCIPLE [*]

PLC RTU-NFL11

TYPICAL DETAILS NA030, NA090

FLUID

FLUID WATER

MEASUREMENT RANGE 0-1 NTU

SAMPLE FLOW [*]

SAMPLE pH 7-10

PRESSURE [*]

TEMPERATURE [*]

SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3110

ENCLOSURE CLASS NEMA 4X

CLEANING APPARATUS NO

PROCESS CONNECTION INSERTION

HAZARDOUS APPROVALS N/A

ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3110

ENCLOSURE CLASS NEMA 4X

TRANS. MOUNTING REM

POWER 24VDC-1P

SURGE PROTECTION NO

AIR CLEANING SYSTEM NO

SIGNAL OUTPUT MBTCP

OUTPUT MODBUS TCP/IP

TRANS. HAZ APPROVALS N/A

RELAY OPTIONS YES

AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

Analyzer Transmitter

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
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GENERAL

TAG AIT-3111 (AE-3111)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N13
SERVICE BW 11 EXPANSION
POWER LOCATION RTU-NFL11
MEASURING PRINCIPLE [*]
PLC RTU-NFL11
TYPICAL DETAILS NA902, NA900, NA900

FLUID

FLUID WATER
MEASUREMENT RANGE 0-50 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3111
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION SUBMERSION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3111
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
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GENERAL

TAG AIT-3120 (AE-3120)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N14
SERVICE FILTER 12 EFF TURBIDITY
POWER LOCATION RTU-SFL12
MEASURING PRINCIPLE [*]
PLC RTU-SFL12
TYPICAL DETAILS NA030, NA090

FLUID

FLUID WATER
MEASUREMENT RANGE 0-1 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3120
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION INSERTION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3120
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT MBTCP
OUTPUT MODBUS TCP/IP
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

Analyzer Transmitter

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
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GENERAL

TAG AIT-3121 (AE-3121)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N14
SERVICE BW 12 EXPANSION
POWER LOCATION RTU-SFL12
MEASURING PRINCIPLE [*]
PLC RTU-SFL12
TYPICAL DETAILS NA902, NA900, NA900

FLUID

FLUID WATER
MEASUREMENT RANGE 0-50 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3121
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION SUBMERSION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3121
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
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GENERAL

TAG AIT-3130 (AE-3130)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N15
SERVICE FILTER 13 EFF TURBIDITY
POWER LOCATION RTU-NFL13
MEASURING PRINCIPLE [*]
PLC RTU-NFL13
TYPICAL DETAILS NA030, NA090

FLUID

FLUID WATER
MEASUREMENT RANGE 0-1 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3130
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION INSERTION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3130
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT MBTCP
OUTPUT MODBUS TCP/IP
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
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GENERAL

TAG AIT-3131 (AE-3131)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N15
SERVICE BW 13 EXPANSION
POWER LOCATION RTU-NFL13
MEASURING PRINCIPLE [*]
PLC RTU-NFL13
TYPICAL DETAILS NA902, NA900, NA900

FLUID

FLUID WATER
MEASUREMENT RANGE 0-50 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3131
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION SUBMERSION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3131
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

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GENERAL

TAG AIT-3140 (AE-3140)

SPECIFICATION NUMBER 17509

DRAWING NUMBER 30N16

SERVICE FILTER 14 EFF TURBIDITY

POWER LOCATION RTU-SFL14

MEASURING PRINCIPLE [*]

PLC RTU-SFL14

TYPICAL DETAILS NA030, NA090

FLUID

FLUID WATER

MEASUREMENT RANGE 0-1 NTU

SAMPLE FLOW [*]

SAMPLE pH 7-10

PRESSURE [*]

TEMPERATURE [*]

SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3140

ENCLOSURE CLASS NEMA 4X

CLEANING APPARATUS NO

PROCESS CONNECTION INSERTION

HAZARDOUS APPROVALS N/A

ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3140

ENCLOSURE CLASS NEMA 4X

TRANS. MOUNTING REM

POWER 24VDC-1P

SURGE PROTECTION NO

AIR CLEANING SYSTEM NO

SIGNAL OUTPUT MBTCP

OUTPUT MODBUS TCP/IP

TRANS. HAZ APPROVALS N/A

RELAY OPTIONS YES

AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG AIT-3141 (AE-3141)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N16
SERVICE BW 14 EXPANSION
POWER LOCATION RTU-SFL14
MEASURING PRINCIPLE [*]
PLC RTU-SFL14
TYPICAL DETAILS NA902, NA900, NA900

FLUID

FLUID WATER
MEASUREMENT RANGE 0-50 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3141
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION SUBMERSION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3141
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
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GENERAL

TAG AIT-3150 (AE-3150)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N17
SERVICE FILTER 15 EFF TURBIDITY
POWER LOCATION RTU-NFL15
MEASURING PRINCIPLE [*]
PLC RTU-NFL15
TYPICAL DETAILS NA030, NA090

FLUID

FLUID WATER
MEASUREMENT RANGE 0-1 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3150
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION INSERTION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3150
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT MBTCP
OUTPUT MODBUS TCP/IP
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG AIT-3151 (AE-3151)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N17
SERVICE BW 15 EXPANSION
POWER LOCATION RTU-NFL15
MEASURING PRINCIPLE [*]
PLC RTU-NFL15
TYPICAL DETAILS NA902, NA900, NA900

FLUID

FLUID WATER
MEASUREMENT RANGE 0-50 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3151
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION SUBMERSION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3151
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG AIT-3160 (AE-3160)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N18
SERVICE FILTER 16 EFF TURBIDITY
POWER LOCATION RTU-SFL16
MEASURING PRINCIPLE [*]
PLC RTU-SFL16
TYPICAL DETAILS NA030, NA090

FLUID

FLUID WATER
MEASUREMENT RANGE 0-1 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3160
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION INSERTION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3160
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT MBTCP
OUTPUT MODBUS TCP/IP
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

Analyzer Transmitter

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
PROJECT 202001
CUSTOMER JORDAN VALLEY WATER
LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG AIT-3161 (AE-3161)
SPECIFICATION NUMBER 17509
DRAWING NUMBER 30N18
SERVICE BW 16 EXPANSION
POWER LOCATION RTU-SFL16
MEASURING PRINCIPLE [*]
PLC RTU-SFL16
TYPICAL DETAILS NA902, NA900, NA900

FLUID

FLUID WATER
MEASUREMENT RANGE 0-50 NTU
SAMPLE FLOW [*]
SAMPLE pH 7-10
PRESSURE [*]
TEMPERATURE [*]
SAMPLE TEMPERATURE 40 - 80 DEG F

ELEMENT

ELEMENT TAG NO. AE-3161
ENCLOSURE CLASS NEMA 4X
CLEANING APPARATUS NO
PROCESS CONNECTION SUBMERSION
HAZARDOUS APPROVALS N/A
ELEMENT MOUNTING KIT FLOW ASSEMBLY

TRANSMITTER

TRANSMITTER TAG NO. AIT-3161
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
POWER 24VDC-1P
SURGE PROTECTION NO
AIR CLEANING SYSTEM NO
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
RELAY OPTIONS YES
AMBIENT TEMPERATURE 0-95 DEG F

NOTES

[*]

SECTION 17525

ANALYZERS: PROCESS ANALYZER TRANSMITTERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Transmitters for analytical equipment.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Standards:
   1. CSA International (CSA).

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide complete documentation covering the traceability of calibration instruments.

C. Quality Control Submittals:
   1. Manufacturer's representative qualifications as specified in Section 01756 - Commissioning.

D. Owner Training Submittals:
   1. As specified in Section 01756 - Commissioning.

1.04 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions, including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

C. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

1.09 MAINTENANCE

A. Furnish parts, materials, fluids, etc., necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver these supplies before Project Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Manufacturer of transmitter shall match the manufacturer of its associated probe.

B. Provide instruments suitable for the installed Site conditions, including, but not limited to, material compatibility, Site altitude, Site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. ABB, AX460.
   2. Endress+Hauser, Liquiline or CM44x.
   3. GLI, PRO Series.
   4. Hach, SC4500.

2.04 MANUFACTURED UNITS

A. As specified in this Section, including Attachment A - ISA Datasheet - Analyzers: Process Analyzer Transmitters.

B. Process analyzer transmitter:
    1. General:
        a. pH measurement shall use the potentiometric measurement method utilizing a glass electrode. pH sensitive glass membrane surface reacts to the acid content of the solution with a specific voltage, which is measured relative to a reference electrode.
    2. Performance requirements:
        a. Temperature range:
            1) As indicated in the datasheets.
        b. Pollution degree: 4.
    3. Transmitter:
        a. Power supply:
            1) As indicated in the datasheets.
        b. Connections:
            1) Electrical:
                a) 1/2-in NPT.
        c. Outputs:
                a) Minimum 2 isolated channels.
                b) As indicated in the datasheets.
            2) Communications:
                a) As indicated in the datasheets.
            3) Relay outputs:
                a) 2 Form C contact.
                b) Rated minimum 3 amps at 120 VAC.
        d. Display:
            1) Backlit LCD digital display.
        e. Measurement ranges:
            1) As indicated in the datasheets.
        f. Ambient conditions:
            1) Operable from 0 to 45 degrees Celsius.
            2) Relative humidity 0 to 95 percent.
        g. Enclosure rating:
            1) NEMA Type 4X (IP65).
        h. Mounting:
            1) As indicated in the datasheets.
            2) Provide mounting hardware for proper installation and servicing of the sensor assembly.
        i. Electrical certification: NRTL certified to UL and CSA standards, and CE approved.

2.05 ACCESSORIES

A. Transmitter:
    1. Stainless steel tag:
        a. Marking specified in the instrument datasheets.

B. Provide sunshades for outdoor applications.

2.06 FINISHES (NOT USED)

2.07 SOURCE QUALITY CONTROL

A. Factory calibrate each instrument with a minimum 3-point calibration or according to the manufacturer's standard at a facility that is traceable to the NIST:
   1. Submit calibration datasheets to the Engineer at least 30 days before shipment of the instruments to the Project Site.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.03 CALIBRATION AND TESTING

A. As specified in Section 17950 - Commissioning for Instrumentation and Controls.

3.04 OWNER TRAINING

3.05 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - ANALYZERS: PROCESS ANALYZER TRANSMITTERS

A/E:	Carollo Engineers	ANALYZERS: PROCESS ANALYZER TRANSMITTERS					
						Spec. No.	Rev.
Contractor:		No	By	Date	Revision	17525	
Project:						Contract	Date
Customer:							
Plant:						Req.	P.O.
Location:							
BOM No.:						By	Chk App
File:							

GEN	1	Tag No. Element Transmitter	AE/AIT-	
	2	Service		
	3	P&ID		
ELEMENT	4	Type		
	5	Body Style		
	6	Enclosure		
	7	Electrodes		
	8	Ambient Conditions		
	9	Connection		
	10	Sample Flow Required		
	11	pH Measuring Range		
	12	Temperature Measuring Range		
	13	Manufacturer		
	14	Model No.		
	15	Length		
	16	Other	Built in Temperature Sensor	
CABLE	17	Style	N/A	
	18	Length		
	19	Model No.		
	20	Pre-Amplifier		
	21	Other		
TRANSMITTER	22	Type	Control Unit and Display	
	23	Enclosure		
	24	Mounting		
	26	Power Requirements	115 VAC, 60 Hz	
	27	Resolution		
	28	Accuracy		
	29	Calibrated Range		
	31	Outputs	4-20 mA	
	32	Contacts		
	33	Manufacturer		
	34	Model No.		
	35	Display		
	36	Other		
	37	Other		
	38	Other		
OPTS	39	Cleaning		
	40	Low Flow Cell		
	41	Process Assembly		
	42	Other		

Notes:

SECTION 17604

TEMPERATURE MEASUREMENT: RTD

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. RTD temperature instruments.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Abbreviations:
   1. RTD - Resistance temperature detector.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide complete documentation covering the traceability of calibration instruments.

1.04 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions, including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that required accessories are provided and are compatible with the process conditions and physical installation.

C. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

1.09 MAINTENANCE

A. Furnish parts, materials, fluids, etc., necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver these supplies before Project Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide instruments identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed Site conditions, including, but not limited to, material compatibility, Site altitude, Site seismic conditions, humidity, and process and ambient temperatures.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. Process measurement:
      a. Emerson, Rosemount 3144P transmitter with Series 214C sensor.
      b. Endress + Hauser TMT.
      c. Digital Room Temperature AI.
      d. HVAC Devar Inc. d-RTTI.

2.04 MANUFACTURED UNITS

A. Process measurement:
   1. General:
      a. Temperature measuring instrument shall include an RTD temperature element, transmitter, and thermowell.
   2. Performance requirements:
      a. Accuracy:
         1) Within 0.25 percent of calibrated span.

b. Repeatability:
    1) 0.25 percent of full scale.
c. Sensor lead wire compensation: Maximum zero shift of 0.2 percent of the temperature range.

3. Element:
    a. 100-Ohm platinum thin film resistance temperature detector (RTD).
    b. 3-wire.
    c. Hermetically-sealed and enclosed in Type 316 stainless steel outer sheath.
    d. Single element temperature sensor shall be bayonet spring-loaded DIN terminal block.
4. Transmitter:
    a. Microprocessor based.
    b. Compatible with 3-wire and 4-wire RTD inputs.
    c. Local display:
        1) 5-digit LCD.
        2) Scaled in engineering units.
    d. Power supply:
        1) As indicated in the datasheets.
        2) 24 VDC, loop powered.
    e. Outputs:
        1) As indicated in the datasheets.
        2) Isolated 4 to 20 mA DC with HART communication protocol.
        3) 4 to 20 mA VDC HART or digital bus protocol, provide a device type manager (DTM) certification by FDT group.
    f. Transmitter enclosure:
        1) As indicated in the datasheets.
        2) Non-hazardous area:
            a) NEMA 4X.
    g. Transmitter mounting:
        1) As indicated in the datasheets.
        2) Provide necessary hardware for transmitter mounting.

B. Process room:
1. General:
    a. Wall-mounted temperature measuring instrument shall include a transmitter and integral RTD temperature element.
2. Performance requirements:
    a. Transmitter enclosure:
        1) As indicated in the datasheets.
    b. Temperature range:
        1) -40 to 60 degrees Celsius.
    c. Accuracy:
        1) Within 1 degree Celsius.
    d. Element:
        1) As indicated in the datasheets.
        2) Platinum RTD.
    e. Power supply:
        1) As indicated in the datasheets.
    f. Outputs:
        1) As indicated in the datasheets.
        2) Isolated 4 to 20 mA DC with HART communication protocol.

3) 4 to 20 mA VDC HART or digital bus protocol, provide a device type manager (DTM) certification by FDT group.

C. Electrical/Admin room:
   1. General:
      a. Wall-mounted temperature measuring instrument shall include a transmitter and integral RTD temperature element.
   2. Performance requirements:
      a. Transmitter enclosure:
         1) As indicated in the datasheets.
      b. Temperature range:
         1) As indicated in the datasheets.
         2) 0 to 50 degrees Celsius.
      c. Accuracy:
         1) Within 1 degree Celsius.
      d. Element:
         1) Platinum RTD.
      e. Power supply:
         1) 24 VDC, loop powered.
      f. Output:
         1) As indicated in the datasheets.
         2) 4 to 20 mA.

2.05 ACCESSORIES

A. Thermowell:
   1. Unless otherwise noted, provide a thermowell with each RTD.
   2. Process connection: As identified in Attachment A - ISA Datasheet - Temperature Measurement: RTD.
   3. Material: Type 316L stainless steel
   4.
   5. Stem style: As identified in Attachment A - ISA Datasheet - Temperature Measurement: RTD.
   6. Immersion depth:
      a. Minimum 3 inches or 10 times the diameter of the thermowell, whichever is larger.
      b. Where pipe diameter is inadequate for appropriate immersion depth, install thermowell in an elbow on the axis of the pipe.
      c. As identified in Attachment A - ISA Datasheet - Temperature Measurement: RTD.

B. Provide sunshades for outdoor installations.

C. Provide the manufacturer’s mounting hardware and mounting bracket.

2.06 FINISHES (NOT USED)

2.07 SOURCE QUALITY CONTROL

A. Factory calibrate each instrument with a minimum 3-point calibration or according to the manufacturer's standard at a facility that is traceable to the NIST:
   1. Submit calibration datasheets to the Engineer at least 30 days before shipment of the instruments to the Project Site.

B. FM approval certification or equal when installed in classified areas.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with trades to ensure that the mechanical system has necessary appurtenances, including weld-o-lets, valves, etc., for proper installation of instruments.

C. Apply thermally conductive silicone grease to the sensor tip before insertion in thermowell.

D. Unless otherwise noted, install RTD instruments located in process, electrical, and admin rooms 5 feet above finished floor.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.04 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - TEMPERATURE MEASUREMENT: RTD

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Resistance Temperature Device

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG TIT-6357 (TE-6357)

SPECIFICATION NUMBER 17604

MEASURING PRINCIPLE RESISTANCE TEMPERATURE DETECTOR

DRAWING NUMBER 63N16

PLC RTU-CL

SERVICE CL STORAGE ROOM TEMP

TYPICAL DETAILS [*]

CONNECTION

PROCESS CONNECTION N/A

MOUNTING SURFACE

FLUID

FLUID AMBIENT AIR

TEMPERATURE RANGE 40-95

PROCESS TEMPERATURE 40-95 DEG F

AMBIENT TEMPERATURE 40-95 DEG F

ELEMENT

ELEMENT TAG NO. TE-6357

NUMBER OF LEAD WIRES 3-WIRE

ELEMENT TYPE SINGLE ELEMENT

ELEM. TERMINATION STYLE DIN TERMINAL BLOCK

SHEATH MATERIAL 316 SST

THERMOWELL

STEM STYLE MFR. STD.

RTD MOUNTING 1/2" THREADED

THERMOWELL MATERIAL 316L SST

INSERTION LENGTH [*]

TRANSMITTER

TRANSMITTER TAG NO. TIT-6357

AMBIENT TEMPERATURE 0-95 DEG F

ENCLOSURE CLASS NEMA 4X

SIGNAL OUTPUT AI

TRANS. MOUNTING INT

OUTPUT 4-20 MA

HAZARDOUS APPROVALS N/A

RELAY OPTIONS NO

SURGE PROTECTION NO

NOTES

PROVIDE WALL MOUNT BRACKET FOR TRANSMITTER AND HVAC SENSOR

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PROJECT INFORMATION

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CUSTOMER JORDAN VALLEY WATER

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GENERAL

TAG TIT-6358 (TE-6358)

SPECIFICATION NUMBER 17604

MEASURING PRINCIPLE RESISTANCE TEMPERATURE DETECTOR

DRAWING NUMBER 63N16

PLC RTU-CL

SERVICE TRUCK BAY ROOM TEMP

TYPICAL DETAILS [*]

CONNECTION

PROCESS CONNECTION N/A

MOUNTING SURFACE

FLUID

FLUID AMBIENT AIR

TEMPERATURE RANGE 40-95

PROCESS TEMPERATURE 40-95 DEG F

AMBIENT TEMPERATURE 40-95 DEG F

ELEMENT

ELEMENT TAG NO. TE-6358

NUMBER OF LEAD WIRES 3-WIRE

ELEMENT TYPE SINGLE ELEMENT

ELEM. TERMINATION STYLE DIN TERMINAL BLOCK

SHEATH MATERIAL 316 SST

THERMOWELL

STEM STYLE MFR. STD.

RTD MOUNTING 1/2" THREADED

THERMOWELL MATERIAL 316L SST

INSERTION LENGTH [*]

TRANSMITTER

TRANSMITTER TAG NO. TIT-6358

AMBIENT TEMPERATURE 0-95 DEG F

ENCLOSURE CLASS NEMA 4X

SIGNAL OUTPUT AI

TRANS. MOUNTING INT

OUTPUT 4-20 MA

HAZARDOUS APPROVALS N/A

RELAY OPTIONS NO

SURGE PROTECTION NO

NOTES

PROVIDE WALL MOUNT BRACKET FOR TRANSMITTER AND HVAC SENSOR

Resistance Temperature Device

PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)
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GENERAL

TAG TIT-6359 (TE-6359)
SPECIFICATION NUMBER 17604
DRAWING NUMBER 63N15
SERVICE ELECTRICAL ROOM TEMP
MEASURING PRINCIPLE RESISTANCE TEMPERATURE DETECTOR
PLC RTU-CL
TYPICAL DETAILS [*]

CONNECTION

PROCESS CONNECTION N/A
MOUNTING SURFACE

FLUID

FLUID AMBIENT AIR
PROCESS TEMPERATURE 40-90 DEG F
TEMPERATURE RANGE 40-90
AMBIENT TEMPERATURE 40-90 DEG F

ELEMENT

ELEMENT TAG NO. TE-6359
ELEMENT TYPE SINGLE ELEMENT
SHEATH MATERIAL 316 SST
NUMBER OF LEAD WIRES 3-WIRE
ELEM. TERMINATION STYLE DIN TERMINAL BLOCK

THERMOWELL

STEM STYLE MFR. STD.
THERMOWELL MATERIAL 316L SST
RTD MOUNTING 1/2" THREADED
INSERTION LENGTH [*]

TRANSMITTER

TRANSMITTER TAG NO. TIT-6359
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING INT
HAZARDOUS APPROVALS N/A
SURGE PROTECTION NO
AMBIENT TEMPERATURE 0-95 DEG F
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
RELAY OPTIONS NO

NOTES

PROVIDE WALL MOUNT BRACKET FOR TRANSMITTER AND HVAC SENSOR

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GENERAL

TAG TIT-6360 (TE-6360)

SPECIFICATION NUMBER 17604

MEASURING PRINCIPLE RESISTANCE TEMPERATURE DETECTOR

DRAWING NUMBER 63N17

PLC RTU-CL

SERVICE CL2 FEED ROOM TEMP

TYPICAL DETAILS [*]

CONNECTION

PROCESS CONNECTION N/A

MOUNTING SURFACE

FLUID

FLUID AMBIENT AIR

TEMPERATURE RANGE 40-90

PROCESS TEMPERATURE 40-90 DEG F

AMBIENT TEMPERATURE 40-90 DEG F

ELEMENT

ELEMENT TAG NO. TE-6360

NUMBER OF LEAD WIRES 3-WIRE

ELEMENT TYPE SINGLE ELEMENT

ELEM. TERMINATION STYLE DIN TERMINAL BLOCK

SHEATH MATERIAL 316 SST

THERMOWELL

STEM STYLE MFR. STD.

RTD MOUNTING 1/2" THREADED

THERMOWELL MATERIAL 316L SST

INSERTION LENGTH [*]

TRANSMITTER

TRANSMITTER TAG NO. TIT-6360

AMBIENT TEMPERATURE 0-95 DEG F

ENCLOSURE CLASS NEMA 4X

SIGNAL OUTPUT AI

TRANS. MOUNTING INT

OUTPUT 4-20 MA

HAZARDOUS APPROVALS N/A

RELAY OPTIONS NO

SURGE PROTECTION NO

NOTES

PROVIDE WALL MOUNT BRACKET FOR TRANSMITTER AND HVAC SENSOR

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PROJECT INFORMATION

PLANT JORDAN VALLEY WATER TREATMENT PLANT (JVWTP)

PROJECT 202001

CUSTOMER JORDAN VALLEY WATER

LOCATION 15305 S 3200 W, HERRIMAN 3200 W, HERRIMAN, UT 84065.

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GENERAL

TAG TIT-6557 (TE-6557)

SPECIFICATION NUMBER 17604

MEASURING PRINCIPLE RESISTANCE TEMPERATURE DETECTOR

DRAWING NUMBER 65N07

PLC RTU-CL

SERVICE CS ROOM TEMP

TYPICAL DETAILS [*]

CONNECTION

PROCESS CONNECTION N/A

MOUNTING SURFACE

FLUID

FLUID AMBIENT AIR

TEMPERATURE RANGE 40-90

PROCESS TEMPERATURE 40-90 DEG F

AMBIENT TEMPERATURE 40-90 DEG F

ELEMENT

ELEMENT TAG NO. TE-6557

NUMBER OF LEAD WIRES 3-WIRE

ELEMENT TYPE SINGLE ELEMENT

ELEM. TERMINATION STYLE DIN TERMINAL BLOCK

SHEATH MATERIAL 316 SST

THERMOWELL

STEM STYLE MFR. STD.

RTD MOUNTING 1/2" THREADED

THERMOWELL MATERIAL 316L SST

INSERTION LENGTH [*]

TRANSMITTER

TRANSMITTER TAG NO. TIT-6557

AMBIENT TEMPERATURE 0-95 DEG F

ENCLOSURE CLASS NEMA 4X

SIGNAL OUTPUT AI

TRANS. MOUNTING INT

OUTPUT 4-20 MA

HAZARDOUS APPROVALS N/A

RELAY OPTIONS NO

SURGE PROTECTION NO

NOTES

PROVIDE WALL MOUNT BRACKET FOR TRANSMITTER AND HVAC SENSOR

Resistance Temperature Device

PROJECT INFORMATION

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GENERAL

TAG TIT-6559 (TE-6559)
SPECIFICATION NUMBER 17604
DRAWING NUMBER 65N06
SERVICE CS ELECTRICAL ROOM TEMP TRANSMITTER
MEASURING PRINCIPLE RESISTANCE TEMPERATURE DETECTOR
PLC RTU-CS
TYPICAL DETAILS [*]

CONNECTION

PROCESS CONNECTION N/A
MOUNTING SURFACE

FLUID

FLUID AMBIENT AIR
PROCESS TEMPERATURE 40-90 DEG F
TEMPERATURE RANGE 40-90
AMBIENT TEMPERATURE 40-90 DEG F

ELEMENT

ELEMENT TAG NO. TE-6559
ELEMENT TYPE SINGLE ELEMENT
SHEATH MATERIAL 316 SST
NUMBER OF LEAD WIRES 3-WIRE
ELEM. TERMINATION STYLE DIN TERMINAL BLOCK

THERMOWELL

STEM STYLE MFR. STD.
THERMOWELL MATERIAL 316L SST
RTD MOUNTING 1/2" THREADED
INSERTION LENGTH [*]

TRANSMITTER

TRANSMITTER TAG NO. TIT-6559
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING INT
HAZARDOUS APPROVALS N/A
SURGE PROTECTION NO
AMBIENT TEMPERATURE 0-95 DEG F
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
RELAY OPTIONS NO

NOTES

PROVIDE WALL MOUNT BRACKET FOR TRANSMITTER AND HVAC SENSOR

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Resistance Temperature Device

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GENERAL

TAG TIT-6568 (TE-6568)

SPECIFICATION NUMBER 17604

MEASURING PRINCIPLE RESISTANCE TEMPERATURE DETECTOR

DRAWING NUMBER 65N07

PLC RTU-CL

SERVICE CS ROOM TEMP

TYPICAL DETAILS [*]

CONNECTION

PROCESS CONNECTION N/A

MOUNTING SURFACE

FLUID

FLUID AMBIENT AIR

TEMPERATURE RANGE 40-90

PROCESS TEMPERATURE 40-90 DEG F

AMBIENT TEMPERATURE 40-90 DEG F

ELEMENT

ELEMENT TAG NO. TE-6568

NUMBER OF LEAD WIRES 3-WIRE

ELEMENT TYPE SINGLE ELEMENT

ELEM. TERMINATION STYLE DIN TERMINAL BLOCK

SHEATH MATERIAL 316 SST

THERMOWELL

STEM STYLE MFR. STD.

RTD MOUNTING 1/2" THREADED

THERMOWELL MATERIAL 316L SST

INSERTION LENGTH [*]

TRANSMITTER

TRANSMITTER TAG NO. TIT-6568

AMBIENT TEMPERATURE 0-95 DEG F

ENCLOSURE CLASS NEMA 4X

SIGNAL OUTPUT AI

TRANS. MOUNTING INT

OUTPUT 4-20 MA

HAZARDOUS APPROVALS N/A

RELAY OPTIONS NO

SURGE PROTECTION NO

NOTES

PROVIDE WALL MOUNT BRACKET FOR TRANSMITTER AND HVAC SENSOR

Resistance Temperature Device

PROJECT INFORMATION

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GENERAL

TAG TIT-6585 (TE-6585)
SPECIFICATION NUMBER 17604
MEASURING PRINCIPLE RESISTANCE TEMPERATURE DETECTOR
DRAWING NUMBER 65N04
PLC RTU-CS
SERVICE CAUSTIC FEED PROCESS
TYPICAL DETAILS NT001, NT002

CONNECTION

PROCESS CONNECTION 1/2" THREADED
MOUNTING IMMERSION

FLUID

FLUID CAUSTIC SODA 50%
TEMPERATURE RANGE 32-200 DEG F
PROCESS TEMPERATURE 50-190 DEG F
AMBIENT TEMPERATURE 40-90 DEG F

ELEMENT

ELEMENT TAG NO. TE-6585
NUMBER OF LEAD WIRES 3-WIRE
ELEMENT TYPE SINGLE ELEMENT
ELEM. TERMINATION STYLE BAYONET SPRING-LOADED
SHEATH MATERIAL 316 SST

THERMOWELL

STEM STYLE MFR. STD.
RTD MOUNTING 1/2" THREADED
THERMOWELL MATERIAL 316L SST
INSERTION LENGTH [*]

TRANSMITTER

TRANSMITTER TAG NO. TIT-6585
AMBIENT TEMPERATURE 0-95 DEG F
ENCLOSURE CLASS NEMA 4X
SIGNAL OUTPUT AI
TRANS. MOUNTING INT
OUTPUT 4-20 MA
HAZARDOUS APPROVALS N/A
RELAY OPTIONS NO
SURGE PROTECTION NO

NOTES

[*]

SECTION 17622

WEIGHT MEASUREMENT: PLATFORM SCALE AND LOAD CELLS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Electronic strain weight measurement systems for the following:
      a. Platform scales.
      b. Load cells.
      c. Gas cylinder weight scales.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide complete documentation covering the traceability of all calibration instruments.

C. Furnish commissioning Submittals listed below and specified in this Section as specified in Section 01756 - Commissioning:
   1. Manufacturer's representative qualifications.
   2. Owner training.

D. For platform scales, provide structural calculations for the seismic anchorage of the platform to the supporting structure, and for the seismic anchorage of equipment to the platform scale. Calculations shall be stamped by a Professional Engineer registered in the state of Utah.

1.04 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.

c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 01850 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.08 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

1.09 MAINTENANCE

A. Furnish all parts, materials, fluids, etc., necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver supplies before project substantial completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide all instruments identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

B. Provide a complete seismic load path for any supported equipment to prevent sliding or overturning of the equipment.

2.03 MANUFACTURERS

A. One of the following or equal:
   1. Platform scales:
      a. Force Flow - CHEM-SCALE with SOLO G2 Transmitter.

2. Load cells:
    a. Force Flow - Procell with SOLO G2 Transmitter.
3. Gas cylinder weight scales:
    a. Force Flow - Floquip, CHLOR-SCALE with SOLO G2 Transmitter.

2.04 MANUFACTURED UNITS

A. As specified in this Section including Attachment A - ISA Datasheet - Weight Measurement: Platform Scale and Load Cells.

B. General:
1. Provide a complete integrated system consisting of scale, load cells, indicating display unit, weight transmitter, and interconnecting cables required for weight measurement.

C. Platform scales:
1. Use load cells of the shear beam strain gauge resistive type.
2. Design platform assembly shall be designed to protect load cells and cable from damage by rough handling and use.
3. Steel construction with sealed leads (NEMA 6). Where multiple load cells are used to support the platform or structure, connect their signal leads to a single NEMA 4X junction box. Use cables specifically designed for load cell applications.
4. Provide a single cable to transmit load cell signals to a remote weight indicator. Provide cable as required.
5. Size platform suitable for drums, tote bins, or tanks indicated on the Drawings:
    a. Platform shall have a heavy-duty rigid deck design, reinforced to prevent flexing under load. To facilitate easy loading, overall platform height shall be no more than 3.5 inches.
    b. Equip platform with hold down lugs designed to secure base of tote bins.
6. Process floor:
    a. Non-Corrosive Areas: Stainless steel.
    b. Corrosive Areas: Corrosion-resistant epoxy coating and to be compatible with the chemical that is to be weighed.
7. Provide platform scales with a 150 percent safe overload capacity.
8. Scales shall have mechanical stops or other means to minimize possible damage to load cells due to impact loading.
9. Scales, drums, tanks and tote bins shall be properly secured against shifting and tipping due to possible seismic movement. Any hold down lugs shall be compatible with chemical tanks.
10. Load cells in supporting frames to be rated for the seismic zone in which they are used:
    a. Incorporate seismic restraints in structure to prevent sideways motion of the tank.
    b. Provide a means for replacing damaged load cells.
11. Transmitter:
    a. Microprocessor based with alphanumeric display.
    b. Operator keypad interface.
    c. Capable of monitoring tare weight, gross weight, net remaining, and daily usage of each scale:
        1) Capable of calculating total amount used and rate of feed.

d. Provide a keypad to accept operator entry of tare weights, specific gravity of chemical and low-level alarm points.
e. Provide an integral power supply for load cells.
f. Enclosure Rating:
    1) As indicated in the datasheets.
g. Power supply:
    1) As indicated in the datasheets.
h. Outputs:
    1) As indicated in the datasheets.
    2) Isolated 4 to 20 mA DC with HART communication protocol.
    3) 4 to 20 mA VDC HART or digital bus protocol, provide a Device Type Manager (DTM) certification by FDT group.

D. Load cells:
1. Load cells shall have the following individual characteristics:
    a. Temperature stable, rolling diaphragm type, allows 4-degree tilt of load plate without affecting scale accuracy.
    b. Rated capacity:
        1) As indicated in Attachment A - ISA Datasheet - Weight Measurement: Platform Scale and Load Cells.
    c. Maximum loads:
        1) Safe: 150 percent of rated capacity.
        2) Ultimate overload: 300 percent of rated capacity.
        3) Safe side: 100 percent of rated capacity.
    d. Gauge cavity seal type: Welded hermetic gauge cover.
2. Load cells to be constructed of 17-4 PH stainless steel and shall have a welded hermetic gauge cover over the gauge and wiring cavities.
3. Each load cell to have an integral conduit fitting on the cable entrance into the load cell for enhanced moisture protection.
4. Each load cell to have a data plate affixed to the load cell which clearly shows:
    a. Manufacturer.
    b. Capacity.
    c. Part number.
    d. Serial number.
    e. National Type Evaluation Program certificate of performance number.
    f. Class number.
    g. Maximum divisions (NMax).
    h. Load cell Vmin.
5. Quantity: As indicated on the Drawings.
6. Transmitter:
    a. Microprocessor-based with alphanumeric display.
    b. Operator keypad interface.
    c. Capable of monitoring tare weight and gross weight.
    d. Mounting:
        1) As indicated in the datasheets.
    e. Enclosure Rating:
        1) As indicated in the datasheets.
        2) NEMA 4X.
    f. Power supply:
        1) As indicated in the datasheets.
        2) 24VDC.

g. Outputs:
    1) As indicated in the datasheets.
    2) For all instruments with 4 to 20 mA HART or digital bus protocol, provide a Device Type Manager (DTM) certification by FDT group.

E. Gas cylinder weight scales:
1. Type: Electronic load cell (strain gauge type) with transmitter and digital readout:
    a. Single load cell design.
    b. Quantity:
        1) One load cell per container.
    c. Weight transferred via levers to a single NTEP approved load cell of the shear beam strain gauge type.
    d. Connect load cell to indicator with flexible cable to allow easy remote mounting of indicator.
    e. Platforms for horizontal drums shall have a mechanism to prevent drums from rolling.
    f. Flexible cable lead from cell:
        1) Able to allow remote installation of the readout.
2. Transmitter:
    a. Microprocessor based with alphanumeric display.
    b. Operator keypad interface.
    c. Capable of monitoring tare weight, gross weight, net remaining, and daily usage of each scale:
        1) Capable of calculating total amount used and rate of feed.
    d. Provide a keypad to accept operator entry of tare weights, specific gravity of chemical and low-level alarm points.
    e. Enclosure Rating:
        1) As indicated in the datasheets.
        2) NEMA 4X.
    f. Power supply:
        1) As indicated in the datasheets.
        2) 24VDC.
    g. Outputs:
        1) As indicated in the datasheets.
        2) 4 to 20 mA HART.
        3) For all instruments with 4 to 20 mA HART or digital bus protocol, provide a Device Type Manager (DTM) certification by FDT group.

2.05 ACCESSORIES

A. Provide stainless steel tags for each instrument. Tags shall be labeled as specified in the Contract Documents.

B. Provide sunshades for all transmitters located outdoors.

C. Weight indicators shall be provided as specified in 17710 - Control Systems: Panels, Enclosures, And Panel Components.

2.06 FINISHES (NOT USED)

2.07 SOURCE QUALITY CONTROL

A. Factory calibrate each instrument with a minimum 3-point calibration or according to manufacturer's standard at a facility that is traceable to the NIST.
   1. Submit calibration datasheets to the Engineer at least 30 days before shipment of the instruments to the project site.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.02 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances for proper installation of instruments.

C. Install platform scales and load cells level, to within manufacturer's specified tolerances.

D. Utilize an independent scale and weight set to calibrate the scales(s).

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.04 FIELD QUALITY CONTROL

A. Manufacturer's field service:
   1. Provide field service by the scale manufacturer who shall perform final calibration and certify the scale to an accuracy of, or better than, that required by NIST Handbook 44, as applicable to commercial weighing.

3.05 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

ATTACHMENT A - ISA DATASHEET - WEIGHT MEASUREMENT: PLATFORM SCALE AND LOAD CELLS

Weight Measurement - Platform Scale and Load Cells

PROJECT INFORMATION

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GENERAL

TAG WIT-6211 (WE-6211)
SPECIFICATION NUMBER 17622
DRAWING NUMBER 62N02
SERVICE PRIMARY COAG DAY TANK WEIGHT
POWER LOCATION RTU-PEA
MEASURING PRINCIPLE STRAIN
PLC RTU-PEA
TYPICAL DETAILS [*]

MEASUREMENT

APPLICATION PRIMARY COAGULANT
VESSEL TYPE TANK
WEIGHT RANGE 0 - 11,000 LBS
RATED CAPACITY [*]

ELEMENT

ELEMENT TAG NO. WE-6211
ELEMENT MOUNTING FRAME

TRANSMITTER

TRANSMITTER TAG NO. WIT-6211
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING [*]
SURGE PROTECTION NO
POWER 24VDC-1P
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
AMBIENT TEMPERATURE 70 DEG F

NOTES

[*]

Weight Measurement - Platform Scale and Load Cells

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GENERAL

TAG WIT-6531 (WE-6531)
SPECIFICATION NUMBER 17622
DRAWING NUMBER 65N02
SERVICE CS DAY TANK PLATFORM SCALE
POWER LOCATION RTU-CS
MEASURING PRINCIPLE STRAIN
PLC RTU-CS
TYPICAL DETAILS [*]

MEASUREMENT

APPLICATION CAUSTIC SODA
VESSEL TYPE TANK
WEIGHT RANGE 0 - 17,500 LBS
RATED CAPACITY [*]

ELEMENT

ELEMENT TAG NO. WE-6531
ELEMENT MOUNTING FRAME

TRANSMITTER

TRANSMITTER TAG NO. WIT-6531
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
SURGE PROTECTION NO
POWER 24VDC-1P
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
AMBIENT TEMPERATURE 70 DEG F

NOTES

[*]

Weight Measurement - Platform Scale and Load Cells

PROJECT INFORMATION

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GENERAL

TAG WIT-6905 (WE-6905)
SPECIFICATION NUMBER 17622
DRAWING NUMBER 69N01
SERVICE PEA AGING TANK 1 WEIGHT
POWER LOCATION RTU-PEA
MEASURING PRINCIPLE STRAIN
PLC RTU-PEA
TYPICAL DETAILS [*]

MEASUREMENT

APPLICATION POLYMER
VESSEL TYPE TANK
WEIGHT RANGE 0 - 19,500 LBS
RATED CAPACITY [*]

ELEMENT

ELEMENT TAG NO. WE-6905
ELEMENT MOUNTING FRAME

TRANSMITTER

TRANSMITTER TAG NO. WIT-6905
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
SURGE PROTECTION NO
POWER 24VDC-1P
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
AMBIENT TEMPERATURE 70 DEG F

NOTES

[*]

Weight Measurement - Platform Scale and Load Cells

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GENERAL

TAG WIT-6915 (WE-6915)
SPECIFICATION NUMBER 17622
DRAWING NUMBER 69N02
SERVICE PEA AGING TANK 2 WEIGHT
POWER LOCATION RTU-PEA
MEASURING PRINCIPLE STRAIN
PLC RTU-PEA
TYPICAL DETAILS [*]

MEASUREMENT

APPLICATION POLYMER
VESSEL TYPE TANK
WEIGHT RANGE 0 - 19,500 LBS
RATED CAPACITY [*]

ELEMENT

ELEMENT TAG NO. WE-6915
ELEMENT MOUNTING FRAME

TRANSMITTER

TRANSMITTER TAG NO. WIT-6915
ENCLOSURE CLASS NEMA 4X
TRANS. MOUNTING REM
SURGE PROTECTION NO
POWER 24VDC-1P
SIGNAL OUTPUT AI
OUTPUT 4-20 MA
TRANS. HAZ APPROVALS N/A
AMBIENT TEMPERATURE 70 DEG F

NOTES

[*]

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Weight Measurement - Platform Scale and Load Cells

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GENERAL

TAG WIT-7105 (WE-7105)

SPECIFICATION NUMBER 17622

DRAWING NUMBER 71N02

SERVICE PEA AGING TANK 3 WEIGHT

POWER LOCATION RTU-PEA

MEASURING PRINCIPLE STRAIN

PLC RTU-PEA

TYPICAL DETAILS [*]

MEASUREMENT

APPLICATION POLYMER

VESSEL TYPE TANK

WEIGHT RANGE 0 - 19,500 LBS

RATED CAPACITY [*]

ELEMENT

ELEMENT TAG NO. WE-7105

ELEMENT MOUNTING FRAME

TRANSMITTER

TRANSMITTER TAG NO. WIT-7105

ENCLOSURE CLASS NEMA 4X

TRANS. MOUNTING REM

SURGE PROTECTION NO

POWER 24VDC-1P

SIGNAL OUTPUT AI

OUTPUT 4-20 MA

TRANS. HAZ APPROVALS N/A

AMBIENT TEMPERATURE 70 DEG F

NOTES

[*]

SECTION 17710

CONTROL SYSTEMS: PANELS, ENCLOSURES, AND PANEL COMPONENTS

TABLE OF CONTENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Design, fabrication and assembly of instrumentation enclosures, control panels and components provided under this Contract, including, but not limited to:
      a. Custom built instrumentation and control panels, including enclosures for hand stations controllers, low voltage power distribution and marshalling panels.
      b. Control panels furnished as part of equipment systems specified in other Divisions, such as vendor control panels (VCPs) and chemical feed panels.
      c. Control components.
      d. Control panel installation.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Standards:
   1. Institute of Electrical and Electronics Engineers (IEEE):
      a. C62.41.1 - Guide on the Surge Environment in Low-Voltage (1,000 V and less) AC Power Circuits.
      b. 802.3af - Standard for Information Technology Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.
      c. 802.3at - Standard for Information Technology -- Local and Metropolitan area networks -- Specific requirements -- Part 3: CSMA/CD Access Method and Physical Layer Specifications Amendment 3: Data Terminal Equipment (DTE) Power via the Media Dependent Interface (MDI) Enhancements.
   2. International Electrotechnical Commission (IEC):
      a. 61643-11 - Low-Voltage Surge Protective Devices - Part 11: Surge Protective Devices Connected to Low-Voltage Power Systems - Requirements and test methods.
      b. 61643-21 - Low-Voltage Surge Protective Devices - Part 21: Surge Protective Devices Connected to Telecommunications and Signaling Networks - Performance Requirements and Testing Methods.
   3. National Fire Protection Association (NFPA):
      a. 70 - National Electrical Code (NEC).
   4. Underwriters Laboratories Inc. (UL):
      a. 248-14 - Low-Voltage Fuses - Part 14: Supplemental Fuses.
      b. 497B - Standard for Protectors for Data Communications and Fire-Alarm Circuits.
      c. 508 - Standard for Industrial Control Equipment.
      d. 508A - Standard for Industrial Control Panel.
      e. 698A - Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.

f. 1077 - Standard for Supplementary Protectors for Use in Electrical Equipment.
g. 1283 - Standard for Electromagnetic Interference Filters.
h. 1310 - Standard for Class 2 Power Units.
i. 1449 - Standard for Surge Protective Devices.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. The term “panel” in this Section is interchangeable with the term “enclosure.”

1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

1.05 SUBMITTALS

A. Provide Submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide a control panel hardware Submittal for each control panel/enclosure being provided on this project, including, but not limited to:
   1. Product data:
      a. Enclosure construction details and NEMA type.
      b. Manufacturer’s literature and specification datasheets for each type of equipment to be installed within or on the panel or enclosure.
   2. Shop Drawings:
      a. Scaled, detailed exterior panel (front and side views) and interior panel layout showing equipment arrangement and dimensional information:
         1) Provide draft for review and approval by the Engineer. Engineer has the authority to substantially alter initial panel layouts.
      b. Complete nameplate engraving schedule.
      c. Structural details of fabricated panels.
   3. Calculations:
      a. Cooling calculations, including, but not limited to:
         1) Highest expected ambient temperature for the enclosure’s location.
         2) Internal heat load.
         3) Exposure to direct sunlight.
         4) Dimensions of the enclosure in inches.
         5) Maximum allowable temperature inside the enclosure, based on the lowest operating temperature limit of the installed components.

C. Delegated Design Submittals:
    1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
        a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
        b. For equipment installed outdoors.
        c. For wall mounted equipment weighing 125 pounds or more.

1.06 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Assemble panels, enclosures, and rack systems along with internal and external devices, wiring, equipment, and materials in a facility that is recognized by UL to assemble and certify UL-labeled control panels:
    1. Provide components and equipment with UL 508 listing.
    2. Control panels shall be UL 508A labeled, unless the equipment in the panel and the design in the Contract Documents cannot be reasonably modified to meet the requirements for UL 508A labeling:
    3. Provide fuses for equipment that is not UL or UR listed.
    4. Install intrinsically safe circuits and equipment in accordance with UL 698A.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)

1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide control panels identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Panel dimensions:
    1. Minimum dimensions are scalable from or as indicated on the Drawings and are based upon manufacturer’s non-certified information. It is the responsibility of the Contractor or manufacturer to design and size panels:
        a. Size panels to provide space for equipment, wiring, terminations, and other items in the panel, including 20 percent of the total back panel area shall remain empty.

b. Panel sizes that substantially deviate (within 3 inches in any dimension) from the sizes indicated on the Drawings must be approved by the Engineer.
c. Maximum panel depth: 32 inches, unless otherwise indicated.

B. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria and as indicated on the Drawings.

C. Non-conditioned spaces and outdoor installations:
1. Provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.

D. As listed below in the individual component paragraphs.
1. Provide conditioning equipment incorporated into the equipment to maintain the enclosures within the equipment manufacturer's specified operating ranges.

2.03 MANUFACTURERS (NOT USED)

2.04 EXISTING PRODUCTS

A. Provide labor and materials for complete modifications to existing panels as required.

B. Field cut and refinish existing panel faces to original condition to accommodate installation of new instruments, removal of existing instruments, and fitting of blanks to suit new layouts. New instrument supports shall be provided as required for complete installation.

2.05 MATERIALS

A. Construct and finish enclosures using materials capable of withstanding the mechanical, electrical, and thermal stresses, as well as the effects of humidity and corrosion that are likely to be encountered in normal service:
1. Enclosures shall have the following properties:
a. NEMA Type 1: Steel.
b. NEMA Type 4: Steel with gasketed door, raintight.
c. NEMA Type 4X: Type 316 stainless steel (unless Type 304 is indicated on the Drawings).
d. NEMA Type 4X: Polycarbonate or fiberglass reinforced polyester (FRP) in corrosive areas where stainless steel is incompatible.
e. NEMA Type 12: Steel with gasketed door, dusttight.
f. NEMA Type 7: Cast aluminum.

B. Bolting material:
1. Commercial quality 1/2-inch diameter, stainless steel hex-head Grade 5 bolts, nuts, and washers, with unified coarse (UNC) threads.
2. Carriage bolts for attaching end plates.
3. Other bolted joints shall have S.A.E. standard lock washers.

2.06 MANUFACTURED UNITS

A. Panels/enclosures:
   1. Manufacturers: One of the following or equal:
      a. nVent/Hoffman.
      b. Rittal.
      c. Saginaw Control & Engineering.
   2. Panel assembly:
      a. General guidelines for panel fabrication include:
         1) Continuous welds ground smooth.
         2) Exposed surfaces free of burrs and sharp edges.
         3) Base formed of heavy channel iron, either galvanized or powder coated, minimum 1/2-inch holes at 12-inch spacing to accommodate anchoring of freestanding enclosures to floor.
      b. Construct enclosure and mounting panel using stretcher-level quality sheet metal having minimum thickness not less than the following sizes (U.S. Standard Gauge):

Enclosure Height (inches)	Minimum Enclosure Steel Thickness (gauge)	Minimum Back Mounting Panel Thickness (gauge)
Wall-mounted up to 48	14	14
Up to 57	12	12
57 to 69	12	10
69 to 82	12, except 10 on back	10
82 or more	10	10

         1) Use heavier sheet metal to meet seismic requirements at the Project Site or when required due to equipment requirements.
      c. For Rittal or engineer-approved equal free-standing modular enclosure, construct enclosure and mounting panel using stretcher-level quality sheet metal having minimum thickness not less than the following sizes (U.S. Standard Gauge):

Enclosure Height (inches)	Minimum Enclosure Steel Thickness (gauge)	Minimum Back Mounting Panel Thickness (gauge)
Wall-mounted up to 48	16	14
Up to 57	14	13
57 or more	16	11

      d. Construct supporting frame structure with angled, channeled, or folded rigid section of sheet metal, rigidly attached to and having essentially the same outer dimensions as the enclosure surface and having sufficient torsional rigidity to resist the bending moments applied via the enclosure surface when it is deflected.
      e. Provide stiffeners for back mounting or C folded back panels in enclosures larger than 4 feet. In addition, secure the panels in place by collar studs welded to the enclosure.

f. Door construction:
    1) Turned-back edges suitably braced and supported to maintain alignment and rigidity without sagging.
    2) Sufficient width to permit door opening without interference with rear projection of flush-mounted instruments.
    3) Heavy-gauge stainless steel hinges.
    4) For NEMA Type 12, Type 4, and Type 4X, provide oil-resistant neoprene sealing gasket and adhesive to seal cover to enclosure.
    5) Gasket installed to seal against roll lip on the enclosure opening.
g. Latches:
    1) For panels, provide each door with an oil tight 3-point latching mechanism and locking handle with rollers on the ends of the latch rods. Latch rods shall be connected to a common door handle, hold doors securely, and form a compressed seal between door and gasket, at the top, side, and bottom.
        a) Provide padlock for each enclosure with padlock provisions.
        b) Provide 2 keys per panel.
        c) All locks keyed alike.
    2) For Rittal or engineer-approved equal free-standing modular enclosure, provide each door with a 4-point latching mechanism, if available, or a 2-point latching mechanism if a 4-point is not available.
    3) For cabinets not available with 3-point latching hardware, provide multiple clips and padlock hasps.
h. Panel cut-outs:
    1) Cut, punch, or drill cutouts for instruments, devices, and windows. Smoothly finish with rounded edges.
    2) Allow a minimum of 3-inch envelope around displays, controllers, and monitors.
    3) Reinforce around cut-outs with steel angles or flat bars for the following:
        a) Large panel cutouts; for example, openings for local operator interfaces.
        b) Pilot device groupings, where the removed metal exceeds 50 percent of the available metal.

3. In addition to the requirements specified above, the following requirements for NEMA Type 4X powder coated stainless steel enclosures apply:
    a. Minimum 16-gauge, Type 304 stainless steel.
    b. Captive stainless steel cover screws threaded into sealed wells.
    c. Inside finish: White polyester powder coating.
    d. Specifically designed for use with flange-mounted disconnect handles where required or as indicated on the Drawings.
    e. NEMA Type 4X powder-coated stainless steel enclosures are not an acceptable substitute for stainless steel unless indicated on the Drawings.
4. Outdoor panels. Supplementary requirements for panels located outdoors are as follows:
    a. Enclosures located outdoors shall be explicitly designed and rated for outdoor service by the manufacturer.
    b. Door hardware: Stainless steel.
    c. Provide factory installed rain canopy and sun shield for enclosures with operator interface panels.

d. Bases: Heavy channel, gasketed stainless steel bases, flanges up, for anchoring to pad.

B. Arrangement of components:
   1. Arrange panel internal components for external conduit and piping to enter into panel either from above or below.
   2. Arrange panel instruments and control devices in a logical configuration, associating pushbutton and selector switches with related readout devices, or as indicated on the Drawings.
   3. Mount internal control components on an internal back panel. Devices may be mounted on the side panel only by special permission from the Engineer.
   4. Control panel mounted operator interface devices shall be mounted between 3 feet and 5 feet above finished floor.

C. Overcurrent protection:
   1. Main overcurrent device:
      a. Where the electrical power supply voltage to the control panel is more than 120 VAC, provide the panel with a flange-mounted disconnect handle operating a molded-case circuit breaker and provide a control power transformer for 120-VAC circuits:
         1) Door-mounted disconnect handles are not acceptable.
         2) Mechanically interlock the disconnect switch with the control enclosure doors so that no door can be opened unless the power is disconnected, and the disconnect switch cannot be closed until all doors are closed.
         3) Provide means to defeat the interlock.
         4) Lockable in the off position.
      b. Control panels supplied with 120 VAC:
         1) Provide an internal breaker with the line side terminals covered by a barrier.
         2) Provide a nameplate prominently positioned on the control panel identifying the location of the power source and a warning statement requiring the source to be disconnected before opening the door to the enclosure.
         3) Provide a nameplate prominently positioned on the control panel stating “CAUTION Risk of Electric Shock - UPS equipment outputs remain energized with main disconnect in off position” for any panel containing a UPS.
   2. Provide circuit breakers as specified in Section 16412 - Low Voltage Molded Case Circuit Breakers.
   3. Selection and ratings of protective devices:
      a. Interrupting ratings: Not less than the system maximum available fault current at the point of application.
      b. Voltage rating: Not less than the voltage of the application.
      c. Select current rating and trip characteristics to be suitable for:
         1) Maximum normal operating current.
         2) Inrush characteristics.
         3) Coordination of the protective devices to each other and to the source breaker feeding the panel.

d. Circuit breakers, fuses, and motor overcurrent protection devices used for branch circuit protection must be UL 508A compliant.
    1) Circuit breakers listed under UL 1077 Standard for Supplementary Protectors that do not comply with UL 508A requirements are not acceptable.
    2) Miscellaneous, miniature, and micro fuses listed under UL 248 Part 14 that do not comply with UL 508A requirements are not acceptable.
    3) Manual motor controllers provided with an instantaneous-trip overcurrent mechanism listed under UL 508 that do not comply with UL 508A requirements are not acceptable.

4. Provide a separate protective device for each powered electrical device:
    a. An individual circuit breaker for each 120-VAC instrument installed within its respective control panel and clearly identified for function.
    b. An individual fuse for each PLC discrete output. Provide with individual blown fuse indication external of the I/O card:
        1) Size external fuse to open before any I/O-card-mounted fuses.
    c. Individual discrete inputs shall use a 1/2-amp fuse.
        1) Discrete output:
            a) Size external fuse to open before any I/O-card-mounted fuses.
        2) Analog loop powered from the control panel:
            a) 0.25-amp fuse.
        3) Analog loop powered from the control panel:
            a) 0.25-amp fuse.
    d. Install protective devices on the back mounting panel and identify by a service nameplate in accordance with the wiring diagrams.
5. Fuses for analog and discrete control loops:
    a. Provide durable, readily visible label for each fuse, clearly indicating the correct type, size, and ratings of replacement fuse:
        1) Label shall not cover or interfere with equipment manufacturer's instructions.
    b. Provide fuses rated for the voltage and available short-circuit current at which they are applied.
    c. Manufacturers: One of the following or equal:
        1) Bussmann.
        2) Ferraz Shawmut.
        3) Littelfuse.
6. Fuse holders:
    a. Modular type:
        1) DIN rail mounting on 35-millimeter rail.
        2) Touch-safe design: Connection terminals to be protected against accidental touch.
        3) Incorporates blown-fuse indicator.
        4) Plug-in style fuse terminals and fuse plugs are not acceptable.
    b. Provide nameplate identifying each fuse:
        1) As specified in Section 16075 - Identification for Electrical Systems.
    c. Manufacturers: One of the following or equal:
        1) Allen-Bradley, 1492-FB Series B.
        2) Phoenix Contact, UT4-HESI Series.
7. Control circuit breakers:
    a. DIN rail mounting on 35-millimeter rail.
    b. Manual OPEN-CLOSE toggle switch.

c. Rated for 250 VAC.
d. Interrupting rating: 10 kiloampere (kA) or available fault current at the line terminal, whichever is higher.
e. Current ratings: As required for the application.
f. Provide nameplate identifying each circuit breaker:
    1) As specified in Section 16075 - Identification for Electrical Systems.
g. Manufacturers: One of the following or equal:
    1) ABB.
    2) Allen-Bradley.
    3) Phoenix Contact, TMC Series.
    4) Square D.

8. Electronic circuit protectors:
    a. Used where a NEC Class 2 power circuit is required.
    b. Confirms to NEC Class 2 according to UL 1310.
    c. DIN rail mounting on 35-millimeter rail.
    d. Power source:
        1) Operating voltage: 24 VDC.
        2) Output current ratings: As required for the application.
        3) Maximum output current: 4 A.
        4) Maximum nameplate rating: 100 VA.
    e. LED for status indication.
    f. Remote status contact.
    g. When using multi-channel electronic circuit protectors, distribute devices such that a failure is limited to a single network or segment.
    h. Provide nameplate identifying each circuit electronic circuit protector module:
        1) As specified in Section 16075 - Identification for Electrical Systems.
    i. Manufacturers: One of the following or equal:
        1) Single channel:
            a) Allen-Bradley, 1694 series.
            b) Phoenix Contact, PTCB E1 series.
        2) Multi-channel:
            a) Phoenix Contact, CBMC series.
            b) Puls PISA11 series.

D. Conductors and cables:
1. Power and control wiring:
    a. Materials: Stranded, soft annealed copper.
    b. Insulation: 600 VAC type MTW.
    c. Minimum sizes:
        1) Primary power distribution: 12 AWG.
        2) Secondary power distribution: 14 AWG.
        3) Control: 16 AWG.
    d. Color:
        1) AC power (line and load): Black.
        2) AC power (neutral): White.
        3) AC control: Red.
        4) AC control: Orange for foreign voltages.
        5) DC power and control (ungrounded): Blue.
        6) DC power and control (grounded): White with Blue stripe.
        7) Ground: Green.

2. Signal cables:
    a. Materials: Stranded, soft annealed copper.
    b. Insulation: 600 VAC, PVC outer jacket.
    c. Minimum size: 18 AWG paired triad.
    d. Overall aluminum shield (tape).
    e. Copper drain wire.
    f. Color:
        1) 2-conductor:
            a) Positive (+): Black.
            b) Negative (-): White and red.
        2) 3-conductor:
            a) Positive (+): Black.
            b) Negative (-): Red.
            c) Signal: White.
    g. Insulate the foil shielding and exposed drain wire for each signal cable with heat-shrink tubing.

E. Conductor identification:
    1. Identify each conductor and cable with unique wire numbers as specified in Section 16075 - Identification for Electrical Systems.
    2. Readily identified without twisting the conductor.

F. General wiring requirements:
    1. Wiring methods: Wiring methods and materials for panels shall be in accordance with the NEC requirements for General Purpose (no open wiring) unless otherwise specified.
    2. Install components in accordance with the manufacturer's instructions included in the listing and labeling.
    3. Provide a nameplate on the cover of the control panel identifying sources of power supply and foreign voltages within the control panel.
    4. Provide transformers, protective devices, and power supplies required to convert the supply voltage to the needed utilization voltage.
    5. Provide power surge protection for control panels.
    6. Provide signal surge protection within control panels for each analog I/O, discrete I/O, and data line (Copper Ethernet, Coax, Fieldbus signals) that originates from outdoor devices.
    7. Provide non-metallic ducts for routing and organization of conductors and cables:
        a. Provide wiring separation plan.
        b. Size ducts for ultimate build-out of the panel, or for 20-percent spare, whichever is greater.
        c. Provide separate ducts for signal and low voltage wiring from power and 120 VAC control wiring:
            1) 120 VAC: Grey colored ducts.
            2) 24 VDC: White colored ducts.
    8. Cables shall be fastened with cable-mounting clamps or with cable ties supported by any of the following methods:
        a. Screw-on cable tie mounts.
        b. Hammer-on cable-tie mounting clips.
        c. Fingers of the nonmetallic duct.

9. Wire ties:
    a. No wire ties inside wire duct.
    b. Use Panduit cable tie installation tool, with tension control/cutoff.
    c. Verify cut ends are cut flush filed smooth after installed.
10. Provide supports at the ends of cables to prevent mechanical stresses at the termination of conductors.
11. Support panel conductors where necessary to keep them in place.
12. Wiring to rear terminals on panel-mount instruments shall be run in nonmetallic duct secured to horizontal brackets run adjacent to the instruments.
13. Conductors and cables shall be run from terminal to terminal without splice or joints. Exceptions:
    a. Factory-applied connectors molded onto cables shall be permitted. Such connectors shall not be considered as splices or joints.
14. Control panel shall be the source of power for 120 VAC devices interconnected with the control panel, including, but not limited to:
    a. Solenoid valves.
    b. Instruments both mounted in the control panel and remotely connected to the control panel.

G. Provide power circuits for Contractor- and vendor-furnished PLC cabinets in accordance with the PLC and instrument power wiring diagrams indicated on the Drawings or as specified.

H. Thermal management:
1. Provide heating, cooling, and dehumidifying devices in order to maintain instrumentation and control devices to within a range as specified in Section 17050 - Common Work Results for Process Control and Instrumentation.
2. Air conditioner:
    a. Provide solid-state cabinet coolers or air conditioning units on outdoor panels containing electronic components such as local operator interfaces, panel instruments, programmable logic controllers, or remote I/O.
    b. Provide filters on intake and exhaust openings.
    c. Increase panel sizes as needed to accommodate cooling units.
3. Heating:
    a. Provide panels located in areas that are not climate controlled with thermostatically controlled strip heaters, except where all of the following conditions apply:
        1) Panel is not supplied with 120 VAC power.
        2) There are no electronics or moisture-sensitive devices in the enclosure.
        3) Panel is smaller than 38 inches high.
4. Heat exchanger:
    a. Closed-loop design ensuring separation of ambient air and clean air inside the cabinet.
    b. Filterless design to facilitate easy cleaning of the core.
    c. Mounting: As indicated on the Drawings.
    d. Manufacturers: One of the following or equal:
        1) ICEqube, Blade series.
        2) Noren, CC Series.

5. Enclosure temperature switch:
    a. Provide wall-mounted bimetallic switch transmitter (to measure internal cabinet temperature in enclosures) containing electrical components such as PLCs, RTUs, RIO, and VFDs.
    b. Sensor and electronic enclosure.
    c. Accuracy: Within 2 degrees Fahrenheit.
    d. Single contact:
        1) Manufacturers: One of the following or equal:
            a) nVent/Hoffman ATEMNC.
            b) Pfannenberg FLZ.
            c) Rittal.
    e. Dual contact:
        1) Manufacturers: One of the following or equal:
            a) nVent/Hoffman ADLTEMP.
            b) Rittal.
6. Status relays and discrete inputs for switches, power supplies, and fieldbus devices (if applicable):
    a. Provide as indicated on the Drawings or as specified.
7. Fan ventilation:
    a. Provide nVent/Hoffman or Rittal fan speed control:
        1) Provide 2 door/cabinet-mounted vent fans for every 72 inches of cabinet width.
        2) Provide finger-guard kit.
        3) Filter kit with 2 spare filters for each intake fan.
        4) Provide bezel and gasket kit.
        5) Provide fan shroud.
        6) Automatically adjust fan speed depending on remote temperature sensor input.
        7) 120 VAC, 60 hertz.

I. Panel meters:
1. Pointer type:
    a. Suitable for panel mounting.
    b. Minimum scale length: 3 inches.
    c. Calibrated in engineering units.
    d. Accuracy: Within 2 percent of span.
    e. NEMA Type 4/IP65 sealed front metal bezel.
    f. Manufacturers: One of the following or equal:
        1) Red Lion.
        2) Yokogawa.
2. Digital process indicators:
    a. General:
        1) Integral provisions for scaling.
        2) Scale to process engineering units.
        3) Switch-programmable decimal points.
        4) NEMA Type 4/IP65 sealed front bezel.
    b. Current and voltage indicators:
        1) 3-1/2-digit minimum.
        2) Minimum character height: 0.5 inches.
        3) Accuracy:
            a) AC/DC volts: Within 0.1 percent of reading plus 2 digits.

b) DC current: 4 to 20 mA; within 0.1 percent of reading plus 1 digit.
c) DC voltage: 0 to 10 volts; within 0.1 percent of reading plus 1 digit.

c. Operating voltage: 120 VAC.
d. Operating temperature: 32 degrees to 140 degrees Fahrenheit.
1) Manufacturers: One of the following or equal:
a) Action Instruments, Visipak.
b) Red Lion.

3. Digital bar graph meter:
a. Self-contained instruments that display process signals directly in engineering units, both in decimal format and as a bar graph display.
b. Suitable for panel mounting.
c. LED display:
1) Not less than 3 decimal digits.
2) Not less than a 101-segment LED bar graph.
d. Input signal:
1) Conventional current loops and voltage control signals.
e. Minimum sample rate of once per second.
f. Provisions for field-adjustable scaling and/or offset.
g. Accuracy shall be within 1 least-significant digit.
h. Manufacturers: One of the following or equal:
1) Ametek Dixson.
2) Weschler Instruments.
3) Yokogawa.

4. Counters:
a. 6 digits.
b. Switch-selectable inputs:
1) Switch contacts.
2) CMOS.
3) TTL.
4) Magnetic pickup.
5) RLC sensors.
c. Selectable up/down control via external signal.
d. Remote reset.
e. Remote inhibit to prevent accumulating counts.
f. Programmable to enable or disable front panel reset.
g. Non-volatile memory to retain all data upon loss of supply power.
h. Sunlight readable.
i. Operating temperature: 32 degrees to 122 degrees Fahrenheit.
j. Manufacturers: The following or equal:
1) Red Lion, PAX Series.

J. Pilot devices:
1. General:
a. Provide operator pushbuttons, switches, and pilot lights, from a single manufacturer.
b. Size:
1) 30.5 millimeters.
c. Heavy duty.

d. Pushbuttons:
    1) Contacts rated:
        a) NEMA Type A600.
    2) Furnish 1 spare normally open contact and normally closed contact with each switch.
    3) Equipment shutdown (ESD): Palm or mushroom-head type with self-latching feature. ESD device will remain in the actuated position until deliberately reset.
e. Selector switches:
    1) Contacts rated:
        a) NEMA Type A600.
        b) Knob type.
    2) Furnish 1 spare normally open contact and normally closed contact with each switch.
    3) Provisions for locking in the OFF position where lockout provisions are indicated on the Drawings.
f. Pilot lights:
    1) Type:
        a) LED for interior installations.
    2) Push to test.
    3) Lamp color:
        a) On/Running/Start: Red.
        b) Off/Stop: Green.
        c) Power: White.
        d) Alarm/Fail: Amber.
        e) Status or normal condition: White.
        f) Valve or Gate Opened: Red.
        g) Valve or Gate Closed: Green.

2. Indoor and outdoor areas:
    a. NEMA Type 4/13.
    b. Manufacturers: One of the following or equal:
        1) Allen-Bradley, Type 800T.
        2) General Electric, Type CR104P.
        3) IDEC, TWND Series.
        4) Schneider Electric, Class 9001, Type K.
3. Corrosive areas:
    a. NEMA Type 4X.
    b. Corrosion resistant.
    c. Exterior parts of high-impact strength fiberglass-reinforced polyester or multiple-layer epoxy-coated zinc.
    d. Manufacturers: One of the following or equal:
        1) Allen-Bradley Type 800H.
        2) Cutler Hammer, Type E34.
        3) IDEC, TWND Series.
        4) Schneider Electric, Class 9001, Type SK.
4. Hazardous (classified) areas/Class I Division 2:
    a. NEMA Type 4X.
    b. Corrosion resistant.

c. Exterior parts of high-impact strength fiberglass-reinforced polyester or multiple-layer epoxy-coated zinc:
    1) Contacts contained within a hermetically sealed chamber:
        a) Pushbuttons.
        b) Selector switches.
        c) Push-to-test contacts on pilot lights.
    2) UL listed and labeled for Class I Division 2 areas.
d. Manufacturers: One of the following or equal:
    1) Allen-Bradley, Type 800H.
    2) Cutler Hammer, Type E34.

K. Potentiometer and slidewire transmitters:
1. Provide a DC output in proportion to a potentiometer input.
2. Potentiometer input:
    a. 100 ohms to 100 K ohms.
    b. Impedance greater or equal to 1 M ohms.
    c. Zero turn-up: 80 percent of full-scale input.
    d. Span turn-down: 80 percent of full-scale input.
3. Field-configurable output:
    a. Voltage and current: Conventional current loops and voltage control signals.
4. Accuracy including linearity and hysteresis within 0.1 percent maximum at 77 degrees Fahrenheit.
5. Operating temperature: 32 degrees to 131 degrees Fahrenheit.
6. Supply power: 9 to 30 VDC.
7. Manufacturers: One of the following or equal:
    a. Allen Bradley Type 800T-U29.
    b. Phoenix Contact, Mini Analog Pro.

L. Signal isolators and converters:
1. Furnish signal isolators that provide complete isolation of input, output, and power input:
    a. Minimum isolation level: 1.0 kilovolts AC/50 hertz for at least 1 minute.
    b. Adjustable span and zero.
    c. Accuracy: Within 1.0 percent of span.
    d. Ambient temperature range: -4 degrees to 149 degrees Fahrenheit.
2. Manufacturers: One of the following or equal:
    a. Acromag, 1500, 600T, 800T, Flat Pack, or ACR Series.
    b. Action Instruments, Q500 Series or Ultra SlimPak II.
    c. AGM Electronics, Model TA-4000.
    d. Moore Industries, MIT 4-Channel.
    e. Phoenix Contact, Mini Analog Pro.

M. Relays:
1. General:
    a. For all types of 120-VAC relays, provide surge protection across the coil of each relay.
    b. For all types of 24-VDC relays, provide a free-wheeling diode across the coil of each relay.
    c. For plug in type relays, provide a relay base from the same manufacturer as the relay manufacturer.

2. Control:
    a. Magnetic style.
    b. For use as standard control relay for motor and starter relay logic.
    c. NEMA ratings:
        1) 300 volts.
        2) 10 amps thermal continuous test current.
        3) 60 amps make.
        4) 6 amps break.
    d. Plug-in type.
    e. LED indication for energization status.
    f. Coil voltages: As required for the application.
    g. Minimum poles: DPDT.
    h. Touch-safe design: Connection terminals to be protected against accidental touch.
    i. Enclose each relay in a clear plastic heat and shock-resistant dust cover.
    j. Quantity and type of contact shall be as indicated on the Drawings or as needed for system compatibility.
    k. Relays with screw-type socket terminals.
    l. Provide additional relays when the following occurs:
        1) Number or type of contacts shown exceeds the contact capacity of the specified relays.
        2) Higher contact rating is required in order to interface with starter circuits or other equipment.
    m. DIN rail mounting on 35-millimeter rail.
    n. Ice-cube-type relays with retainer clips to secure relay in socket.
    o. Integrated label holder for device labeling.
    p. Manufacturers: One of the following or equal:
        1) Allen-Bradley: Type 700 HC.
        2) IDEC: R* Series (* = H, J, R, S, U).
        3) Potter and Brumfield: Type KRP or KUP.
        4) Square D: Type K.
3. Isolation:
    a. Electromechanical style.
    b. For use as an interposing relay for PLC based discrete I/O signals.
    c. NEMA ratings:
        1) Switching voltage: 250 volts AC/DC.
        2) Limiting current: 6 amps continuous.
        3) Interrupt: 1,500 volt-amperes.
    d. Plug-in type.
    e. LED indication for energization status.
    f. Coil voltages: As required for the application.
    g. Minimum poles: SPDT.
    h. Touch-safe design: Connection terminals to be protected against accidental touch.
    i. Quantity and type of contact shall be as indicated on the Drawings or as needed for system compatibility.
    j. Relays with screw-type socket terminals.
    k. DIN rail mounting on 35-millimeter rail.
    l. Integrated label holder for device labeling.
    m. Manufacturers: One of the following or equal:
        1) Allen-Bradley Type 700 HL TBR Series.

2) Eaton XR TBR Series.
3) IDEC RV8H Series.
4) Phoenix Contact PLC-INTERFACE Series.

4. Latching:
   a. Magnetic-latching control relays.
   b. NEMA ratings:
      1) 300 volts.
      2) 5 amps continuous.
      3) 360 volt-amperes make.
      4) 320 volt-amperes break.
   c. Plug-in type.
   d. DIN rail mounting on 35-millimeter rail.
   e. Coil voltage: As required for the application.
   f. Minimum contacts: DPDT; as required for the application. Plus 1 spare contact.
   g. Touch-safe design: Connection terminals to be protected against accidental touch.
   h. Clear cover for visual inspection.
   i. Provide retainer clip to secure relay in socket.
   j. Manufacturers: One of the following or equal:
      1) IDEC, RR2KP Series.
      2) Square D, 8501, Type K.
5. Time delay:
   a. Provide time-delay relays to control contact transition time.
   b. Contact rating:
      1) 240 volts.
      2) 10 amps continuous.
      3) 3,600 volt-amperes make.
      4) 360 volt-amperes break.
   c. Coil voltage: As required for the application.
   d. Provide pneumatic or electronic type with on-delay, off-delay, and on/off-delay:
      1) For off-delay, use true power-off time-delay relays. Where the required timing range exceeds capability of the off-delay relay use, signal off-delay where power loss will not cause undesirable operation or pneumatic time-delay relays.
   e. Minimum contacts: DPDT.
   f. Units include an adjustable dial with a graduated scale covering the time range in each case.
   g. Minimum timing range: 0.1 second to 10 minutes, or as required for the application.
   h. Manufacturers: One of the following or equal:
      1) Allen-Bradley, Type 700-HR.
      2) IDEC, RTE Series.
      3) Tyco Electronics, Agastat 7000 Series (pneumatic).

N. Terminal blocks:
   1. DIN rail mounting on 35-millimeter rail.
   2. Rated for 15 amps at 600 volts.
   3. Screw terminal type.

4. Provide mechanism to prevent wire connection from loosening in environments where vibration is present. This mechanism shall not cause permanent deformation to the metal body.
5. Finger-safe protection for terminals for conductors.
6. Construction: Polyamide insulation material capable of withstanding temperature extremes from -40 degrees to 221 degrees Fahrenheit.
7. Terminals: Plainly identified to correspond with markings on the diagrams:
    a. Permanent machine-printed terminal identification.
8. Disconnect-type field signal conductor terminals with socket/screw for testing.
9. Identify terminals suitable for use with more than 1 conductor.
10. Position:
    a. So that the internal and external wiring does not cross.
    b. To provide unobstructed access to the terminals and their conductors.
11. Manufacturers: One of the following or equal:
    a. Allen-Bradley, 1492 Series.
    b. Phoenix Contact, UT4 Series.

O. DIN rail grounding:
1. Grounding terminal blocks used exclusively for bonding each DIN rail section to panel grounding busbar shall:
    a. Mount to DIN rail via grounding foot with mounting screw.
    b. Connect to the panel grounding busbar shall be via a green insulated conductor sized in accordance with NEC.
    c. Not be used for grounding signal cable shields.
2. Screw terminal type.
3. DIN rail mounting on 35-millimeter rail.
4. Provide mechanism to prevent wire connection from loosening in environments where vibration is present. This mechanism shall not cause permanent deformation to the metal body.
5. Finger-safe protection for terminals for conductors.
6. Terminals: Plainly identified to correspond with markings on the diagrams:
    a. Permanent machine-printed terminal identification.
7. Manufacturers: One of the following or equal:
    a. Allen-Bradley, 1492-JG Series.
    b. Phoenix Contact, USKLG Series.

P. Wire duct:
1. Provide flame retardant plastic wiring duct, slotted with dust cover.
2. Type:
    a. Wide slot.
    b. Narrow slot.
    c. Round hole.
3. Manufacturers: One of the following or equal:
    a. ABB.
    b. Iboco.
    c. Panduit.
    d. Phoenix Contact.

Q. DIN rail:
1. Perforated steel.
2. 35 mm width.

3. 15 mm deep.
4. Provide 2-inch offset using one of the following:
    a. Offset brackets.
    b. Preformed standoff DIN Rail Channel.

R. Surge protection devices (SPD):
1. 120 VAC control panel power SPD:
    a. Provide SPD for panel 120 VAC power entrances:
        1) Non-faulting and non-interrupting design.
        2) Provide line to neutral and neutral to ground surge protection.
    b. Provide surge protection at secondary of main circuit breaker:
        1) Surge protection is not required for 120 VAC circuits that are only used for panel lights and receptacles.
        2) For panels receiving power at 480 VAC, provide surge protection on the 120 VAC control power transformer secondary.
    c. DIN rail mounting.
    d. Attach wiring to the SPD by means of a screw-type cable-clamping terminal block:
        1) Gastight connections.
        2) Visual status indication of MOV status on the input and output circuits.
        3) Dry contact rated for remote status indication.
    e. Approvals:
        1) Tested in accordance with IEC 61643-11.
        2) Tested in accordance with UL 1283.
        3) Tested in accordance with UL 1449.
        4) Surge protection minimum requirements: Withstand a minimum 10-kA test current of an 8/20 µs waveform in accordance with IEEE C62.41.1 Category C Area.
    f. Manufacturers: One of the following or equal:
        1) ASCO, Model 277.
        2) Phoenix Contact, Type SFP Filter.
        3) Rockwell, 4983-DC series.
        4) Sola HD, STFE Elite series.
2. 24 VDC control panel power SPD:
    a. Provide SPD for 24 VDC power circuits.
    b. Provide surge protection at DC power supply output.
    c. DIN rail mounting.
    d. Attach wiring to the SPD by means of a screw-type cable clamping terminal block:
        1) Optical status indicator.
        2) Dry contact rated for remote status indication.
    e. Approvals:
        1) Tested in accordance with IEC 61643-11.
    f. Manufacturers: One of the following or equal:
        1) Field instruments that require auxiliary power:
            a) Emerson, Model 265 (SLAC) series.
            b) Phoenix Contact, Plugtrab PLT--SEC-T3-24-FM-UT.
        2) Loop powered field instruments:
            a) Emerson/Edco, Model SS65-036-2.

3. Panel mounted control, signal, and data line SPD:
    a. General:
        1) This section applies to SPD located in a control panel, field panel, network junction box, or marshalling panel.
        2) Approvals:
            a) Tested in accordance with IEC 61643-21.
            b) Tested in accordance with UL 497B.
        3) SPD shall consist of 2 parts:
            a) Base module:
                (1) DIN rail mounting.
                    (a) Grounded to DIN rail via mounting rail foot.
            b) Plug protection module:
                (1) Replacing a plug shall not require the removal of any wires nor interrupt the signal.
        4) Provide indirect shield ground style SPD unless otherwise noted.
        5) Provide ability to locally identify and indicate SPD health.
        6) SPD shall be provided with controller module with dry contact for remote status monitoring of SPD device health.
        7) SPD modules shall be compatible with signal, communication bus type, data type, or control power being protected.
        8) Provide dedicated SPD for each signal, communication bus type, or data line being protected.
    b. Manufacturers: One of the following or equal:
        1) Dehn, Blitzductor XTU Series.
        2) Phoenix Contact, Plugtrab PT-IQ Series.
4. Copper Ethernet SPD:
    a. Protects network equipment from lightning or other surge events.
    b. Suitable for Gigabit networks.
    c. Shielded RJ-45 ports.
    d. Compliant with PoE standards IEEE 802.3af and 802.3at.
    e. Nominal discharge surge current: 10 kA.
    f. Approvals:
        1) Tested in accordance with IEC 61643-21.
        2) Tested in accordance with UL 497B.
    g. Manufacturers: One of the following or equal:
        1) Citel, MJ8-C6A.
        2) Eaton/MTL, ZoneBarrier High Energy Ethernet.
        3) Phoenix Contact, DT-LAN-CAT6+.
        4) Weidmuller, VDATA CAT6.
5. Field device mounted SPD:
    a. Conduit entry mounting.
        1) Provide parallel or through wiring configurations as required by the application.
            a) Use parallel wiring configuration if there is an available cable gland at the device.
            b) Use through wiring configuration if there is no available cable gland at the device.
        2) Provide screw connections compatible with field device.
    b. NEMA 4X stainless steel material housing.
    c. Approvals:
        1) Tested in accordance with IEC 61643-21.

d. 4-wire field device:
    1) Module shall provide simultaneous protection of signal cable, communication bus, or data line, and power supply line.
        a) Maximum continuous voltage:
            (1) DC:
                (a) Signal: 32 VDC.
                (b) Power supply: 255 VDC.
            (2) AC:
                (a) Signal: 22.6 VAC.
                (b) Power supply: 255 VAC.
    2) Manufacturers: The following; Engineer knows of no equal:
        a) Endress+Hauser, HAW569-CB2C.
e. 2-wire or 3-wire field device:
    1) Module shall provide protection for the signal cable, communication bus or data line.
    2) Manufacturers: One of the following or equal:
        a) Eaton/MTL, TP Series.
        b) Endress+Hauser, HAW569 Series.
        c) Phoenix Contact, Surgetrab S-PT Series.

S. Horns and beacons:
1. Beacons/horn combination units:
    a. Manufacturers: One of the following or equal:
        1) Edwards, Multi-Status LED 108i with tone module.
        2) Federal Signals, AV1ST Strobe Combination Audible/Visual Signal.
    b. LED Colors: Red, Green, and Amber.
    c. Power: 24 VDC.
    d. Provide accessories such as pipe mount flange, pipe extensions, corner mount brackets, or wall mount brackets as needed.
    e. Horn rated 80 dB minimum at 10 feet.
2. Dedicated beacon unit:
    a. Manufacturers: One of the following or equal:
        1) Allen-Bradley, 855 B *-* 10 Series.
        2) Edwards, 102 Series.
        3) Federal Signal Corp., Starfire Series.
3. Dedicated horn unit:
    a. Electromechanical:
        1) Manufacturers: One of the following or equal:
            a) Edwards, 878EX or 879EX Series.
            b) Federal Signal, 350 or 31X Series.
    b. Electronic:
        1) Manufacturers: One of the following or equal:
            a) Allen-Bradley, 855H or 855XH Series.
            b) Edwards, 5530M or 5533MD Series.
            c) Federal Signal, 300GCX or 300X Series.
    c. Rated for 80 dB minimum at 10 feet.

T. Power supplies:
1. Configure power supply system so that either the primary or backup supply can be removed, repaired or replaced, and returned to service without disrupting the system operation.

2. Convert 120 VAC to 24-volt DC or other DC voltages required or as required for the application.
3. Provide redundant backup 24 VDC power supply units to automatically supply the load upon failure of the primary supply.
4. Provide power supply arrangement that is configured with several modules to supply adequate power in the event of a single module failure in either a 1+1 or N+1 configuration as required:
    a. Provide automatic switchover upon module failure.
    b. Alarm contacts monitored by the PLC.
5. Provide protective isolation between power supply units either by means of Diodes, Diode Modules, MOSFET Modules, or use power supplies with built in redundancy. Power supplies with built in redundancy must actively isolate each power supply and be designed as such.
6. Sized to provide 40-percent excess rated capacity.
7. UL 508 listed to allow full-rated output without de-rating.
8. Provide fuse or short-circuit protection.
9. Provide a minimum of 1 set of dry contacts for each power supply configured to change state on failure for monitoring and signaling purposes.
10. Output regulation: Within 0.05 percent for a 10-percent line change or a 50-percent load change.
11. Operating temperature range: 32 degrees to 140 degrees Fahrenheit.
12. Touch-safe design: Connection terminals to be protected against accidental touch.
13. DIN rail mounting on 35-millimeter rail:
    a. Mount the power supply in the proper orientation as recommended by the manufacturer to ensure adequate thermal dispersion without derating the power supply.
14. Provide self-protecting power supplies with a means of limiting DC current in case of short circuit.
15. Manufacturers: One of the following or equal:
    a. Fully redundant:
        1) IDEC, PS5R Series:
        2) Phoenix Contact, Quint Power Supply with SFB technology.
            a) Phoenix Contact, Quint.
        3) PULS.
        4) Sola.
    b. Redundancy module:
        1) Phoenix Contact, O-ring redundancy module.

U. Limit switches:
1. NEMA Type 4X.
2. AC contact rating 120 volts, 10 A.
3. DC contact rating 125 volts, 0.4 A.
4. Provide robust actuation mechanism not prone to degradation.
5. Provide complete actuator mechanism with required hardware.
6. Allows for contact opening even during contact weld condition.
7. UL approved.
8. Operating temperature range: 0 degrees to 230 degrees Fahrenheit).
9. Manufacturers: One of the following or equal:
    a. ABB.
    b. Allen-Bradley, 802 Series.

c. Eaton, E47, E49, E50.
d. Honeywell, HDLS Series.
e. Omron, D4 Series.

V. Proximity switches:
1. Power supply: 24 VDC supply voltage.
2. 1 normally open and normally closed contacts.
3. LED optical sensing, polar-retro.
4. Distance: 6 meters (19.8 feet).
5. Manufacturers: The following or equal:
a. Banner T30 or equal.

W. Current switches:
1. Power supply: 120 VAC supply voltage.
2. 1 normally open and normally closed contacts.
3. Adjustable current setting.
4. Manufacturers: One of the following or equal:
a. Phoenix Contact, EMD Series.
b. Zelio®, RM35.

X. Current transmitters:
1. Input current range: As indicated on the Drawings.
2. Output: 4 to 20 mA.
3. Power supply: 24 VDC supply voltage.
4. Output overload protected.
5. Accuracy: Within 0.5 percent full-scale.
6. Ripple and Noise: 1 percent max., peak to peak.
7. Frequency: 50/60 hertz.
8. Manufacturers:
a. American Aerospace: 1070 Series.
b. CR Magnetics: CR4320 series.
c. Phoenix Contact: Mini Analog Pro Series.

Y. Panel mount quick connector:
1. Keyed insertion plug.
2. Threaded cap to protect connection when not in use.
3. Material: Stainless steel.
4. Pre-wired pigtails.
5. Indoor/outdoor:
a. Rating: Meets or exceeds panel rating.
b. Manufacturers: One of the following or equal:
1) Amphenol.
2) Sealcon.
6. Hazardous (classified) areas:
a. UL listed and labeled for area as indicated on the Drawings.
b. Manufacturers: The following or equal:
1) Amphenol HDE Series.

2.07 ACCESSORIES

A. Provide panels with an inside protective pocket to hold the panel drawings. Ship panels with 1 copy of accepted Shop Drawings, including, but not limited to, schematic diagram, connection diagram, and layout drawing of control wiring and components in a sealed plastic bag stored in the panel drawing pocket.

B. Provide floor stands or legs with a minimum height of 12 inches where needed or as indicated on the Drawings.

C. Provide a folding shelf for enclosures that contain programmable controllers. Shelf shall be mounted on the inside surface of the door, capable of supporting a laptop computer.

D. Provide nameplate to each panel as indicated on the Drawings:
   1. As specified in Section 16075 - Identification for Electrical Systems on internal and external instruments and devices.
   2. Panel Name Plates shall be White with Black letters.
   3. With the following markings that is plainly visible after installation:
      a. Manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the panel can be identified.
      b. Supply voltage, phase, frequency, and full-load current.
      c. Power source or circuit ID.
      d. Short-circuit current rating of the panel based on one of the following:
         1) A listed and labeled assembly.
         2) Established utilizing an approved method.

E. Provide a window kit where indicated on the Drawings or where a transmitter with display is mounted inside a control panel. Window shall meet the following requirements:
   1. Safety plate glass.
   2. Secured by rubber locking seal.
   3. Allow full viewing of devices issuing visual process data or diagnostics.

F. Lighting:
   1. Provide 1 luminaire for each section, on the interior of the panel, spaced evenly along the top-front of the enclosure door opening(s):
      a. Covered or guarded.
      b. Provide On-Off door-activated switches where indicated on the Drawings.
      c. 120-volt, single-phase, 15-amp style plug.
      d. Provide 4,000 K, 900 lumens LED fixture.
         1) Provide additional fixtures for every 36 inches of width.

G. Receptacles:
   1. Provide 1 duplex receptacle located every 6 feet of enclosure width, spaced evenly along the back mounting panels.
   2. GFCI, 120-volt, single-phase, 15-amp style plug.
   3. Provide circuit breaker or fuse to limit receptacle draw to 5 amps.

H. Grounding:
   1. Provide the following:
      a. Grounding strap between enclosure doors and the enclosure.
      b. Equipment grounding conductor terminals.
      c. Provide equipment grounding busbar with lugs for connection of equipment grounding wires.
      d. Bond multi-section panels together with an equipment grounding conductor or an equivalent grounding busbar.
   2. Identify equipment grounding conductor terminals with the word “GROUND,” the letters “GND”, the letter “G”, or the color green.
   3. Signal cable shields shall only be grounded at a single point in the loop. Unless otherwise noted, ground signal cable shields at control panel.
   4. Ensure the continuity of the equipment grounding system by effective connections through conductors or structural members.
   5. Design so that removing a device does not interrupt the continuity of the equipment-grounding circuit.
   6. Provide an equipment-grounding terminal for each incoming power circuit, near the phase conductor terminal.
   7. Size ground wires in accordance with NEC and UL Standards, unless noted otherwise.
   8. Unless otherwise noted, connect exposed, noncurrent-carrying conductive parts, devices, and equipment to the equipment-grounding circuit.
   9. Connect the door stud on the enclosures to an equipment-grounding terminal within the enclosure using an equipment-bonding jumper.
      a. Control Panel ground lugs and ground bar shall be copper mechanical or compression connection type. Aluminum connectors or lugs are not acceptable for use with copper conductors.

I. Provide sunshades and insulation for outdoor installations.

2.08 FINISHES

A. Finishes:
   1. Metallic (non-stainless):
      a. Metal surfaces of panels shall be prepared by chemical cleaning and mechanical abrasion in accordance with the finish manufacturer’s recommendations to achieve a smooth, well-finished surface.
      b. Scratches or blemishes shall be filled before finishing. 1 coat of zinc phosphate shall be applied according to the manufacturer’s recommended dry-film thickness and allowed to dry before applying the finish coat.
      c. Finish coat shall be a baked polyester-urethane powder, aliphatic air-dry polyurethane, or epoxy enamel to meet NEMA rating specified application.
      d. Exterior of enclosures located outdoors shall be UV-resistant polyester powder coating. Total dry film thickness shall be 3 mils, minimum.
   2. Stainless steel:
      a. Stainless enclosures shall be provided with a Number 4 brushed finish - not painted.

B. Colors:
   1. Exterior color of panels mounted indoors shall be manufacturer's standard light gray.
   2. Exterior of panels mounted outdoors shall be manufacturer's standard white.
   3. Panel interiors shall be manufacturer's standard white.

PART 3 EXECUTION

3.01 PREPARATION

A. Equipment support and anchoring to structures:
   1. As specified in Section 01850 - Design Criteria, including, but not limited to:
      a. Anchor bolt layout.
      b. Equipment templates.
      c. Anchor installation.

3.02 INSTALLATION

A. Install enclosures so that their surfaces are plumb and level within 1/8-inch over the entire surface of the panel: Anchor securely to wall and structural supports at each corner, minimum. Direct attachment to drywall is not permitted.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details.

C. Provide floor stand kits for wall-mounted enclosures larger than 48-inches high.

D. Provide concrete housekeeping pads for freestanding enclosures.
   1. Refer to the structural typical details.

E. Install gasket and sealing material under panels with floor slab cutouts for conduit:
   1. Undercoat floor-mounted panels.

F. Provide a full-size equipment-grounding conductor in accordance with NEC included with the power feeder. Terminate to the incoming power circuit-grounding terminal.

G. Holes for field conduits, etc., shall be cut in the field. No additional holes, factory cut holes, or hole closers allowed. Incorrect holes, additional holes, or miscut holes shall require that the entire enclosure be replaced.

H. Protect wiring from sharp edges and corners.

I. Control panels that are adjacent to motor control centers shall be fully wired to the motor control centers using wireways integral to the motor control center or additional conduits as needed. These interconnections are not shown or reflected on the Conduit Schedule but shall be shown on the loop drawings prepared by the Contractor.

J. Provide individually fused analog input module points with blown-fuse indicator lights, mounted external of the module on the output terminal strip.

K. Side panels:
   1. Side panels shall be kept free of control equipment and devices. Any deviation must be sent to the Engineer in writing asking for a deviation.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

END OF SECTION

SECTION 17712

CONTROL SYSTEMS: UNINTERRUPTIBLE POWER SUPPLIES 10 KVA AND BELOW

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Single-phase double conversion uninterruptible power supplies rated 10 kVA and below.

1.02 REFERENCES

A. As specified in Sections 16050 - Common Work Results for Electrical and 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Abbreviations:
   1. MOV: Metal oxide varistor.

C. Definitions:
   1. Critical load: Load supplied by the UPS.

D. Standards:
   1. Federal Communications Commission (FCC):
      a. FCC Part 15, Class A.
      b. FCC Part 15, Class B.
   2. Institute of Electrical and Electronic Engineers (IEEE):
      a. 519 - IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
      b. 1184 - IEEE Guide for Batteries for Uninterruptible Power Supply Systems.
      c. C62.41 - IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250 - Enclosures for Electrical Equipment (1000 V Maximum).
   4. Underwriters Laboratories, Inc. (UL):
      a. UL 1778 - Standard for Uninterruptible Power Supply Systems and Equipment.

1.03 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Product data:
   1. Manufacturer and model number.
   2. Catalog data.

3. Dimensions:
    a. Height.
    b. Width.
    c. Depth.
    d. Weight.
4. Ratings:
    a. Input voltage.
    b. Output voltage.
    c. Input/output power factor.
    d. Efficiency.
    e. Harmonic distortion.
    f. Runtime.
5. Noise specifications.
6. Heat dissipation.
7. Warranties and maintenance contracts:
8. All communications requirements such as software, cards, etc.
9. Alarms and status available for remote monitoring and system health.

C. Shop drawings:
1. Power distribution block diagrams.
2. Front and rear views of equipment enclosures:
    a. Front elevation including all control and indicating devices.
3. Support points and weight of overall equipment.
4. Schematic and control wiring diagrams including, but not limited to:
    a. Line and load terminals.
    b. Alarm and status terminals.
    c. Manual maintenance bypass switch terminals.
    d. External Battery or Step-down/Step-up Transformers if any.
    e. External wiring requirements for all communication signals.
5. Switching and overcurrent protective devices.

D. Calculations:
1. Include derating for temperature and elevation as necessary.
2. UPS sizing computation:
    a. Apply safety factors as specified in this Section.
    b. Provide itemized list of critical loads, including individual VA and watt ratings.
3. Battery time calculation based on specified runtime for total load with the safety factor multiplied to it. Table/graph for back-up time calculation.
4. Load calculation shall include power for all shown in the power distribution drawing, which include but not limited to PLC power supply, field instruments (120VAC and 24VDC), Instrument power, Ethernet switches, and I/O modules. Refer to Network Drawings for additional information and notes.
5. Total battery recharge time as a function of capacity utilized.

E. Design data:
1. Design mounting and anchorage for seismic design criteria specified in Section 01850 - Design Criteria:
    a. Provide seismic kits as required to meet design criteria.

F. Record documents:
   1. Provide Record Drawings of installed unit(s) including layout and wiring.

G. Manufacturer's field reports.

H. Operation and maintenance manuals:
   1. System instruction manuals that describe troubleshooting, installation, operations, and safety procedures.
   2. Recommendations for maintenance procedures and intervals.
   3. Battery data/replacement information.
   4. Parts list.

1.04 QUALITY ASSURANCE

A. Manufacturer qualifications:
   1. A minimum of 10 years' experience in the design, manufacture, and testing of solid-state UPS systems.
   2. ISO 9001 certified.

B. Regulatory requirements for complete UPS system:
   1. UL listed per UL Standard 1778.
   2. IEEE C62.41, Categories B.
   3. FCC 15:
      a. Greater than 2,000 VA - Class A.
      b. Less than 2,000 VA - Class B.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS (NOT USED)

1.08 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide complete, factory-assembled, wired, and tested, true on-line double conversion UPS equipment including, but not limited to, rectifier, DC bus, inverter, battery charger, batteries, automatic bypass, and ancillary components as specified in this Section and as indicated on the Drawings.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Critical loads as indicated on the Drawings.

2.03 MANUFACTURERS

A. Double conversion true online UPS system:
   1. The following or equal:
      a. LTI Power Systems.

2.04 EXISTING PRODUCTS (NOT USED)

2.05 MATERIALS (NOT USED)

2.06 MANUFACTURED UNITS

A. Design requirements:
   1. The minimum VA rating of the UPS shall be greater than or equal to the safety factor (as indicated in the UPS schedule) times the connected load or 700 VA, whichever is greater.
   2. UPS System Input:
      a. Input Voltage:
         1) Less than or equal to 3 kVA UPS:
            a) 120VAC within 3 percent, single-phase, 2-wire plus ground (L1, N, G).
         2) Greater than 3 kVA UPS:
            a) 208VAC within 5 percent, single-phase, 3-wire plus ground (L1, L2, N, G).
         3) Frequency: 60 hertz:
            a) Auto sensing on initial power up.
            b) User configurable.
      b. Input current harmonic distortion (THDi%):
         1) Less than or equal to 5 percent at full load operation.
      c. Input power factor:
         1) Greater than or equal to 0.99 lagging at rated load.
      d. Input connections:
         1) As specified and as indicated on the Drawings.
   3. UPS Inverter:
      a. Output Voltage:
         1) Less than or equal to 3kVA UPS:
            a) Standard:
               (1) 120VAC.
            b) User selectable:
               (1) 100VAC, 110VAC, 120VAC, 125VAC.
         2) Greater than 3kVA UPS:
            a) Standard:
               (1) 208VAC.
            b) User selectable: A.
               (1) 200VAC, 208VAC, 220VAC, 230VAC, 240VAC.
      b. AC-AC Efficiency:
         1) Greater than or equal to 89 percent at full rated resistive linear load.

c. Transient recovery time:
    1) To nominal voltage within 100 milliseconds.
d. Voltage regulation:
    1) Within1 percent steady state.
e. Output Voltage Distortion (THDV%):
    1) Linear load: Less than 2 percent.
    2) Non-linear load: Less than 5 percent.
f. Output power factor:
    1) The load power factor range shall be 0.65 lagging to 1.0 (unity) leading without power derating.
g. Current overload capability:
    1) The UPS shall attempt to clear overloads while maintaining normal operation before transferring to bypass.
    2) Bypass transfer thresholds shall follow inverse time-current characteristic that operates when the load exceeds the nameplate rating of the UPS.
    3) Transfer load to bypass when overload capacity is exceeded.

4. Batteries:
    a. Internal battery shall utilize lithium-ion cells.
    b. UPS shall have capability for connection of external battery modules to extend total available run time. External batteries shall match the UPS in aesthetics and color.
5. Mounting:
    a. Configurable for rack and tower mounting applications.
    b. Provide manufacturer's standard mounting kit as required by the application.
6. Cooling:
    a. UPS shall have integral forced air cooling.
7. Output connections:
    a. Receptacles:
        1) Less than or equal to 3kVA UPS:
            a) Provide a minimum of four NEMA Type 5-15R or Type 5-20R receptacles.
            b) Provide at least one NEMA Type L5-30R receptacle.
        2) Greater than 3kVA UPS:
            a) Provide a minimum of four NEMA Type 5-20R receptacles.
            b) Provide at least one NEMA Type L14-30R receptacle.
        3) Provide hardwired connections as required and as indicated on the Drawings.

B. Environmental requirements:
    1. Operating ambient temperature:
        a. UPS module: 50 degrees Fahrenheit to 104 degrees Fahrenheit (10 degrees Celsius to 40 degrees Celsius).
        b. Battery: 68 degrees Fahrenheit to 86 degrees Fahrenheit (20 degrees Celsius to 30 degrees Celsius).
    2. Operating altitude:
    3. Project site conditions as specified in Section 01850 - Design Criteria.
    4. Surge protection:
        a. UPS shall confirm to ANSI C62.41, Category B.

5. Audible noise:
    a. Less than 46 dB at 1 meter.

C. Communications:
1. Relay outputs:
    a. The UPS shall contain on the rear panel a terminal block to provide low voltage signals for On Battery, Low Battery, Any Mode Shutdown and Battery Mode Shutdown.
2. Serial:
    a. The UPS shall provide a RS232 serial connection.
3. USB:
    a. The UPS shall provide a USB connection that is HID compliant for network connection.

2.07 ACCESSORIES

A. External maintenance bypass:
1. Manufacturers: One of the following or equal:
    a. Vertiv, Liebert Micropod Series.
    b. Eaton HotSwap MBP Series.
2. Properties:
    a. Provides isolation of the UPS for maintenance purposes.
    b. Provide maintenance bypass from the same manufacturer as the UPS manufacturer.
    c. UL 1778 listed.
    d. Provide manufacturer's recommended mounting kit as required by the application.
    e. Make-before-break design so that UPS can be isolated from the critical loads by placing these loads on source power without interruption of operation.
    f. Utility and UPS status indications.
    g. Rated to carry the full input current of the UPS.
    h. Connections to match UPS connections and as indicated on the Drawings.
    i. Supply necessary input/output cords and receptacles for connections with power source and UPS.
    j. Connections to match UPS connections and as indicated on the Drawings.
    k. Supply necessary input/output cords and receptacles for connections UPS and critical loads.

B. External batteries:
1. Manufacturers: One of the following or equal:
    a. Vertiv, Liebert GXT5 EBC Series.
    b. Eaton 9PX EBM Series.
2. Properties:
    a. External batteries to provide extended runtime capabilities.
    b. Provide batteries from the same manufacturer as the UPS manufacturer.
    c. UL listed.
    d. Housing shall match the appearance of the UPS.

e. Provide manufacturer’s recommended mounting kit as required by the application.
f. Connections to match UPS connections and as indicated on the Drawings.
g. Supply necessary cords and cables for connection to UPS.
h. [Communication:
    1) Ethernet:
        a) External batteries shall include Ethernet network communication card.
        b) Network protocols: SNMP, Modbus TCP.
        c) Network interface: RJ45.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 INSTALLATION

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

B. Do not utilize extension cords, adapters, or other electrical connectors for UPS input.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.04 FIELD QUALITY CONTROL

A. Perform inspections and test procedures before UPS startup:
    1. Inspect equipment for signs of damage.
    2. Verify installation as indicated on the Drawings and specified in the Specifications.
    3. Inspect cabinets for foreign objects.
    4. Verify neutral and ground conductors are properly sized and terminated.
    5. Inspect battery cases.
    6. Inspect batteries for proper polarity.
    7. Check power and control wiring for tightness.
    8. Check terminal connectors for tightness.
    9. Ensure connection and voltage of the battery string(s).

3.05 SCHEDULES

TAG	MINIMUM RUNTIME	INPUT VOLTAGE / CONNECTION	SAFETY FACTOR	NOTES
UPS-CL	15 minutes	480V, 1 PH	1.5	
UPS-CS	15 minutes	480V, 1 PH	1.5	

END OF SECTION

SECTION 17720

CONTROL SYSTEMS: PROGRAMMABLE LOGIC CONTROLLERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Programmable logic controller (PLC) based control systems hardware.
   2. Development software to be used with the specified PLC hardware.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Abbreviations:
   1. CPU: Central processing unit.
   2. I/O: Input/Output.

C. Standards:
   1. Institute of Electrical and Electronics Engineers (IEEE).

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Application software: The software that is programmed specifically for the Project.
   2. Development operating software: The software provided by the PLC manufacturer for use in programming the PLC.

1.04 SUBMITTALS

A. Furnish submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Product data:
   1. CPU:
      a. Processor type.
      b. Processor speed.
      c. Memory.
      d. Internal processor battery backup time.
   2. I/O modules:
      a. Type.
      b. Standard wiring diagram.
   3. Programming languages.

4. Operating system requirements.

C. Calculations:
   1. Submit calculations or documented estimate to verify that memory requirements of this Section are met, including spare requirements. If possible, use PLC manufacturer's calculation or estimating worksheet.
   2. Submit calculations to verify that spare I/O requirements of this Section are met.
   3. Submit calculations to verify that PLC power supply requirements of this Section are met.

D. Control logic:
   1. Fully annotated copy of programmed PLC logic.
   2. Cross-referenced index of PLC registers or points.

E. Provide application software for the specific Project process requirements:
   1. Fully annotated copy of programmed PLC logic in its native format.
   2. Cross-referenced index of PLC registers or points.

1.05 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide PLC hardware manufactured at facilities certified to the quality standards of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)

1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

1.10 MAINTENANCE

A. Furnish the following:
   1. CPU: 1 spare for each type of CPU in the system.
   2. I/O cards: 3 spares for each type of I/O card in the system.
   3. Power supplies: 2 spares for every power supply in the system.
   4. Network/communications cards: 1 spare for every network or communications card in the system.
   5. Remote adapter: 1 spare for every remote adaptor in the system.
   6. Chassis: 1 spare for each chassis size in the system.

7. Communication cable: 1 spare for each type of cable used in the system.

B. Installed spare requirements:
   1. I/O points:
      a. Provide total of 25 percent spare I/O capacity for each type of I/O at every PLC/RIO rack using the following calculation:

$$\left(1 - \frac{\text{UTILIZED IO POINT COUNT}}{\text{TOTAL IO POINT COUNT}}\right) * 100 = \%\text{SPARE}$$

      b. Wire spare I/O points to field terminal blocks in the same enclosure the PLC/RIO resides in.
   2. PLC backplane capacity:
      a. Provide 25-percent or 3 spare backplane slots, whichever is greater, in racks containing I/O.
   3. PLC memory:
      a. Provide 50-percent spare program volatile memory.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide PLC hardware as indicated on the Drawings and as specified in this Section.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide PLC system components by a single manufacturer:
   1. Third-party communication modules may be used only for communication or network media functions not provided by the PLC manufacturer.

B. Use PLC manufacturer approved hardware, such as cable, mounting hardware, connectors, enclosures, racks, communication cable, splitters, terminators, and taps.

C. PLC hardware, CPUs, I/O devices, and communication devices shall be new, free from defects, and produced by manufacturers regularly engaged in the manufacture of these products.

2.03 MANUFACTURERS

A. The following, no equal:
   1. Modicon:
      a. M340.

B. The PLC programming software system shall be manufactured by PLC hardware manufacturer:
   1. Modicon:
      a. EcoStruxure.

2.04 MANUFACTURED UNITS

A. Programmable logic controller:
   1. Construction:
      a. Furnish plug-in modular system.
      b. Provide PLCs capable of operating in a hostile industrial environment without fans, air conditioning, or electrical filtering:
         1) Temperature: 0 to 55 degrees Celsius.
         2) RFI: 80 to 1,000 MHz.
         3) Vibration: 10 to 500 hertz.
         4) Humidity: 0 to 95 percent.
      c. Provide internal power supplies designed to protect against overvoltage and frequency distortion characteristics frequently encountered with the local power utility.
      d. Design the PLC system to function as a standalone unit that performs all of the control functions described in this Section completely independent from the functions of the HMI system PC-based operator interfaces:
         1) Failure of the HMI system shall not impact data acquisition, control, scaling, alarm checking, or communication functions of the PLC.
   2. CPU:
      a. Configure each CPU so that it contains all the software relays, timers, counters, number storage registers, shift registers, sequencers, arithmetic capability, and comparators necessary to perform the specified control functions.
      b. Capable of interfacing with discrete inputs, analog inputs, discrete outputs, analog outputs, and communication cards to meet the specified requirements.
      c. Capable of supporting and implementing closed-loop floating-point math and PID control that is directly integrated into the CPU control program.
   3. Memory:
      a. Non-volatile memory: On-board complementary metal-oxide-semiconductor (CMOS), electrically erasable programmable read-only memory (EEPROM), PCMCIA, compact flash card, or SD card.
      b. Supply with sufficient memory to implement the specified control functions plus a reserve capacity as specified with the requirements of this Section:
         1) Reserve capacity:
            a) Totally free from any system use.
         2) Programmed in a multi-mode configuration with multiple series or parallel contacts, function blocks, counters, timers, and arithmetic functions.
   4. Programming:
      a. Provide a system where processors are programmed by:
         1) Portable laptop computer both locally and via the PLC control network.
   5. PLC power supply:
      a. Input: 120 VAC.
      b. Mounted in the PLC housing or as indicated on the Drawings.
      c. Sized to power modules mounted in that housing including an average module load for any empty housing slots plus 50 percent above that total.

6. PLC input/output, I/O modules: 8-channel, 16-channel, 32-channel:
    a. General:
        1) Compatible with all PLCs being furnished under the contract and by the same manufacturer as the PLCs.
        2) Provide I/O modules that:
            a) Isolate in accordance with IEEE Surge Withstand Standards and NEMA Noise Immunity Standards.
            b) Provide A/D and D/A converters with optically or galvanically isolated inputs and outputs.
            c) Accept dual-ended inputs.
        3) Use of common grounds between I/O points is not acceptable.
        4) Provide modules that are removable without having to disconnect wiring terminals:
            a) Utilize a swing-arm or plug-in wiring connector.
        5) Provide at each PLC the I/O modules for the following:
            a) Designated future I/O points contained in the I/O Lists and/or shown on the P&IDs, control schematics, or described in the control strategies.
            b) Installed spare capacity in accordance with the requirements of this Section.
            c) Wire spares provided to the field terminal strip.
        6) Condition, filter, and check input signals for instrument limit conditions.
        7) Filter, scale, and linearize the raw signal into an engineering-units-based measurement.
        8) Alarm measurements for high, low, rate-of-change limits, and alarm trends.
        9) Provide external fuses mounted on the field connection terminal block for discrete input, discrete output, and analog input I/O points.
        10) When multiple cards of the same I/O type are provided and parallel equipment, instrumentation, or redundant processes exist, distribute I/O among cards to ensure that a single card failure will not render an entire process unavailable.
        11) Provide 25% spare capacity for each type of I/O at each PLC and RIO.
    b. Discrete input modules:
        1) Defined as contact closure inputs from devices external to the input module.
        2) Provide inputs that are optically isolated from low-energy common-mode transients to 1,500 volts peak from users wiring or other I/O modules.
        3) Individually isolated inputs.
        4) With LEDs to indicate the status of each discrete input.
        5) Input voltage: 24 VDC.
        6) Provide input module points that are individually fused with blown-fuse indicator lights, mounted external of the module on the output terminal strip:
            a) Coordinate external fuse size with the protection located on the module so that the external fuse opens first under a fault condition.

c. Discrete output modules:
    1) Defined as contact closure outputs for ON/OFF operation of devices external to the output module:
        a) Triac outputs may be used, with the permission of the Engineer. Care must be used in applying this type of module to ensure that the leakage current through the output device does not falsely signal or indicate an output condition.
    2) Optically isolated from inductively generated, normal mode and low-energy common-mode transients to 1,500 volts peak.
    3) LEDs to indicate status of each output point.
    4) Output voltage: 24 VDC.
d. Analog input modules: Individually isolated:
    1) Signal type: Provide 4 to 20 mA for most applications; other levels are acceptable to interface to vendor control panels.
    2) Analog-to-digital conversion: Minimum 12-bit precision with the digital result entered into the processor.
    3) Analog-to-digital conversion updated with each scan of the processor.
    4) Individually isolated each input.
    5) Coordinate the size of the external fuse with the protection located on the module, so that the external fuse opens first under a fault condition.
    6) Provide field mounted surge suppression modules for analog signals that are located outside the building that houses the PLC node:
        a) Manufacturers: One of the following, or equal:
            (1) Emerson/Edco, model SS65-036-2, or similar for loop powered field instruments.
            (2) Emerson, model 265 (SLAC) series.
            (3) Phoenix Contact, PLUGTRAB SEC series, or similar for field instruments that require auxiliary power (24 VDC/VAC, 120 VAC, 230 VAC).
e. Analog output modules:
    1) Signal type: Provide 4 to 20 mA for most applications; other levels are acceptable to interface to vendor control panels.
    2) Individual isolated output points each rated for loads of up to 1,000 ohms.
f. Specialty I/O modules:
    1) Resistance temperature detector (RTD) input module:
        a) Channels per module: 4 minimum.
        b) RTD types accepted:
            (1) 100-ohm platinum.
        c) Provide input module that accepts 2-, 3-, or 4-wire RTD.
    2) HART analog input module:
        a) Channels per module: 4 minimum.
        b) Signal type: Each channel individually configurable for current (0 to 20 mA DC or 4 to 20 mA DC) or voltage (0 to 5 VDC, 0 to 10 VDC, or -10 to 10 VDC).
        c) Each channel can individually have HART enabled or disabled.
        d) Flash-upgradeable firmware.
        e) Mounts in slot in PLC backplane.

f) Modules shall be configured using the specified PLC programming software.

3) HART analog output module:
   a) Channels per module: 4 minimum.
   b) Signal type: Each channel individually configurable for current (0 to 20 mA DC or 4 to 20 mA DC) or voltage (0 to 5 VDC, 0 to 10 VDC, or -10 to 10 VDC).
   c) Each channel can individually have HART enabled or disabled.
   d) Flash-upgradeable firmware.
   e) Mounts in slot in PLC backplane.
   f) Modules shall be configured using the specified PLC programming software.

g. Pre-wired I/O cable system (FOR ANALOG CARDS ONLY):
   1) Provide the pre-wired I/O cables to eliminate field wiring between the I/O module and field wiring terminal blocks.
   2) Pre-wired I/O cable system consists of the following:
      a) Interface module terminal block assembly:
         (1) Installed on standard DIN rail.
         (2) Provided with terminals for necessary field wiring for 1 I/O module.
         (3) Equipped with a manufacturer standard connector port.
      b) Pre-wired I/O cable:
         (1) Terminate 1 end with manufacturer standard connector to connect to the interface module.
         (2) Pre-wire 1 end to a removable terminal block that plugs into the front of the I/O module.

7. PLC backplane housing:
   a. Mount the PLC power supply, CPU, communications module, and I/O modules in a suitable standard PLC backplane or housing.
   b. Provide 3 spare backplane slots at each PLC and RIO.
   c. Provide a blank slot filler module for each spare slot.

B. HMI system interface:
   1. As specified in Section 17733 - Control Systems: Network Materials and Equipment.

C. PLC programming software:
   1. Furnish operating software capable of monitoring and/or controlling the PLCs via the PLC data network:
      a. Contain diagnostics to collect troubleshooting and performance data and display it in easy to understand graphs and tables.
      b. Monitor devices at each drop on the PLC data network for proper communications.
      c. Provide the ability to program PLCs on the PLC data network from the Engineer’s console.
   2. PLC programming laptop/desktop operating system:
      a. Microsoft Windows 10.
   3. Suitable for the PLCs specified above.
   4. For programming, monitoring, searching, and editing:
      a. Usable both on-line, while connected to the PLC, and off-line.

b. Operating software shall display multiple series and parallel contacts, coils, timers, counters, and mathematical function blocks.
c. Capable of disabling/forcing inputs, outputs, and coils to simulate the elements of the ladder logic; forced elements shall be identifiable by means of color change.
d. Include a search capability to locate any address or element and its program location.
e. Display at the EC, PLC status information, such as faults and communication errors and amount of memory remaining.

5. Support IEC-61131-3 compliant programming languages:
6. Generate a PLC program printout, which is fully documented, through the PLC programming software:
   a. Fully documented program listings include, as a minimum, appropriate rungs, address, and coils shown with comments to clarify to a reader what that segment of the program accomplishes on an individual line-by-line basis.
   b. Include a sufficient embedded comment for every rung of the program explaining the control function accomplished in said rung.
   c. Use a mnemonic associated with each contact, coil, etc., that describes its function.
   d. Utilize the tag and loop identification as contained in the P&IDs:
      1) If additional internal coils, timers, etc., are used for a loop, they shall contain the loop number.
   e. Provide a cross-reference report of program addresses.
7. Software functions automatically without operator intervention, except as required to establish file names and similar information:
   a. Furnish the operating system software that is the standard uncorrupted product of the PLC manufacturer with the following minimum functions:
      1) Respond to demands from a program request.
      2) Dynamic allocation of the resources available in the PLC. These resources include main memory usage, computation time, peripheral usage, and I/O channel usage.
      3) Allotment of system resources based on task priority levels such that a logical allocation of resources and suitable response times are ensured.
      4) Queuing of requests in order of priority if one or more requested resources are unavailable.
      5) Resolution of contending requests for the same resource in accordance with priority.
      6) Service requests for execution of 1 program by another.
      7) Transfer data between programs as requested.
      8) Management of information transfers to and from peripheral devices.
      9) Control and recovery from program fault conditions.
      10) Diagnose and report real-time hardware device errors.
8. Program execution:
   a. Application software - program execution scheduled on a priority basis:
      1) A multilevel priority interrupt structure is required.
      2) Enter into a list of pending programs a program interrupted by a higher priority program:
         a) Resume its execution once it becomes the currently highest priority program.

3) Schedule periodic programs.
4) Base the allocation of resources to a time-scheduled program on its relative priority and the availability of resources.

9. Start-up and restart:
   a. Provide software that initializes and brings a PLC or any microprocessor-based hardware unit from an inactive condition to a state of operational readiness.
   b. Initialization:
      1) Determination of system status before start-up of initializing operating system software and initializing application software.
      2) Loading of memory-resident software, initializing timers, counters, and queues, and initialization of dynamic database values.
10. Shutdown:
   a. Where possible, provide orderly shutdown capability for shutdowns resulting from equipment failure, including other PLC processor failures, primary power failure, or a manually entered shutdown command.
   b. Upon loss of primary power, a high-priority hardware interrupt initiates software for an immediate, orderly shutdown.
   c. Hardware is quickly and automatically commanded to a secure state in response to shutdown command or malfunction.
   d. Alarm PLC failure at the operator interface level.
11. Diagnostics:
   a. Furnish diagnostic programs with the PLC software package to detect and isolate hardware problems and assist maintenance personnel in discovering the causes for system failures.
   b. Use the manufacturer's standard diagnostic routines as much as possible.
   c. Furnish diagnostic software and test programs for each significant component in the control system.
   d. As a minimum, provide diagnostic routines to test for power supply, central processing unit, memory, communications, and I/O bus failures.
12. Calendar/time program:
   a. To update the second, minute, hour, day, month, and year and transfer accurate time and date information to system-level and application software.
   b. Variations in the number of days in each month and in leap years must be handled automatically by the program.
   c. Operator must be able to set or correct the time and date from any operator interface, only at the highest security level.
13. Algorithms:
   a. Implementation of algorithms for the determinations of control actions and special calculations involving analog and discrete data.
   b. Algorithms must be capable of outputting positional or incremental control outputs or providing the product of calculations.
   c. Algorithms must include alarm checks where appropriate.
   d. Provide, as a minimum, the following types of algorithms:
      1) Performs functions such as summing several variables, raising to a power, roots, dividing, multiplying, and subtracting.
      2) A switch algorithm, which reads the current and value from its input address and stores it as the value of its output address. 2 types of switches shall be accommodated: 2 outputs with 1 input and 1 output with 2 inputs.

3) A 3-mode proportional-integral-derivative, PID, controller algorithm, with each of the 3 modes independently adjustable, supports both direct and reverse-acting modes.
4) Lead, lag, dead time, and ratio compensators.
5) Integration and totalization of analog process variables.

14. Furnish a comprehensive database for the analog inputs, calculated values, control modules, and outputs:
    a. In addition, provide spare database points for future expansion.
15. 1 integrated database can be utilized for all types of analog points or separate databases for each type; in either case, the database for each point must include all specified aspects.
16. All portions of the database must be available for use by the display, report, and other specified software modules.
17. Data fields and functions specified below must be part of the point definition database at the operator interface. Provide the capability to define new database points through the point display specified below as well as modifying defined points through these displays. This point definition and modification must include all features and functions defined below. Analog database software must support the following functions and attributes:
    a. Analog input signal types:
        1) Provide software at the remote terminal units (RTUs) and PLCs to read variable voltage/current signals and pulse duration/frequency type analog input signals.
    b. Input accuracy:
        1) Inputs must be read with an accuracy of within 0.05-percent full-scale or better.
        2) Data conversion errors must be less than 0.05-percent full-scale.
        3) Pulse accumulation error less than or equal to 1 count of actual input count at a scan rate of once per minute.
        4) Maintain for a minimum of 1 year the system accuracy stated above without adjustments.
    c. Blocking:
        1) Provide mechanisms to inhibit or block the scanning and/or processing of any analog input through the operator interface.
        2) For any input so blocked, the operator may manually enter a value to be used as the input value.
    d. Filtering:
        1) For each analog input, provide a first order lag digital filter with an adjustable filter factor.
    e. Linearizing:
        1) Where analog inputs require square root extraction or other linearization, provide a mechanism to condition the filtered data before the process of scaling and zero suppression takes place.
    f. Calculated values:
        1) Provide means to allow for pseudo-inputs calculated by algebraic and/or Boolean expressions utilizing real inputs, other calculated values, constants, etc.
        2) These values must be handled the same as real inputs in terms of record-keeping, alarming, etc.

g. Scaling and zero suppression:
    1) Provide a conversion program to convert input values into engineering units in a floating-point format.
h. Alarms:
    1) Provide an alarm program to check analog variables against high-high, high, low, and low-low alarm limits.
    2) When an analog value exceeds a set limit, it must be reported as an alarm based on individually set priority level for each alarm point.
    3) Provide an adjustable hysteresis band in order to prevent excessive alarms when a variable is hovering around an alarm limit.
    4) Must be possible to inhibit alarms based on external events, e.g., lock-out low pump flow alarm when the pump is off.
i. Averages:
    1) Provide a program to calculate and store hourly, daily, and monthly averages of analog variables.
    2) Continuously compute averages, e.g., the average for the current period to the present point in time must be stored in memory and available for use in displays, etc.
    3) Update hourly averages each minute or at the polling interval for the selected variable.
    4) Update daily averages at least once each hour and calculate using the results of the hourly averages.
    5) Update monthly averages at least once each day and calculate using the results of the daily averages.
    6) At the end of each averaging period, store the average values for the period on the hard disk for historical record-keeping and reset the present period average register to the present value of the variable.
    7) Active database must include the present period average and previous period average for each variable and averaging period.
j. Totals:
    1) Provide a program to calculate and store hourly, daily, and monthly totalization of analog variables.
    2) Assign a scaling factor to each variable to convert to the appropriate units based on a 1-minute totalizing interval.
    3) Assign a separate factor for each totalizing interval.
    4) Variables for which totalization is inappropriate must have scaling factors of zero.
    5) At the end of each totalizing period, store the totalized values for the period on the hard disk for historical record-keeping and reset the present period totalization register to zero.
    6) Active database must include the present period total and previous period total for each variable and totalizing period.
k. Engineering units:
    1) Provide software to allow the system and the operator to convert the measured analog variables to any desired engineering units.
    2) Operator must be able to view displays and generate reports of any measured variable in one or more engineering units, such as flow in gpm, mgd, cfs, and acre-feet per day.
    3) Pre-program the conversion of the engineering units, and, if not pre-programmed, the operator must be able to program new

engineering unit conversions by using simple methods, e.g., multiplication of the database attributes by a constant.

4) Programming method must be at a level and compatible with the specified training of the operator and the Owner's personnel.

5) New conversions must not require the services of a special programmer and/or special, high-level, programming training.

l. Control modules:

1) For each control function configured, whether processed at the RTU, PLC, or operator interface, maintain a file of necessary data including input values, setpoints, constants, intermediate calculated values, output value and limit clamps, etc.

2) Input and output assignments, setpoints, and constants must be adjustable by the operator through the operator interface.

3) Provide control algorithms for manual control with output values adjustable by the operator.

m. Analog outputs:

1) Analog outputs must be maintained as part of the database.

2) These outputs must be adjustable manually by the operator through the operator interface or through automatic control algorithms.

18. Some of the above functions may be better accomplished in the data acquisition and graphic display software package; it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.

D. General control functions:

1. Analog control functions:

a. PID, lead/lag, signal select, alarm, limit, delay, and time base.

b. Furnish the control system complete with a library of mathematical/calculation software to support averaging, weighted average, addition, subtraction, multiplication, division, square root extraction, exponential, AND, OR, NAND, NOR, XOR, and NXOR functions.

c. Math utilities must be linkable to process data points or manual inputs via control block configuration.

d. By linking control blocks to data points, the math library must support system unit conversion and calculation requirements.

2. Discrete control functions:

a. AND, OR, NOT, EXCLUSIVE OR, comparators, delays, and time base.

3. Software support:

a. Retain in firmware all control and logic functions at each RTU and PLC and in RAM at the operator interface.

b. Call each function as required by the configured controls to perform the intended function.

4. Control and status discrepancies:

a. Generate a discrepancy/fail alarm for any pump, valve, or final control element if a discrepancy exists between a system or operator command and the device status:

1) For example, the system commands to start (call), and the pump fails to start (run status report back), within predetermined operator-programmable time delay (time disagree), then a discrepancy (fail) alarm shall be generated.

b. Involuntary change in the device's status must also generate an alarm:
    1) For example, a pump starts when not commanded to do so, or a pump shuts down while running even though it still has a command to run.
c. Each command, status, and alarm must cause the color of the symbol to change.
d. Because many discrete final control elements have a cycle time in excess of the scan interval, provide each control output with an associated delay period selected to be longer than the operating period of the control element:
    1) Delay periods for each final control element must be adjustable at the operator interface.
    2) List time delays in the final documentation.

5. Some of the above functions may be better accomplished in the data acquisition and graphic display software package; it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.

E. Control configuration:
1. Provide software to allow control strategies to be developed, and their operation initiated through the operator interface.
2. Provide standardized control point displays for defining the control functions including the function type, input/output addresses, setpoints, tuning constants, etc.
3. Provide a mechanism to link separate control functions together into an integrated control strategy.
4. Provide a mechanism to download operational/control setpoints developed at any operator interface to any PLC or RTU for operational implementation.
5. Provide a mechanism to define and implement operational/control setpoints locally at the PLC or RTU, and to upload them to the operator interface for operational record-keeping.
6. Perform control configurations on-line at the operator interface; the PLC or RTU may be taken off-line when being configured or downloaded.

F. Remote inputs and outputs (RIOs):
1. Compatible with all PLCs being furnished under this Contract, shall be by the same manufacturer as the PLCs, and, as a minimum, include:
    a. Power supply.
    b. Rack.
    c. Backplane.
    d. Communications module.
    e. I/O modules.
    f. Enclosure.
2. Provide cables and software needed for a complete and operational RIO system as specified in the Contract Documents.
3. Provide a group of pre-assigned diagnostic registers to report RIO system faults to the driver PLC.
4. Control system must continue operation should a fault occur on a single RIO drop:
    a. Upon clearing the fault, restart communications to that drop automatically.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Utilize personnel to accomplish or supervise the physical installation of all elements, components, accessories, or assemblies:
   1. Employ installers who are skilled and experienced in the installation and connection of all elements, components, accessories, and assemblies.

C. All components of the control system, including data network cables, are the installation responsibility of the ICSC unless specifically noted otherwise.

D. General:
   1. Control system logic program shall reside at the PLC level.

E. Use the tag and loop identifications found on the P&IDs for all tags used and/or assigned as part of the application software work provided by the ICSC.

F. Program the PLC logic using the following language(s):
   1. Ladder Diagram.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Owner Training:
   1. As specified in Section 17950 - Commissioning for Instrumentation and Controls.

END OF SECTION

SECTION 17721

CONTROL SYSTEMS: LOCAL OPERATOR INTERFACE (LOI)

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Local operator interface (LOI) control systems hardware and software.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.03 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Product data:
   1. Complete manufacturer's brochures for each item of equipment.
   2. Complete manufacturer's brochures that identify LOI software and options. Mark up to clearly show options and components to be provided, and cross out any options or components that will not be provided.
   3. Manufacturer's operation and installation instructions.
   4. Additional requirements:
      a. Display type and size.
      b. Operator input.
      c. Processor type and speed.
      d. Memory size.
      e. Programming protocols.
      f. Communication protocols.
      g. Power requirements.
      h. Operating temperature and humidity ranges.
      i. NEMA ratings.

C. Shop Drawings:
   1. Furnish the following:
      a. System block diagram showing relationship and connections between devices. Include manufacturer and model information and address settings.
      b. Mounting drawings with dimensions and elevations for each equipment location, including identification of all components, preparation and finish data, and nameplates.
      c. Electrical connection diagrams.
      d. Complete grounding requirements.

2. Graphic screens:
    a. Color printouts of each graphic screen and all control pop-ups.
3. Furnish datasheets for each component together with a technical product brochure or bulletin:
    a. Manufacturer's model number.
    b. Project equipment tag.
4. Complete and detailed bills of materials identified by each cabinet. Include with each bill of material item the following:
    a. Quantity.
    b. Description.
    c. Manufacturer.
    d. Part numbers.

D. Owner Training Submittals:
1. As specified in Section 01756 - Commissioning.

E. Operation and maintenance manuals:
1. As specified in Section 01782 - Operation and Maintenance Manuals.

F. Record documents:
1. Electrical connection diagrams revised to reflect any changes made in the field and submitted as record drawings.

1.04 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the LOI equipment is compatible with the installed conditions.

C. Notify the Engineer if any installation condition does not meet the manufacturer's recommendations or specifications.

D. Provide LOI hardware manufactured at facilities certified to the quality standards of ISO 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

E. System compatibility:
1. Software must be the standard operating software system designed specifically for use with the LOI hardware.
2. Software must be furnished and developed by the manufacturer of the LOI hardware.

1.05 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria:
   1. Provide LOI equipment suitable for the installed Site conditions, including, but not limited to, Site altitude, Site seismic conditions, humidity, and ambient temperatures.

1.07 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Provide a licensed copy of the manufacturer's programming software for the selected LOIs.

1.08 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

1.09 MAINTENANCE

A. Provide system upgrades and maintenance fixes for a period of 2 years from Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide LOI hardware identified in the Contract Documents.

2.02 DESIGN AND PERFORMANCE CRITERIA (NOT USED)

2.03 MANUFACTURERS

A. One of the following or equal:
   1. Schneider Electric
      a. GTU.
      b. GTUX.

B. Provide the LOI graphic software system manufactured by the LOI hardware manufacturer.
   1. Schneider Electric, Vijeo Designer.

2.04 MANUFACTURED UNITS

A. Local operator interface:
   1. General:
      a. Provide LOI located on the face of the PCM as indicated on the Drawings.
      b. LOI consists of graphical display screen with operator input capabilities.
      c. Capable of stand-alone operation in conjunction with 1 PLC.
      d. Equipped with data network communication capabilities.

2. Display:
    a. Type:
        1) Color TFT LCD screen.
        2) Color STN LCD screen.
    b. Resolution:
        1) 1024 by 768 pixels.
        2) 1280 by 800 pixels.
    c. Size: As indicated on the Drawings.
    d. Easy display viewing at any angle in various ambient light conditions.
    e. Operator input:
        1) Configurable touch screen.
    f. Screen update speed and screen change speed less than 1 second.
    g. Provide the following features for outdoor use:
        1) Anti-glare screen overlay.
        2) Luminescence: Minimum 1,000 nits.
3. Graphic configuration:
    a. Easily configured graphics by:
        1) Portable laptop computer both locally and via the PLC data network.
        2) SCADA engineer's console via the PLC data network.
    b. As specified in this Section.
4. Memory:
    a. Application:
        1) 4 GB flash EEPROM.
5. CPU: Minimum 100 MHz.
6. Communications:
    a. Ethernet.
    b. Modbus.
7. Environment:
    a. Temperature: 0 to 50 degrees Celsius.
    b. Relative humidity: 10 to 90 percent.
8. Electrical:
    a. Power supply:
        1) 24 VDC.

B. LOI software:
1. Provide a complete software package to be used for programming the necessary screens and operator interaction with the LOIs.
2. Operating system:
    a. Microsoft Windows 10.
3. Furnish software with preconfigured symbols, objects, graphics, and imported bitmaps for the generation of the displays.
4. Software must allow bitmaps to be imported or exported to or from other applications.
5. Capable of generating custom reports, complete with screen prints.
6. Capable of working with multiple screens concurrently.
7. Provide dialog boxes for defining object attributes.
8. Configure objects using fill in dialog boxes.
9. Furnish graphic and text editor that allows custom formatting in order to customize and change the appearance of objects and text:
    a. Allow selection of different fill patterns to define object status.

10. As a minimum, provide the following object capabilities:
    a. Operator inputs:
        1) Momentary pushbutton.
        2) Maintained pushbutton.
        3) Latched pushbutton.
        4) Multistate pushbutton.
        5) Keypad enable button.
        6) Cursor point.
    b. Control list selectors:
        1) Standard control list.
        2) Piloted control list.
    c. Global objects.
    d. Display objects:
        1) Bar graph.
        2) Scale.
        3) Message display.
        4) Multistate indicator.
        5) List indicator.
        6) Numeric data display.
    e. Screen selector objects:
        1) Go to.
        2) Return.
        3) Screen list selector.
    f. Embedded variables:
        1) Time.
        2) Date.
        3) Numeric variable.
    g. Graphics:
        1) Lines.
        2) Shapes.
        3) Freeform drawings.
        4) Imported graphics.
        5) Background text.
        6) Selection table for standard ISA symbols.
        7) PID controller faceplate.
    h. Alarm screens.
11. Documentation:
    a. Provide complete user documentation, including examples of how to operate the various modules within the system.
    b. Electronic format, HTML based with the ability to search for topics by keyword or search or specific text.
12. Online help:
    a. Provide an online help facility, based upon Windows standard Hypertext:
        1) Useful, context-sensitive information on the operation of the package:
            a) Can be invoked online through a point-and-click operation.
            b) Help facility must also support the ability to perform full text word search, add custom comments, bookmark topics, copy and pasting into another application, printing, and use of system fonts and colors.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. All components of the control system, including data network cables, are the installation responsibility of the ICSC unless specifically noted otherwise.

C. Provide panel support bracing if more than 25 percent of the area has been removed to allow for the mounting of the LOI.

D. All tags used and/or assigned as part of the application programming work are to use the tag and loop identifications found on the P&IDs.

E. Station graphics:
   1. Configure the graphic display for each device both in the treatment plant, and/or process area, including, but not limited to:
      a. Symbols for:
         1) Pumps.
         2) Valves.
         3) Major instruments.
         4) Flowmeters.
         5) Pressure transmitter.
         6) Major equipment.
      b. Alarm symbols, including intrusion alarm.
      c. Relevant test and operational data.
      d. Status for each controller or controlled device:
         1) Hand-Off-Auto Status.
         2) Local-Off-Remote Status.
         3) Run.
         4) Call.
         5) Fail.
         6) Open.
         7) Close.
         8) Hold.
         9) Modulate.
         10) Running.
      e. Depict a change of state of pumps and valves by a change in color.
   2. Production and usage bar graph:
      a. Depict the production for each site and/or piece of equipment, as determined during the requisite graphics meeting, within the treatment plant, summarized to type, and total usage, with a bar graph and numeric value for each analog value.
   3. System level summary:
      a. Show the level for the plant influent and effluent production, etc., via a display using bar graphs and numbers, as determined during the requisite graphics meeting.

3.03 TESTING

A. As specified in Section 17950 - Commissioning for Instrumentation and Controls.

3.01 OWNER TRAINING

A. As specified in Section 17950 - Commissioning for Instrumentation and Controls.

END OF SECTION

SECTION 17733

CONTROL SYSTEMS: NETWORK MATERIALS AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Materials and equipment used in process control and LAN networks, including:
      a. Network switches.
      b. Media converters.
      c. Routers.
      d. Patch panels and other data network hardware.
      e. Related accessories.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Standards:
   1. Electronic Industries Alliance (EIA):
      a. 310-E - Cabinets, Racks, Panels, and Associated Equipment.
   2. Institute of Electrical and Electronics Engineers (IEEE):
      a. 802.1X - Standard for Local and Metropolitan Area Networks—Port-Based Network Access Control.
      b. 802.3 - Standard for Ethernet.
      c. 802.11b - Standard for Information Technology - Telecommunications and information exchange between systems - Local and Metropolitan networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: Higher Speed Physical Layer (PHY) Extension in the 2.4 GHz band.
   3. National Electrical Code (NEC).
   4. National Electrical Manufacturers Association (NEMA):
      a. 250 - Enclosures for Electrical Equipment (1000 V Maximum).
   5. Telecommunications Industry Association (TIA):
      a. 569 - Telecommunications Pathways and Spaces.
      b. 607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
   6. Underwriters Laboratories, Inc. (UL).

1.03 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

1.04 SUBMITTALS

A. Furnish submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Include information on all network equipment.
   2. Manufacturer’s operation and installation instructions.

C. Shop drawings:
   1. Complete set of drawings including but not limited to:
      a. System block diagram showing relationship and connections between devices provided under this Contract, including connections to any existing equipment.
      b. Include manufacturer and model information, and address settings.
      c. Network riser diagram.
      d. Network port diagram, which physically locates all ports within the facility, and identifies their patch panel and switch port.
      e. Construction drawings for all equipment cabinets, including dimensions, identification of all components, preparation and finish data, and nameplates.
      f. Electrical connection diagrams.
      g. Complete grounding requirements.
   2. Furnish data sheets for each component together with a technical product brochure or bulletin:
      a. Manufacturer's model number.
      b. Project equipment tag.
   3. Complete and detailed bills of materials broken up by each cabinet. Each bill of material item will include the following:
      a. Quantity.
      b. Description.
      c. Manufacturer.
      d. Part numbers.

D. Test reports:
   1. As specified in Section 16125 - Fiber Optic Cable and Appurtenances and Section 17950 - Commissioning for Instrumentation and Controls.
   2. Signed test results as described in this Section.
   3. Test results shall include:
      a. Narrative describing the test procedures followed.
      b. Block diagram of test setup.
      c. Manufacturer’s information on test equipment used.
      d. Detailed test results.
      e. A narrative summarizing the testing results and identifying any further action required.

E. Operating manuals:
   1. Complete installation, operation, calibration, and testing manuals as specified in Section 01756 - Commissioning.

F. Record drawings:
    1. As specified in Section 17950 - Commissioning for Instrumentation and Controls.
    2. Electrical connection diagrams shall be revised to reflect any changes made in the field and submitted as record drawings.

1.05 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.06 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

1.07 ADMINISTRATIVE REQUIREMENTS (NOT USED)

1.08 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL (NOT USED)

2.02 DESIGN AND PERFORMANCE CRITERIA

A. The vendor shall manufacture using low VOC-based materials to provide superior indoor air quality, as Greenguard certification demonstrates.

2.03 MANUFACTURERS

A. As listed below in the individual component paragraphs.

2.04 MANUFACTURED UNITS

A. Ethernet switches:
    1. Un-Managed Process Floor Ethernet switches:
        a. Manufacturers: One of the following, no equal:
            1) Phoenix Contact FL 2207-FX.
        b. Properties:
            1) Hardware:
                a) Power supply:
                    (1) Accepts redundant power feeds.
                        (a) Provide NEC Class 2 power circuit.
                        (b) 24 VDC, 100VA maximum rating.
                b) No fans or moving parts.
            2) Performance:
                a) 10/100 mbps.
            3) Environment:
                a) Operating temperature range: 32 to 140 Degrees Fahrenheit.

b) Humidity:10 to 95 percent, non-condensing.
4) Connections:
a) Copper: RJ-45.
(1) Auto-negotiating.
(2) Quantity: 7 RJ-45. indicated on the Drawings plus 20 percent spare.
b) Fiber: Gigabit SC port.
5) Mounting:
a) DIN Rail mounting.

B. Copper patch panels:
1. General:
a. All equipment and premises cables shall be terminated at a patch panel, except for field equipment connections.
b. Final connections between the patch panel and network equipment shall be by patch cords.
c. Provide factory-tested copper patch cords as required to support all network devices.
1) Provide 25 percent spare copper patch cords.
d. Cables shall be installed so that the outer sheath of the cable is carried into the patch panel before the conductors are broken out.
e. Maintain twist of broken-out conductors in accordance with TIA standards.
f. UL listed.
g. Properties:
1) Modular, all-metal construction with built-in strain relief.
2) Compatible with both shielded and unshielded jack modules.
3) Patch panel and jack modules shall be by the same manufacturer.
4) Utilizes jack modules for copper Ethernet cable termination.
5) Provided shielded jack modules with a 360-degree conductive path to the ground as required by the installation. Install per manufacturer's recommendation.
6) Patch panel and jack modules shall meet or exceed category cable standard.
7) Jack module shall be capable of at least 20 termination cycles.
8) Provide 25 percent spare jack modules of each type.
h. Accessories:
1) Removable rear cable management bracket.
2) Rear individual port labels.
3) Front color-coded individual port labels.
4) Termination tool.
2. Manufacturers: One of the following or equal:
a. DIN Rail mounted:
1) DINSpace, SNAP XL.
2) OCC, DTC.

2.05 ACCESSORIES

A. Provide duplex patch cords to connect the interface cards provided with the associated patch panels.

PART 3 EXECUTION

3.01 PREPARATION

A. Equipment support and anchoring to structures:
   1. As specified in Section 01850 - Design Criteria, including but not limited to:
      a. Anchor bolt layout.
      b. Equipment templates.
      c. Anchor installation.

3.02 INSTALLATION

A. Provide installation and configuration for the new and existing managed Ethernet switches. Provide configuration of the Ethernet switch network for a complete, functioning plant control system as indicated on the Drawings and as specified in this Section:
   1. Refer to SCADA block diagrams for all new network connections.
   2. Provide configurations for all managed Ethernet switches and other components, including but not limited to VLAN (virtual local area network), additional Plant PLC communication cards, and separate managed Ethernet switches as required, such that there is isolation of the following networks:
      a. Remote I/O network: This includes the connections between the Plant PLC and:
         1) Plant PLC expansion racks.
         2) Plant PLC remote I/O (RIO) racks.
      b. Field network: This includes the connections between the PLC and:
         1) Field devices.
         2) LOI (Local Operator Interface).
         3) Vendor-furnished Ethernet network components.
         4) Valve actuator network: This includes the connections between the PLC and the valve master stations.
      c. PLC network: This includes the connections between the Plant PLCs and the I/O server(s).
      d. Process control network: This includes the connections between the I/O server(s) and other equipment, including but not limited to servers, workstations, and printers.
      e. Security control network: This includes any security hardware with Ethernet communication as provided by the security subcontractor.

B. All racks shall be level and plumb.

C. All work shall be performed in a neat and workmanlike manner.

D. Cable management:
   1. All cables and equipment shall be installed in strict conformance with the manufacturer’s recommendations.
   2. Install cable using a lubricant designed for cable pulling.
   3. Install hook-and-loop wrap on all cable bundles within the network rack/enclosure. Plastic tie-wraps are not acceptable.
   4. Install network cables without splices.
   5. Installed bend radius shall be a minimum of 10 times the cable diameter.

6. Terminate all pairs at the jack and patch panel.
7. Route all cables through cable management or other form of containment. No loose, unsupported cables are permitted to span across network equipment.
8. Use corner strips to protect cables from edges inside ducts and to maintain bend radius requirements.

E. Internal rack wiring:
   1. Install cables avoiding sharp bends.
   2. Provide enough working space inside rack or cabinets such that closing enclosure doors does not crush or compress cabling.
   3. Bundle cables together in groups of no more than 12.
   4. Route cables from both sides of the rack to patch panels. Do not bring all the bundles from a single side.
   5. No cabling shall obstruct equipment ventilation.
   6. Individual pairs will be untwisted less than 1/2-inch at termination points.
   7. Ground enclosure and equipment in accordance with TIA-607.
      a. Individually bond all network equipment chassis to rack's grounding busbar. Do not daisy-chain bonding conductors.
      b. Size the bonding conductor per network equipment manufacturer's recommendation, or #10 AWG, whichever is larger.

F. External rack wiring:
   1. Do not install fiber cables in non-continuous cable supports such as cable ladders or wire baskets without radius cable supports or solid bottoms.
   2. Maintain cable separation in accordance with TIA-569.
      a. Install cables a minimum of 40 inches away from electrical motors and transformers.
      b. Install cables a minimum of 12 inches away from fluorescent lighting.

G. All cables and terminations shall be labeled with cable designations as specified in Section 16075 - Identification for Electrical Systems.

H. Each data port shall be individually labeled with its patch panel/switch port ID:
   1. Labeling must be printed - no handwritten labels will be allowed.

I. At the completion of the wiring installation, provide the following documentation:
   1. A plan-view of the premise(s) showing the jack numbering scheme.
   2. A printed certification report for the entire wiring installation showing compliance with all TIA specifications for data cable.
   3. Reports such as those generated by Fluke DSP cable certification equipment meet this requirement.

J. Managed Ethernet switches:
   1. Configure switches to prevent broadcast storms.
   2. All installations shall employ IGMP snooping to limit multicast messaging.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Owner Training:
   1. As specified in Section 17950 - Commissioning for Instrumentation and Controls.

3.04 FIELD QUALITY CONTROL (NOT USED)

3.05 ADJUSTING

A. Perform all firmware installations, configuration and other set up, as required, to place the network into proper operation.

END OF SECTION

SECTION 17903

SCHEDULES: I/O LIST

PART 1 GENERAL

1.01 SUMMARY

A. The I/O list is not a take-off list. Additional information is as indicated on the Drawings and specified in the Contract Documents. Where any discrepancies between this list and the P&ID drawings arise, the P&ID shall govern.

B. Abbreviations used in the I/O list are indicated on the Drawings.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 I/O LIST

A. As specified in Attachment A - I/O list.

END OF SECTION

ATTACHMENT A - I/O LIST

PLC I/O Rollup

COADE DASHBOARD

PLC: RTU-BL

I/O Type	I/O Count
AI	5
DI	13
DO	2
	Total Points = 20

PLC: RTU-CDS

I/O Type	I/O Count
DI	1
	Total Points = 1

PLC: RTU-CDX

I/O Type	I/O Count
DI	8
DO	2
	Total Points = 10

PLC: RTU-CL

I/O Type	I/O Count
AI	32
DI	91
DO	25
	Total Points = 148

PLC: RTU-CLIP

I/O Type	I/O Count
AI	18
D0	2
DI	57
DO	13
	Total Points = 90

PLC: RTU-CPS

I/O Type	I/O Count
DI	8
	Total Points = 8

PLC: RTU-CS

I/O Type	I/O Count
AI	14
AO	4
DI	69
DO	19
MODBUS RTU	10
	Total Points = 116

PLC: RTU-ELEC1

I/O Type	I/O Count
AI	5
AO	3
DI	23
DO	4
MODBUS RTU	5
	Total Points = 40

PLC: RTU-ELEC2C

I/O Type	I/O Count
MODBUS RTU	5
	Total Points = 5

PLC: RTU-FL

I/O Type	I/O Count
MODBUS RTU	5
	Total Points = 5

PLC: RTU-NFL1

I/O Type	I/O Count
AI	8
AO	6
DI	25
DO	21
MODBUS RTU	5
MODBUS TCP	8
	Total Points = 73

PLC: RTU-NFL11

I/O Type	I/O Count
AI	8
AO	6
DI	24
DO	21
MODBUS RTU	5
MODBUS TCP	8
	Total Points = 72

PLC: RTU-NFL13

I/O Type	I/O Count
AI	8
AO	6
DI	24
DO	21
MODBUS RTU	5
MODBUS TCP	8
	Total Points = 72

PLC: RTU-NFL15

I/O Type	I/O Count
AI	8
AO	6
DI	24
DO	21
MODBUS RTU	5
MODBUS TCP	8
	Total Points = 72

PLC: RTU-NFL3

I/O Type	I/O Count
AI	8
AO	6
DI	24
DO	21
MODBUS RTU	5
MODBUS TCP	8
	Total Points = 72

PLC: RTU-NFL5

I/O Type	I/O Count
AI	8
AO	6
DI	24
DO	21
MODBUS RTU	5
MODBUS TCP	8
	Total Points = 72

PLC: RTU-NFL7

I/O Type	I/O Count
AI	8
AO	6
DI	24
DO	21
MODBUS RTU	5
MODBUS TCP	8
	Total Points = 72

PLC: RTU-NFL9

I/O Type	I/O Count
AI	8
AO	6
DI	24
DO	21
MODBUS RTU	5
MODBUS TCP	8
	Total Points = 72

PLC: RTU-PEA

I/O Type	I/O Count
AI	26
AO	16
DI	138
DO	62
MODBUS RTU	60
	Total Points = 302

PLC: RTU-SCHAN

I/O Type	I/O Count
DI	3
DO	2
	Total Points = 5

PLC: RTU-SFL10

I/O Type	I/O Count
AI	8
AO	6
DI	24
DO	21
MODBUS RTU	5
MODBUS TCP	8
	Total Points = 72

PLC: RTU-SFL12

I/O Type	I/O Count
AI	8
AO	6
DI	24
DO	21
MODBUS RTU	5
MODBUS TCP	8
	Total Points = 72

PLC: RTU-SFL14

I/O Type	I/O Count
AI	8
AO	6
DI	24
DO	21
MODBUS RTU	5
MODBUS TCP	8
	Total Points = 72

PLC: RTU-SFL16

I/O Type	I/O Count
AI	8
AO	6
DI	24
DO	21
MODBUS RTU	5
MODBUS TCP	8
	Total Points = 72

PLC: RTU-SFL2

I/O Type	I/O Count
AI	8
AO	6
DI	24
DO	21
MODBUS RTU	5
MODBUS TCP	8
	Total Points = 72

PLC: RTU-SFL4

I/O Type	I/O Count
AI	8
AO	6
DI	24
DO	21
MODBUS RTU	5
MODBUS TCP	8
	Total Points = 72

PLC: RTU-SFL6

I/O Type	I/O Count
AI	8
AO	6
DI	24
DO	21
MODBUS RTU	5
MODBUS TCP	8
	Total Points = 72

PLC I/O Rollup

PLC: RTU-SFL8

I/O Type	I/O Count
AI	8
AO	6
DI	24
DO	21
MODBUS RTU	5
MODBUS TCP	8
	Total Points = 72

SECTION 17950

COMMISSIONING FOR INSTRUMENTATION AND CONTROLS

TABLE OF CONTENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Testing requirements that apply to process control and instrumentation systems for the entire Project.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Abbreviations:
   1. PTO: Profibus Trade Organization.

C. Definitions:
   1. Complete End-to-End Testing (CEET) - Signals are tested from the field device through the PLC program, the network, and all the way to the operator's HMI graphic screens.
   2. Loop validation tests - Signals are tested from the field device to the PLC.
   3. Platform testing: Testing of the PLC and SCADA/HMI or programmer's shop to demonstrate the program's functionality based upon specified and designed control requirements.
   4. Permanent link: The fixed portion of cabling installed between an equipment outlet and its immediate distributor or between 2 distributors.

D. Standards:
   1. Electronics Industries Alliance (EIA).
   2. Telecommunications Industry Association (TIA).

1.03 SUBMITTALS

A. Furnish submittals as specified in Section 01330 - Submittal Procedures.

B. General:
   1. Reference additional detailed test submittal scheduling and prerequisite requirements as specified in the Sequencing article of Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

C. Furnish commissioning submittals listed below and specified in this Section as specified in Section 01756 - Commissioning:
   1. Manufacturer's representative qualifications.
   2. Owner training.

D. Test reports:
   1. At the conclusion of each test, submit a complete test report, including all test results and certifications.
   2. Include all completed test binders, forms, and checklists.
   3. Submission, review, and acceptance of each test report is required before the start of the sub-system.

E. Furnish electronic copies of the following:
   1. Application software:
      a. Finalized fully annotated copy of programmed PLC logic in its native format.
      b. Cross-referenced index of all PLC registers or points.

1.04 QUALITY ASSURANCE

A. Test personnel:
   1. Furnish qualified technical personnel to perform all calibration, testing, and verification. Test personnel are required to be familiar with this Project and the equipment, software, and systems before being assigned to the test program.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 INSTALLATION

A. Installation supervision:
   1. Provide as specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Testing and training phase:
   1. Source testing:
      a. Manufacturer services: Provide as specified in the table below.

Section Number	Section Title	Source Testing (Witnessed or Non-Witnessed)
17100	Control Strategies	Witnessed
17101	Specific Control Strategies	Witnessed
17710	Control Systems - Panels, Enclosures, and Panel Components	Witnessed
17950	Commissioning for Instrumentation and Controls	Witnessed

      b. Prerequisite requirements:
         1) Engineer approval of the hardware and equipment source testing submittal, Manufacturer Certificate of Source Testing, is required before proceeding to Preliminary FAT.

c. Preliminary FAT (Pre-FAT):
    1) The purpose of the Pre-FAT is to provide assurance that the HMI/SCADA system is ready for the full, witnessed FAT, in terms of both stability and functionality:
        a) Debugging of software and troubleshooting of hardware shall occur during and before the pre-FAT, not during the FAT.
        b) Contractor shall fully test the HMI/SCADA system and fix all deficiencies found before the FAT.
    2) Conduct utilizing test procedures approved by Engineer.
    3) Owner shall have the right to witness any or all of the Pre-FAT testing and shall be notified in writing 20 days before the start of the pre-FAT.
    4) Submit a letter, signed by the Contractor's project manager or company officer, certifying that integrated system hardware and software has been tested and confirmed to be fully operational and in compliance with the requirements specified in the Contract Documents and is fully ready for the full, witnessed FAT:
        a) Attach the completed pre-FAT test forms, signed by the Contractor's staff.
    5) Engineer approval of the pre-FAT submittal is required before proceeding to FAT.
d. FAT hardware and communications testing:
    1) Perform tests to show that the integrated system hardware and software is fully operational and in compliance with the requirements specified in the Contract Documents.
    2) The complete PCIS system including operator stations, servers, network equipment, printers, PCMs, PLCs, RTUs, LCPs, CCS, peripherals, communications equipment, and other HMI/SCADA equipment, shall be assembled, connected, and software loaded for a fully functional FAT of the integrated system.
    3) For any fault tolerant networks such as ring topology networks, disconnect each segment of the network individually to demonstrate proper failover and alarming at the HMI.
    4) Testing simulation:
        a) Inputs and outputs shall be simulated and proper control and system operation shall be validated.
        b) Whenever supplied equipment is available, such as devices internal to the control panel, test input and output signals using the equipment. Simulation is not acceptable.
        c) FAT shall make use of simulators that contain switches, pilot lights, variable analog signal generators, and analog signal level displays, which shall be connected to the I/O points within the HMI/SCADA system:
            (1) The simulator may consist of a PLC operating under an HMI/SCADA software package or other approved software that has its I/O points wired to PLC's I/O points.
            (2) Software operating on a PC may then act as the switches, pilot lights, variable analog signal generators, and analog signal level displays.
    5) Additional source tests are specified in other sections of the Instrumentation and Control Specifications.

6) Owner shall have the right to witness any or all of the FAT testing and shall be notified in writing 20 days before the start of the FAT.
7) Verify communications between the hardware and the programmer's software comply with specified requirements:
    a) For systems that contain RTUs or remote communications with other devices, the complete communications system must be factory tested, including actual interfacing with telephone company equipment and/or the actual radios used for radio-based telemetry systems.
8) Panel inspections:
    a) Engineer will inspect each control panel for completeness, workmanship, fit and finish, and compliance with the Contract Documents and the accepted shop drawings:
        (1) Inspection to include, as a minimum: Layout, mounting, wire and data cable routing, wire tags, power supply, components and wiring, I/O components layout (including terminals, wiring and relays), device layout on doors and front panels, and proper ventilation operation.
    b) Inspection forms:
        (1) Provide panel inspection forms as part of the FAT procedures submittal.
        (2) A sample FAT control panel form has been provided at the end of this Section.
9) I/O test:
    a) Engineer will verify that I/O is properly wired to field terminals and is properly mapped into the PLC and the rest of the SCADA system, including all operator interface devices:
    b) Test methodology:
        (1) Discrete inputs:
            (a) Apply appropriate input from simulator at panel terminal, observe input card indicator, observe data value at each indicated data address, and observe data received at field wiring terminals or operator interface screen.
        (2) Discrete outputs:
            (a) Issue commands from operator interface screen or PLC, verify output card indicator light, and measure response at field wiring terminals or multimeter.
        (3) Analog inputs:
            (a) Apply appropriate analog input signal at panel terminals on simulator, observe data value at each indicated data address, and observe data properly received at field wiring terminals or operator interface screen.
            (b) Check each point at 0 percent, 50 percent, and 100 percent of scale.
        (4) Analog outputs:
            (a) Enter scaled values in the output buffer file, observe the output data file value, and measure appropriate response at field wiring terminals or multimeter.

(b) Check each point at 0 percent, 50 percent, and 100 percent of scale.

c) Test forms to include, but not be limited to the following data:
(1) PLC and panel number.
(2) I/O type.
(3) I/O tag name.
(4) Rack/slot/number of I/O point.
(5) Check-off for correct response for each I/O point.
(6) Comments field.
(7) Initials of individual performing test.
(8) Date test was performed.
(9) Witness signature lines.

10) System configuration test:
a) Demonstrate and test the setup and configuration of operator stations, servers, development stations, and peripherals.
b) Demonstrate utility software and functions, such as virus protection, backup, optical drive burning, network monitoring, etc.
c) Demonstrate the proper operation of peripheral hardware.
d) Demonstrate general HMI/SCADA functions.
e) Demonstrate proper operation of log-on and other security access functions.
f) Demonstrate the proper operation of all historical data storage, trend, display, backup, and report functions.
g) Test automatic fail over of redundant equipment.
h) Demonstrate the proper operation of the alarm display and acknowledgement functions.
i) For any fault tolerant networks, such as ring topology networks, disconnect each segment of the network individually to demonstrate proper failover and alarming.
j) Test forms:
(1) For each test, list the specification page and paragraph of the function demonstrated, and provide a description of the function.
(2) List the specific tests and steps to be conducted.
(3) For each function, list all of the different sub-functions or ways the function can be used, and provide a test check-off for each:
(a) Include signature and date lines.

11) Engineer approval of the FAT Communication Testing activities is required before proceeding to FAT Platform Testing.

e. FAT Platform Testing - Control logic test:
1) Verify the PLC, HMI and SCADA, provides monitoring and control functionality based upon specified and designed control requirements.
2) Testing requirements:
a) Demonstrate each function described in the Control Strategies.
b) Demonstrate in detail how each function operates under a variety of operating scenarios:
(1) Test to verify the application of each general control strategy function to each specific control strategy or loop description.

c) Demonstrate the proper operation of the programming and configuration for each control strategy or loop description:
(1) Test each strategy or loop description on a sentence by sentence and function by function basis.
(2) Loops with similar or identical logic must each be tested individually.
(3) Test the boundaries of each numeric operator input by entering values outside of the allowable range.

d) Demonstrate the proper operation of all digital communication links and networks.
(1) Verify each digital communication I/O point.

e) Failure testing: Demonstrate how the system responds to and recovers from abnormal conditions including, but not limited to, equipment failure, operator error, communications subsystem error, communications failures, simulated/forced software lockups, power failure (both utility power and power to HMI and/or SCADA hardware), process equipment failure, and high system loading conditions.

3) Test forms:
a) Submit completed test forms for each loop including but not limited to the fully revised and approved control strategy.
b) Identify the cause and effect as each I/O point is toggled through the simulator:
(1) Identify and track proper and/or improper operation of the loop.
c) Note any deficiencies or operational changes on the forms for correction and documentation:
(1) Include signature and date lines.

4) Engineer approval of the FAT submittal is required prior to shipment of system components.

2. Owner Training:
a. Perform Owner training as specified in Section 01756 - Commissioning.

Table 1

Course Title	Minimum Course Length (hours per session)	Personnel (Estimated Number of Students)	Minimum Number of Sessions
System Overview	8	10	1
Operator Training	24	10	2
LOI Hardware and Software	16	5	1
Follow-Up Training	8	5	5

3. Training course requirements:
a. Operator training:
1) Furnish training courses that instruct system operators in the efficient operation of Contractor-provided aspects of the PCIS, including not only the general operation of each control system but also the operation of specific system features.

2) Operator's training shall include the following for each vendor package and programmable device:
    a) Control system overview: Architecture, equipment functions, software components, etc.
    b) Display navigation, overview, and types of displays.
    c) Process and equipment monitoring and control: Basic principles and operation.
    d) Control strategies: Present an average 15-minute review of each control strategy, including a hands-on demonstration of screens and operator functions for each.

4. Installation testing:
    a. Calibration:
        1) Performed by Contractor and ICSC.
        2) Calibrate and adjust all instruments, devices, valves, and systems, in conformance with the component manufacturer's instructions and as specified in these Contract Documents.
        3) Replace either individually or within a system, defective elements that cannot achieve proper calibration or accuracy.
            a) Calibration for discrete devices:
                (1) Calibrate and adjust devices for reliable operation and to avoid nuisance tripping.
            b) Calibration for ultrasonic and radar level devices:
                (1) Provide Echo Transmission and signal quality on level transmitters including guided and unguided units.
                    (a) Submit printout of the actual transmission and parameters.
                (2) Adjust mounting, as required, to obtain accurate readings.
                (3) Post mounting: Provide any additional calibration required by manufacturer.
            c) Calibrating analog transmitters:
                (1) Components having adjustable features are to be set accurately for the specific conditions and applications of this installation.
                (2) Test and verify that components and/or systems are within the specified limits of accuracy.
                (3) Calibration points:
                    (a) Calibrate each analog instrument at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of span, using test instruments with accuracies traceable to NIST.
                (4) Field verify calibration of instruments including units that have been factory-calibrated to determine whether any of the calibrations are in need of adjustment.
            d) Analyzer calibration:
                (1) Calibrate and test each analyzer system as a workable system after installation. Follow the testing procedures directed by the manufacturers' technical representatives.
                (2) Submit completed instrument calibration sheets for every field instrument and analyzer.

(3) Calibration tags:
(a) Attach a calibration and testing tag to each instrument, piece of equipment, or system.
(b) Sign the tag when calibration is complete.
e) Calibration for industrial networking test equipment:
f) Submit calibration documentation.

b. Loop check:
1) Performed by the Contractor.
2) Cabling installed, terminated, and labeled.
3) Perform continuity check of wiring to each field device through intermediate devices to field terminals in the cabinet.
4) Complete loop check form for each device.
5) Submit loop check test results before proceeding to the next step.

c. Loop validation tests:
1) Performed by the Contractor, ICSC, and manufacturer's representative, working together, and witnessed by the Owner or Owner's representative.
2) Perform tests on the signal from each field device through intermediate devices to the I/O module on the PLC.
a) The PLC may or may not be connected to the network.
3) Engineer approval of the loop validation test submittal is required before proceeding to CEET.

d. Copper Ethernet cable acceptance testing:
1) All testing procedures and field-test instruments shall comply with applicable requirements of:
a) TIA-1152 - Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling.
b) TIA-568.0-E - Generic Telecommunications Cabling for Customer Premises.
c) TIA-568.1-E - Commercial Building Telecommunications Infrastructure Standard.
d) TIA-568.2-D - Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
e) Copper Ethernet cable installation testing as specified in Section 16950 - Field Electrical Acceptance Tests.
2) Testing shall be performed by trained technicians who have successfully completed an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:
a) Manufacturer of the connectors or cable.
b) Manufacturer of the test equipment used for the field certification.
c) Training organizations (e.g., BICSI).
3) Submit the following information before testing begins:
a) Manufacturer’s catalog sheets, specifications, and the most recent calibration report for the test equipment.
b) Certificate of testing technician’s training.
c) A schedule of all balanced twisted-pair copper links to be tested, including:
(1) Cable identification as it appears on the cable records.

(2) Cable identification as it appears on the individual test reports.
(3) Cable identification as specified in Section 16075 - Identification for Electrical Systems.

d) Sample test reports.

e) All installed cabling Permanent Links shall be field-tested and pass the test requirements and analysis as described below:
(1) Any Permanent Link that fails these requirements shall be diagnosed and corrected.
(2) Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected Permanent Link meets performance requirements.
(3) The final and passing result of the tests for all Permanent Links shall be provided in the test results documentation in accordance with the testing requirements.

f) Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with Contract Documents and to the satisfaction of the Engineer.

4) Cable field-test instruments:

a) The field-test instrument shall be within the calibration period recommended by the manufacturer, typically 12 months.

b) Certification tester requirements:
(1) Level III in accordance with TIA-1152.
(2) Independent verification of accuracy.
(3) Must be capable of storing more than 10,000 results for all required measurements.
(4) Manufacturer: The following or equal:
(a) Fluke CableAnalyzer Industrial Ethernet Kit, DSX2-5-IE-K1.

c) Permanent Link adapters:
(1) Use manufacturer's adapter for connecting to tested equipment.
(a) Patch cables shall not be used for testing.
(2) RJ45 plug must meet the requirements for NEXT, FEXT and Return Loss in accordance with TIA-568.2-D Annex C.

d) Measurement capabilities:
(1) Wire Map.
(2) Length.
(3) Propagation Delay.
(4) Delay Skew.
(5) DC Loop Resistance.
(6) DC Resistance Unbalance.
(7) Insertion Loss.
(8) NEXT (Near-End Crosstalk).
(9) PS NEXT (Power Sum Near-End Crosstalk).
(10) ACR-N (Attenuation to Crosstalk Ratio Near-End).
(11) PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End).
(12) ACR-F (Attenuation to Crosstalk Ratio Far-End).

(13) PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End).
(14) Return Loss.
(15) TCL (Transverse Conversion Loss).
(16) ELTCTL (Equal Level Transverse Conversion Transfer Loss).
(17) Time Domain Reflectometer.
(18) Time Domain Xtalk Analyzer.

5) Testing requirements:
   a) Field-test instruments shall have the latest software and firmware installed.
   b) Permanent Link test results including the individual frequency measurements from the tester shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.
   c) Testing shall be performed on each cabling segment from connector to connector:
      (1) Sampling is not acceptable.
   d) The installer shall build a reference link:
      (1) All components shall be anchored so it is not possible to disturb them.
      (2) The technician is to conduct a Permanent Link test each day, for each type of category cable used, to ensure no degradation of the tester or its Permanent Link adapters.
   e) Unless noted otherwise, tests shall use the following frequency resolution:
      (1) 1 - 31.25 MHz: 150 kHz.
      (2) 31.25 - 100 MHz: 250 kHz.
      (3) 100 - 250 MHz: 500 kHz.
   f) Wire Map measurement:
      (1) Wire map test is intended to verify pin-to-pin termination at each end and check for installation connectivity errors. For each of the 8 conductors in the cabling, the wire map indicates:
         (a) Continuity to the remote end.
         (b) Shorts between any two or more conductors.
         (c) Reversed pairs.
         (d) Split pairs.
         (e) Transposed pairs.
         (f) Distance to open on shield.
         (g) Any other miss-wiring.
         (h) The correct connectivity of telecommunications outlets/connectors is defined in TIA-568.2-D:
            - 2 color schemes are permitted.
            - User shall define which scheme is to be used.
            - Field tester shall document which color scheme was used.

g) Length measurement:
   (1) Record the length of each cable. Use the physical length of the link calculated using the pair with the shortest electrical delay for reporting and to determine pass/fail.
   (2) Pass or fail criteria is based on the maximum length allowed for the Permanent Link as specified in TIA-568.D-2 plus the nominal velocity of propagation (NVP) uncertainty of 10 percent. For a Permanent Link, the length measurement can be 325 feet before a fail is reported.

h) Propagation Delay measurement:
   (1) Is the time it takes for a signal to reach the end of the link.
   (2) The measurement shall be made at 10 MHz in accordance with TIA-1152.
   (3) The propagation delay of each balanced twisted pair shall be recorded.
   (4) Is not to exceed 498 ns in accordance with TIA-568.2-D Section 6.4.21.

i) Delay Skew measurement:
   (1) Is the difference in propagation delay at 10 MHz between the shortest delay and the delays of the other wire pairs.
   (2) The delay skew of each balanced twisted pair shall be recorded.
   (3) Is not to exceed 44 ns in accordance with TIA-568.2-D Section 6.4.22.

j) DC Resistance:
   (1) Often reported as Resistance, is the loop resistance of both conductors in the pair.
   (2) Is not specified in TIA-1152 but shall be recorded for all 4 pairs.

k) DC Resistance Unbalance:
   (1) Often reported as Resistance Unbalance, is the difference in resistance of the 2 wires within the pair.
   (2) Is not specified in TIA-1152 for a Permanent Link but shall be recorded for all 4 pairs.

l) Insertion Loss:
   (1) Is the loss of signal strength over the cabling (in dB).
   (2) Worst case shall be reported for all 4 pairs in one direction only.
   (3) Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk.
   (4) Is not to exceed the Category 6 Permanent Link limits in accordance with TIA-568.2-D Section 6.4.10.

m) NEXT (Near-End Crosstalk):
   (1) Is the difference in amplitude (in dB) between a transmitted signal and the crosstalk received on other wire pairs at the same end of the cabling.
   (2) Shall be measured in both directions (12 pair to pair possible combinations).
   (3) Both worst case and worst margins shall be reported.
   (4) Is not to exceed the Category 6 Permanent Link limits in accordance with TIA-568.2-D Section 6.4.11.

(5) Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
(6) The Time Domain Xtalk data shall be stored for any marginal or failing NEXT results.

n) PS NEXT (Power Sum Near-End Crosstalk):
(1) Is the difference (in dB) between the test signal and the crosstalk from the other pairs received at the same end of the cabling.
(2) Shall be measured in both directions (8 pair possible combinations).
(3) Both worst case and worst margins shall be reported.
(4) Is not to exceed the Category 6 Permanent Link limits in accordance with TIA-568.2-D Section 6.4.12.
(5) Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
(6) Time Domain Xtalk data shall be stored for any marginal or failing PS NEXT results.

o) ACR-N (Attenuation Crosstalk Ratio Near-End):
(1) Is a calculation of NEXT minus Insertion Loss of the disturbed pair in dB.
(2) Shall be calculated in both directions.
(3) Is not specified in TIA-1152 but shall be recorded for all 12 possible combinations.

p) PS ACR-N (Power Sum Attenuation Crosstalk Ratio Near-End):
(1) Is a calculation of PS NEXT minus Insertion Loss of the disturbed pair in dB.
(2) Shall be calculated in both directions.
(3) Is not specified in TIA-1152 but shall be recorded for all 8 possible combinations.

q) ACR-F (Attenuation Crosstalk Ratio Far-End):
(1) Is a calculation of FEXT minus Insertion Loss of the disturbed pair in dB.
(2) Shall be measured in both directions (24 pair to pair possible combinations).
(3) Both worst case and worst margins shall be reported.
(4) Is not to exceed the Category 6 Permanent Link limits in accordance with TIA-568.2-D Section 6.4.14.
(5) Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).

r) PS ACR-F (Power Sum Attenuation Crosstalk Ratio Far-End):
(1) Is a calculation of PS FEXT minus Insertion Loss of the disturbed pair in dB.
(2) Shall be measured in both directions (8 pair possible combinations).
(3) Both worst case and worst margins shall be reported.
(4) Is not to exceed the Category 6 Permanent Link limits in accordance with TIA-568.2-D Section 6.4.16.
(5) Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).

s) Return Loss:
   (1) Is the difference (in dB) between the power of a transmitted signal and the power of the signals reflected back.
   (2) Shall be measured in both directions (8 pair possible combinations).
   (3) Both worst case and worst margins shall be reported.
   (4) Shall be ignored at all frequencies where the Insertion Loss is less than 3 dB for that pair.
   (5) Is not to exceed the Category 6 Permanent Link limits in accordance with TIA-568.2-D Section 6.4.9.
   (6) Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (*).
   (7) Time Domain Reflectometer data shall be stored for any marginal or failing Return Loss results.

t) TCL (Transverse Conversion Loss):
   (1) Is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the near-end on the same wire pair.
   (2) Shall be measured in both directions.
   (3) Is not specified in TIA-1152 for a Permanent Link but shall be recorded for all 8 possible combinations.

u) ELTCTL (Equal Level Transverse Conversion Transfer Loss):
   (1) Is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the far end on the same wire pair minus the Insertion Loss of that pair.
   (2) Shall be measured in both directions.
   (3) Is not specified in TIA-1152 for a Permanent Link but shall be recorded for all 8 possible combinations.

6) Test results documentation:
   a) The detailed test results documentation data is to be provided in an electronic database for each tested balance twisted pair and shall contain the following information:
      (1) The overall Pass/Fail evaluation of the link-under-test.
      (2) The date and time the test results were saved in the memory of the tester.
      (3) The identification of the customer site as specified by the end-user.
      (4) The name of the test limit selected to execute the stored test results.
      (5) The name of the personnel performing the test.
      (6) The version of the test software and the version of the test limit database held within the test instrument.
      (7) The manufacturer, model and serial number of the field-test instrument.
      (8) The adapters used.
      (9) The factory calibration date.
      (10) Wire Map.
      (11) Propagation Delay values, for all 4 pairs.
      (12) Delay Skew values, for all 4 pairs.
      (13) DC Resistance values, for all 4 pairs.

(14) DC Resistance Unbalance, values for all 4 pairs.
(15) Insertion Loss, worst case values for all 4 pairs.
(16) NEXT, worst case margin and worst case values, both directions.
(17) PS NEXT, worst case margin and worst case values, both directions.
(18) ACR-F, worst case margin and worst case values, both directions.
(19) PS ACR-F, worst case margin and worst case values, both directions.
(20) Return Loss, worst case margin and worst case values, both directions.
(21) TCL, worst case values both directions.
(22) ELTCTL, worst case values, both directions.
(23) Time Domain Crosstalk data if the link is marginal or fails.
(24) Time Domain Reflectometer data if the link is marginal or fails.

b) Maintain a set of “red-line” throughout during construction:
(1) Drawings shall be available for review at any time as requested by Owner or Engineer.
(2) Provide record copy drawings at the end of the project shall be in CAD format and include notations reflecting the as built conditions of any additions to or variation from the drawings provided such as, but not limited to cable paths and termination point.
(3) The as built drawings shall include, but are not limited to block diagrams, frame and cable labeling, cable termination points, equipment room layouts and frame installation details.
(4) The as-builts shall include all field changes made up to construction completion:
(a) Field directed changes to pull schedule.
(b) Horizontal cable routing changes.

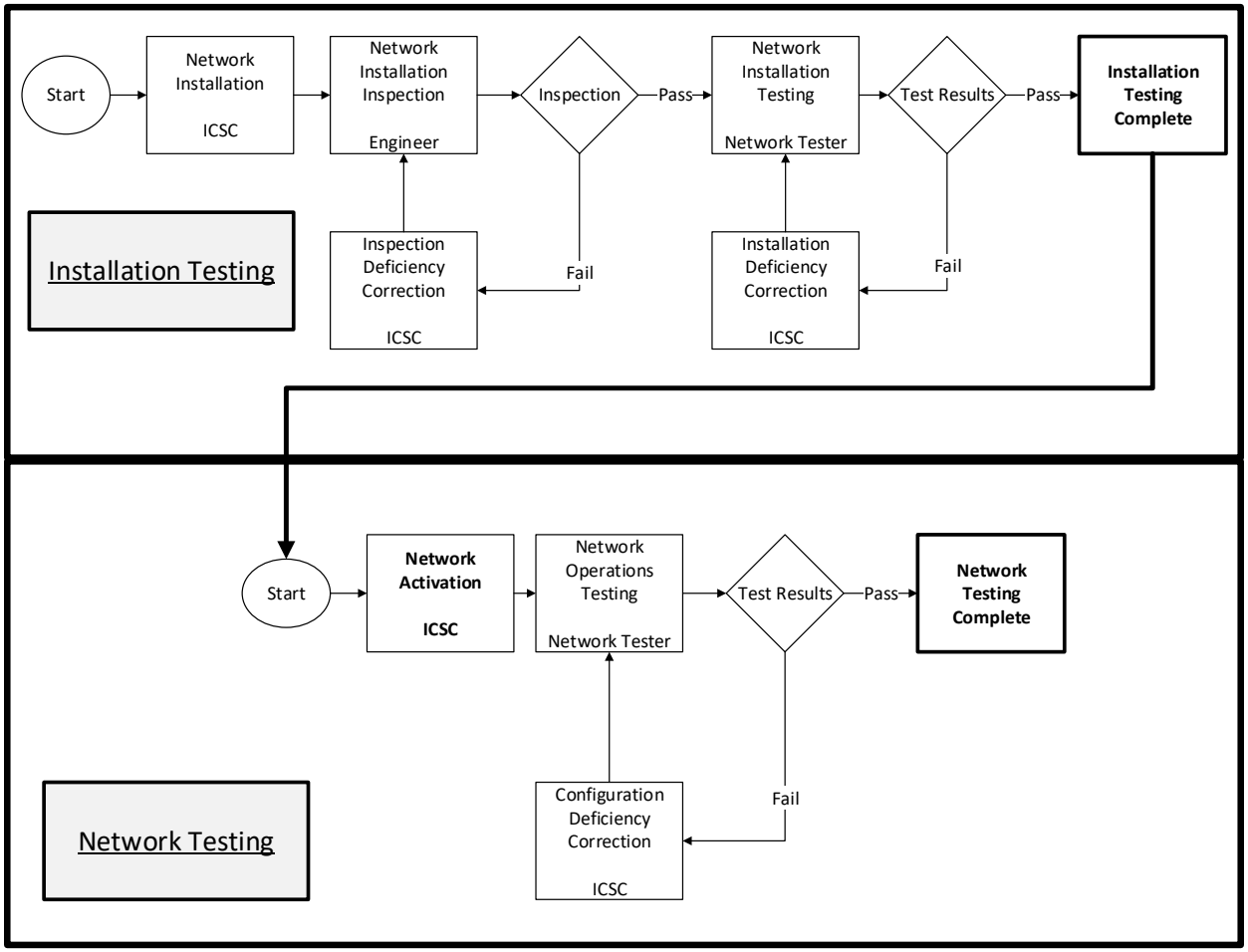
7) Associated detail drawings. Engineer approval of the copper Ethernet cable acceptance-testing submittal is required before proceeding to CEET.

e. Industrial network testing:
1) General test requirements:
a) Contractor will hire a ‘Network Tester’ who is a Certified Profibus Installer for testing for the proper installation and operation of the Profibus network.
b) Provide necessary components and labor required to address changes required to bring the network into compliance.
c) Personnel shall be available at the time of network inspection and testing to address network deficiencies.
d) Before commencing any network inspection or testing activities:
(1) Verify that network segments and nodes are in their final installed condition:
(a) Network node devices installed.
(b) Field devices physically disconnected from the network.

(2) Process and process equipment is not dependent on operation of the network.
(3) Inspect network components and deficiencies addressed.
(4) Manufacturer's data and specifications for installed network components, available on-site for use by the network testing firm.
(5) A complete set of Contract Documents included addenda and change orders are available on-site for use by the network testing firm.

e) Network operation may be interrupted for inspection and testing.
f) Figure 1, Network Test Sequence and Responsibilities, defines the general test sequence.

Figure 1. Network Test Sequence and Responsibilities



2) Test equipment:
a) Use the following test equipment:
(1) Network line analyzer: ProfiTrace v1.6 or equivalent.
(2) Oscilloscope: Fluke Scopemeter Series 190 or equivalent.
(3) Digital VOM: Fluke 87 Multimeter or equivalent.
(4) Network bus monitor, ProfiTrace v1.6 or equivalent.

3) Network installation testing:
    a) Performed by Contractor/ICSC, Network Tester, and Owner's representative working together.
    b) This activity focuses on the physical media and its installation.
    c) Conduct a physical inspection to establish the network configuration as indicated on the Drawings:
        (1) Validate the node type and quantity.
        (2) Identify improper installation and damaged components.
    d) Validate integrity of cables and connectors via a physical media test to confirm the signal propagation capabilities of the network media using visual and mechanical inspection:
        (1) Compare network devices nameplate data with drawings and specifications.
        (2) Confirm network components are PTO compliant.
        (3) Verify labeling of trunk cables.
        (4) Confirm permissible cable length.
        (5) Confirm the correct cable type.
        (6) Verify the presence/absence of stub lines.
        (7) Verify network terminators are in place.
        (8) Verify power supply source and connections for active terminations.
        (9) Verify the total network node count.
        (10) Verify power supply specifications, including quantity, ratings, locations, and configuration. Verify the power supply source of supply location, conductor size, and rating.
        (11) Inspect accessible network cabling for adherence to specified installation practices:
            (a) Cable is installed in a conduit or protective raceway.
            (b) Cable proximity to high voltage wiring.
            (c) extreme temperatures, shock, vibration, chemicals, or moisture exposure.
            (d) Bend radius.
        (12) Inspect cable and conductor terminations for adherence to specified installation practices.
        (13) Check all accessible components for evidence of physical damage.
        (14) Check grounding techniques, including ground conductor sizes and termination points.
        (15) Eliminate signal reflections.
    e) Electrical tests:
        (1) Measure total network resistance.
        (2) Cable length and configuration evaluation:
            (a) Confirm the network cable topology (length and configuration) does not exceed data rate limitations.
            (b) Confirm that the total stub length (if required by design) does not exceed data rate limitations.
            (c) Calculate spare trunk length for the specified data rate.
        (3) Line analysis for the following conditions:
            (a) Short circuit between signal lines A and B.
            (b) Short circuit between signal lines A and B and the cable shield.

(c) Shield continuity.
(d) Cross-wired signals lines.
(e) Terminator installed in wrong position.
(f) Poor transmission or reception levels.
(g) Non-permissible stub line.

(4) Examine the data traffic between the controller and each agent device.
(5) Verify baud rate meets specified requirements.
(6) Confirm signal level meets specified requirements.
(7) Verify network cycle time meets specified requirements.
(8) Generate agent device list.
(9) Verify and record scanner diagnostic data including node status and error codes.
(10) Monitor and capture network waveform.
(11) Measure and record power supply voltage at active terminations.

f) Submit corrective measures recommendations based on the results of the inspections and testing.
g) Engineer approval of the network installation validation and testing submittal is required before proceeding to network operations validation and testing.

4) Network Operations Testing:
a) Performed by Contractor/ICSCOwner's representativeworking together.
b) General requirements:
(1) The network performance is monitored and measured using non-intrusive test equipment and procedures in accordance with the Referenced standards:
(a) Profibus networks.
(2) Modifications required as a result of network operations validation and shall be in conformance with the applicable standards from Profibus organization, North America, PTO.
c) Online evaluation:
(1) Confirm specified agent devices appear on the live list.
(2) Evaluate data traffic between controller and each agent to confirm proper agent configuration and performance.
(3) Inspect waveform capture for evidence of excessive noise.
(4) Evaluate and report any failed or questionable network tests.
(5) Evaluate and report network error codes and related symptoms.
d) Network Operations Validation and Testing Report:
(1) Prepare a report that documents the results of the qualification and testing activities include, but not limited to, the following:
(a) Document the installed condition of the network and provide baseline values for future network maintenance and testing activities.
(b) Executive summary for each network including the following:
- Inspection and test results for each network.

- Calculated network parameters.
- Recommendations.
- Description of test procedures and required test equipment.
- Network agency specifications.

(c) Manufacturer's specifications and guidelines:

- Include applicable manufacturer's specifications and guidelines.
- Manufacturer's specifications and guidelines may supersede the specifications of the applicable governing body for the associated network but at a minimum must meet the governing body's requirements.

e) Submit final report of the industrial network testing to the Engineer upon successful completion of the testing.

5) Engineer approval of the industrial network testing submittals is required before proceeding to CEET.

f. Complete End-to-End Testing (CEET):

1) Performed by Contractor, ICSC, and owner working together, with assistance from the Owner or the inspection staff, as needed:
   a) The participants need to be dedicated full-time to CEET.
   b) ICSC will provide staff to verify input signals at, and create output signals from, an HMI or Engineering Workstation.
   c) Contractor and ICSC will be responsible for creating field signals and verifying proper operation of final control elements.
2) Prerequisites:
   a) CEET cannot begin until the successful completion of the preceding tests:
      (1) Calibration.
      (2) Loop check.
      (3) Loop validation tests.
      (4) Copper Ethernet cable acceptance testing.
      (5) Industrial network testing.
3) Testing description:
   a) This testing is to ensure all I/O signals operate to the intent of the design from the field device to the HMI and all other auxiliary controls and indicators in the PCS.
   b) Connect PLC to the network to test signals from the field device through the PLC program, the network, and to the operator's HMI graphic screens. The outputs will be energized for a duration long enough to verify proper operation of the final control element.
   c) SCADA screens:
      (1) Test and record operator commands and signal readouts to each operator device where there is more than one operator interface point.
      (2) For each signal, perform separate tests for SCADA computer screens, local operator interface (LOI) screens, and local control panels.
      (3) Retest any loop following any necessary corrections.

4) Check control loops under simulated operating conditions by causing a range of input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements, final control elements, and the graphic displays associated with the HMI/SCADA system:
    a) Use actual process inputs wherever available.
    b) Issue commands from the HMI/SCADA system and verify proper responses of field devices:
        (1) Test SCADA system inputs from field device to SCADA system operator workstations:
            (a) Track responses through trend charts in the HMI/SCADA system.
        (2) Test SCADA system outputs from SCADA operator workstations to field devices and equipment.
5) Discrete device testing:
    a) Exercise each field device providing a discrete input to the HMI/SCADA system in the field and observe the proper operation shall be observed at the operator workstation:
        (1) Test limit switches, set limits mechanically, and observe proper operation at the operator workstation.
        (2) Exercise starters, relay contacts, switch contacts, and observe proper operation.
        (3) Calibrate and test instruments supplying discrete inputs and observe proper operation.
    b) Test each device accepting a discrete output signal from the HMI/SCADA. Perform the appropriate operator action at the SCADA operator stations (including LOIs, if present) and confirm the proper operation of the field device:
        (1) Stroke valves through outputs from the HMI/SCADA system and confirm proper directional operation. Confirm travel limits and any feedback signals to the HMI/SCADA system.
        (2) Exercise motors starters from the HMI/SCADA system and verify proper operation through direct field observation.
        (3) Exercise solenoids and other field devices from the HMI/SCADA system and verify proper operation through direct field observation.
6) Analog device testing:
    a) Apply continuously variable up and down analog inputs to verify the proper operation and setting of discrete devices (signal trips, etc.).
    b) Apply provisional settings on controllers and alarm setpoints.
7) Analog input:
    a) Exercise each field device monitoring the analog signal, through the HMI/SCADA system:
        (1) Apply simulated sensor inputs corresponding to 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of span for networks that incorporate analog elements and monitor the resulting outputs to verify compliance to accuracy tolerance requirements.

8) Analog output:
    a) Exercise each field device requiring an analog command signal, through the HMI/SCADA system:
        (1) Vary the output from the PLC HMI/SCADA system and measure the end device position, speed, etc., to confirm the proper operation of the device for the supplied analog signal.
        (2) Manually set the output from the HMI/SCADA screen at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent and measure the response at the final device and at any intermediate devices.
9) Submit completed test forms:
    a) Discrete instrument input devices:
        (1) Switch setting, contact action, and dead band.
        (2) Valve position switches:
            (a) Response in the PLC as the valve is stroked from the PLC.
            (b) Field observed actual valve position, and valve indicator position as the valve is stroked from the PLC.
        (3) Operator interface switches (control stations and other pilot devices) and associated response.
        (4) Starter and drive auxiliary device contact response.
        (5) Response of all other discrete inputs to the PLC.
        (6) Test equipment used and associated serial numbers.
    b) Discrete output devices:
        (1) Observed response of field device to the discrete output from the PLC.
        (2) Observe the proper operation of Open, Close, Start, Stop, On, Off, etc.
        (3) Test equipment used and associated serial numbers.
    c) Analog input devices:
        (1) Calibration range.
        (2) Calibration data: Input, output, and error at each test value.
        (3) Analog input associated PLC register address.
        (4) Value in PLC register at each test point.
        (5) Value displayed at each operator interface station (local operator interface displays and SCADA workstations).
        (6) Test equipment used and associated serial numbers.
    d) Analog output devices:
        (1) Calibration range.
        (2) Test value at each test point.
        (3) Analog output associated PLC register address.
        (4) Control variable value at field device at each test point.
        (5) Physical device response at each test point:
            (a) Response to be actual valve position, or motor speed, etc.
        (6) Test equipment used and associated serial numbers.
10) Failure testing:
    a) Demonstrate how the system reacts and recovers from abnormal conditions including, but not limited to:
        (1) Equipment failure.

(2) Communications sub-system error.
(3) Power failure.
(4) Process equipment failure.
(5) High system loading conditions.

11) Engineer approval of the CEET submittals is required before proceeding to Functional Testing.

5. Functional Testing:
   a. General:
      1) Testing to demonstrate proper operation of systems with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.
      2) Performed by Contractor, Owner ICSC, Programmer working together, with assistance from the Owner or the inspection staff, as needed.
      3) Additional tests are specified in other Instrumentation and Control Sections.
      4) Follow approved detailed test procedures and check lists for Functional Test activities.
   b. Control logic operational validation:
      1) The purpose of control logic validation is to field test the operation of the complete control system, including all parts of the HMI/SCADA system, all control panels (including vendor control panels), all control circuits, all control stations, all monitored/controlled equipment, and final control elements.
      2) Demonstrate control functionality shown on the P&IDs, control schematics, and other drawings, and specified in the loop descriptions, control strategies, Electrical Specifications, and Mechanical Equipment Specifications.
      3) Test in detail on a function-by-function and sentence-by-sentence basis.
      4) Thoroughly test hardware and software functions:
      5) Including all hardwired and software control circuit interlocks and alarms.
      6) Test final control elements, controlled equipment, control panels, and ancillary equipment under startup, shut down, and steady-state operating conditions to verify all logic and control is achieved.
      7) Control logic validation tests to include, but not limited to, a repeat of all control logic tests from the FAT, modified and expanded to include all field instruments, control panels, circuits, and equipment.
   c. Loop tuning:
      1) Optimally tune all electronic control stations and software control logic incorporating proportional, integral, or derivative control. Apply control signal disturbances at various process variable levels and adjusting the gain, reset, or rate settings as required to achieve proper response.
      2) Verify the transient stability of final control elements operating over the full range of operating conditions, by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates. As a minimum, achieve 1/4-wave amplitude decay ratio

damping (subsidence ratio of 4) under the full range of operating conditions.

3) If excessive oscillations or system instability occur, as determined by the Engineer, continue tuning and parameter adjustments, or develop and implement any additional control algorithms needed to achieve satisfactory control loop operation.
4) Functional validation sheets:
    a) Document each Functional test on an approved test form.
    b) Document loop tuning with a report for each loop, including 2-pen chart recordings showing the responses to step disturbance at a minimum of 3 setpoints or process rates approved by the Engineer. Show tuning parameters on the charts, along with time, date, and sign-off by Contractor and Engineer.
    c) Include on the form, functions which can be demonstrated on a loop-by-loop basis:
        (1) Loop number and P&ID number.
        (2) Control strategy, or reference to specification tested.
        (3) Test procedures: Where applicable, use the FAT function-by-function, sentence-by-sentence loop test checklist forms modified to meet the requirements of the Functional test. Otherwise, create new forms.
    d) For functions that cannot be demonstrated on a loop-by-loop basis (such as overall plant power failure), include on the test form a listing of the specific steps and tests to be conducted. Include with each test description the following information:
        (1) Specification page and paragraph of function demonstrated.
        (2) Description of function and/or text from specification.
        (3) Test procedures: use the FAT loop test checklist forms modified to meet the specific testing conditions of the Functional test.
5) Functional certification:
    a) Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning:
        (1) Including all test forms with test data entered, submitted to the Engineer with a clear and unequivocal statement that all Functional test requirements have been satisfied.

6. Clean Water Facility Testing:
    a. Programmer shall be onsite to support Clean Water Test activities and provide functional changes as required:
        1) ICSC shall be available as needed.
    b. ICSC shall be onsite to support Clean Water Test activities and provide functional changes as required.

C. Process Start-up Phase:
    1. Process Start-up:
        a. Programmer shall be onsite to support Process Start-up activities and provide functional changes as required:
            1) ICSC shall be available as needed.

b. ICSC shall be onsite to support Process Start-up activities and provide functional changes as required.

2. Process Operation Period:
   a. Programmer shall be available to support Process Operational Period and provide functional changes as required:
      1) ICSC shall be available as needed.
   b. ICSC shall be available to support Process Operational Period and provide functional changes as required.
3. PCIS Optimization and Fine-Tuning:
   a. General:
      1) After the Process Operational Period, test PCIS system for additional 60 days as specified in this Section to identify issues and make corrections, as needed.
      2) This is part of the Work that must be completed as a condition of substantial completion and final completion for the entire Project.
      3) The complete PLC control and HMI/SCADA system must run continuously for the duration of the PCIS Optimization and Fine-Tuning.
      4) Test and use the entire process control system under standard operating conditions.
      5) Exercise all system functions.
      6) Log failure, any system interruption and accompanying component, subsystem, or program failure including time of occurrence, duration of each failure, failure classification, and cause:
         a) Provide a competently trained technician or programmer on call for the Project Site during all normal working days and hours from the start of the PCIS Optimization and Fine-Tuning until final acceptance of the system:
            (1) Response time to the Project Site: 24 hours or less, for a major failure.
   b. SCADA system testing:
      1) Exercise each system function, e.g., status report, alarms, logs, and displays several times at a minimum, and in a manner that approximates "normal" system operation.
      2) Failure of the HMI/SCADA system during testing shall be considered as indicating that the programs and operating system do not meet the requirements of the specifications:
         a) Corrective action is required before restarting the PCIS Optimization and Fine-Tuning.
      3) Only those components, sub-systems, and systems covered in this Section and supplied under this Contract shall be considered for this acceptance test. Problems and failures of other systems shall not be considered as part of this test, except as they display the capabilities of this system to detect failures.
      4) Failures:
         a) Classify failures as either major or minor:
            (1) Minor failure:
               (a) A small and non-critical component failure or software problem that can be corrected by the Owner's operators.

(b) Log this occurrence but this is not a reason for stopping the test and is not grounds for nonacceptance.
(c) Should the same or similar component failure occur repeatedly, this may be considered as grounds for non-acceptance.
(d) Failure of one printer or operator station is considered a minor failure providing all functions can be provided by backup equipment, i.e., alternate printers and operator station, and repairs can be made, and equipment returned to service within 3 working days.

(2) Major failure:
(a) Considered to have occurred when a component, subsystem, software control, or program fault causes a halt in or improper operation of the system and/or when a technician's work is required to make a repair or to re-initiate operation of the system.
(b) Cause termination of the PCIS Optimization and Fine-Tuning.
(c) Start a new acceptance test when the causes of a major failure have been corrected.
(d) A failure is also considered major when failure of any control system that results in an overflow, underflow, overdose, or underdose condition occurs.

5) Technician report:
a) Each time a technician is required to respond to a system malfunction, they must complete a report, which includes details concerning the nature of the complaint or malfunction and the resulting repair action required and taken.
b) If a malfunction occurs which clears itself or which the operator on duty is able to correct, no report is required or logged as specified above.
c) If a technician has performed work but no report is written, then a major failure is considered to have occurred.
d) Each report shall be submitted within 24 hours to the Engineer and the Owner, or its representative.

3.04 SCHEDULES

A. Example test forms:
1. Example test forms are attached at the end of this Section. They may be used as a starting point for the development of Project-specific test forms for this Project.
2. The example test forms are not intended to be complete or comprehensive. Edit and supplement the forms to meet the requirements for testing and test forms specified in this Section and other Contract Documents.

END OF SECTION

ATTACHMENT A - FACTORY ACCEPTANCE TEST - CONTROL PANELS

	FACTORY ACCEPTANCE TEST - CONTROL PANELS	

1. GENERAL INSPECTION

A. Structural Inspection

- ☐ Verify Lifting Lugs Installed
- ☐ Verity enclosure has lock and lock is functional
- ☐ Confirm that seismic bracing components are provided per manufacturer's installation instructions

B. Exterior Inspection

- ☐ Cabinet exterior is clean, scratch, and dent free
- ☐ Inspect externally for corrosion and damage
- ☐ Verify enclosure door opens and closes easily
- ☐ Verify enclosure has a 3-point latch
- ☐ Verify enclosure has a flange mounted disconnect (where voltages greater than 120 VAC enter the cabinet)
- ☐ Verify enclosure has the appropriate NEMA rating (1, 1G, 12, 3R, 4, 4X, etc.)
- ☐ Verify enclosure is the appropriate size (not grossly larger than design, and will still fit in the plant)

Nameplates

- ☐ Cabinet has identification nameplate
- ☐ All door labels are straight, spelled correctly, and match the tagging defined in the Contract
- ☐ Cabinet has a nameplate that includes the following:
  - ☐ Power source(s)
  - ☐ Integrator's Logo
  - ☐ Circuit ID(s)
  - ☐ Short Circuit KAIC ratings
- ☐ If labels are screwed to door, silicone was utilized to cover screw holes (Labels screwed to the door of a NEMA 4/4X panel technically violates the NEMA rating.)

Door Devices

- ☐ All devices penetrating the outside of panel have gaskets, silicone or both
- ☐ All door devices are installed (HMIs, Pilot Devices, etc.)
- ☐ Door mounted equipment is mounted straight and square
- ☐ All exterior or door mounted equipment present and accounted for, installed and securely fastened
- ☐ NEMA classification has not been violated due to penetrations
- ☐ Door mounted equipment has the same NEMA rating as the panel
- ☐ All door mounted equipment installed at the correct height
- ☐ All door mounted equipment installed in the correct positions and order (layout of door mounted equipment is grouped properly and in a logical manner)
- ☐ Doors with multiple penetrations have adequate bracing (if needed)
- ☐ Visually check condition of indicators , controllers and annunciators
- ☐ Check that pilot lights illuminate correctly
- ☐ Check the Push-To-Test function
- ☐ Ensure correct pilot light color

Peripheral Devices

- ☐ Horn / Beacon is installed (where required)
- ☐ Silence and Reset pushbutton

PROJECT NAME:		TEST DATE:	
FACILITY NAME:		TESTED BY:	
PROCESS AREA:		COMPANY:	
NETWORK ID:		PAGE:	
WITNESSED BY:		SIGNATURE:	

1. GENERAL INSPECTION (continued)

C. Interior Inspection

- ☐ Cabinet is cleaned of marks and dirt.
- ☐ Inspect internally for corrosion and damage.
- ☐ Back panel is clean of marks and dirt.
- ☐ Interior of panel vacuumed and shall be free of all debris.
- ☐ Check that the panel roof is clean and clear of foreign materials.
- ☐ Bottom of panel has been cut out (where bottom entry is required), with angle iron welded around the bottom perimeter. Re-painting has been performed.
- ☐ If internal light door limit switch is provided, ensure the light automatically turns "on" when the doors are open.
- ☐ Check that a document pocket has been provided.
- ☐ Intrusion alarms (where required).

Interior Labeling

- ☐ All panel mounted equipment has identification labeling, by using either a Brothers or Phenolic type tags.
- ☐ Verify that door mounted components are mounted square and symmetrical.
- ☐ Verify that nameplates are straight, legible, and spelled correctly.
- ☐ All terminal blocks are identified/labeled with permanent labels including tight end blocks and caps.
- ☐ All wiring shrink labeled and or phased correctly to the specifications.
- ☐ All wire labels shrunk completely rotated and aligned alike for easy identification.
- ☐ All fuses and circuit breakers are labeled with ID and current rating.
- ☐ System Integrator's label or labels installed on door.
- ☐ Panel manufacturer model/serial number tag is present.
- ☐ All required safety/warning tags installed and straight.
- ☐ Correct UL (typically UL 508) or cUL tag installed and registered and all other associated tags installed and straight (the UL tag might not be installed in the panel at the factory test. If the panel is modified due to changes during the factory test or a punch list generated from the factory test, the UL labeling would need to be re-applied. Some UL shops do not apply the UL label until the panel is released to be shipped.).

Wireways

- ☐ Plastic wire way covers installed properly.
- ☐ Plastic wireways have no sharp edges.
- ☐ No wire Ties inside the wireways.
- ☐ No sharp edges on wire ties.
- ☐ Separation: White duct is used for DC voltages; Gray duct is used for AC voltages.
- ☐ Ensure wiring duct is not over-full, includes provision for 20% more wiring and the cover may easily be installed. Panduit recommends 50% duct fill, but 40% is a better practice.

PROJECT NAME:		TEST DATE:	
FACILITY NAME:		TESTED BY:	
PROCESS AREA:		COMPANY:	
NETWORK ID:		PAGE:	
WITNESSED BY:		SIGNATURE:	

1. GENERAL INSPECTION (continued)

C. Interior Inspection (continued)

Wiring

- ☐ Visually check terminals and condition of internal wirings
- ☐ Verify that the control panel has been assembled and wired as designed
- ☐ Verify that all components are operational and perform the functions intended
- ☐ Verify that all components are sized appropriately for the application
- ☐ Verify that equipment control circuits function as intended
- ☐ Back of door wiring is labeled and neatly formed
- ☐ Back panel to door wiring has sufficient bending radius with spiral wrap
- ☐ Wire connection has been verified wired to correct points within the panel
- ☐ Individual wires have been given a pull test to verify a good terminal connection
- ☐ Wire and cable minimum bending radius have not been violated
- ☐ All equipment installed straight and square to back panel
- ☐ Wire colors are correct:
  - ☐ Black and White > AC hot and neutral, respectively
  - ☐ Red > AC control signals
  - ☐ Blue > DC power and control (Blue w/White stripe for DC ground)
  - ☐ Yellow > Foreign voltages (those still present when panel power is disconnected)
  - ☐ Green > AC equipment ground
  - ☐ Black > TSP (+)
  - ☐ White> TSP(-)
- ☐ Analog wiring shields are continuous (connected by a dedicated terminal block for such shields)
- ☐ Analog shield wires are grounded within the panel, where not otherwise grounded at the transmitter itself
- ☐ Discrete inputs are separately fused or protected by a circuit breaker on a “per loop” basis
- ☐ Intrinsic Safety Wiring
  - ☐ Ensure wiring associated with intrinsic safety circuits or intrinsic safety barriers is kept away from all other wiring by UL minimum distances or by a physical (grounded metal) barrier preventing non-intrinsically safe wiring from coming in contact with intrinsically safe circuits or wiring
- ☐ Verify all spare terminals are installed according to the percentage listed in the specifications

Grounding

- ☐ Equipped with “Blackburn” or other grounding type lug
- ☐ Lug is securely fastened to the panel structure
- ☐ Verify Grounding bar is installed
- ☐ Verify Isolated ground bar is installed

PROJECT NAME:		TEST DATE:	
FACILITY NAME:		TESTED BY:	
PROCESS AREA:		COMPANY:	
NETWORK ID:		PAGE:	
WITNESSED BY:		SIGNATURE:	

2. POWER TEST

A. AC Power

- ☐ AC Power is routed correctly within the panel and is isolated from DC and network wiring.
- ☐ All fuses are installed and sized properly.
- ☐ All breakers are installed and sized properly.
- ☐ 24 VDC Power Supplies are functional.
- ☐ 24 VDC Power fail contacts are functional.
- ☐ 24 VDC power supplies are redundant and have diode modules enabling the hot swap-over between supplies.
  - ☐ 24 VDC supplies are equipped with dry contact failure alarms, wired as PLC inputs to signal failure of any DC power supply. Such alarm inputs to the PLC have been tested as being functional.
- ☐ Dedicated receptacle is wired to receive a dedicated AC supply.
- ☐ Verify continuity for all DC commons, ground and AC neutrals.
- ☐ Verify that the CP temporary input power is connected correctly and is the correct voltage.
- ☐ Close the CP main circuit breaker(s).
- ☐ Verify that voltages at subsequent circuit breakers are correct.
- ☐ Close circuit breakers.
- ☐ Verify that power feeding interruptible and uninterruptible power supplies is correct.
- ☐ Turn on power supplies if they are not already on.
- ☐ Verify that voltages at distribution terminals are correct.
- ☐ Energize any remaining hardware such as the PLC.

B. Uninterruptible Power Supply (UPS)

- ☐ Mounted appropriately within the cabinet, on a dedicated shelf, or rear of a swing-out sub panel.
- ☐ Is equipped with maintenance bypass switch (or at least plug/receptacle means for bypassing the unit).
- ☐ Test all UPS alarms (on inverter, failure, battery failure etc.)
- ☐ Turn off the AC power supply and verify that the UPS will be switched on to supply the designated vital loads in the control panel.

3. CONTROLS & AUXILIARY DEVICES TEST

- ☐ Verify all interposing and auxiliary relays are functioning.
- ☐ Verify panel lights are functioning.

Ventilation and Heating

- ☐ If ventilation fans are fitted, check the fans operate correctly any associated air filters are clean and not blocked.
- ☐ Verify components are installed in the correct orientation for proper air flow.

4. HARDWIRED INTERLOCK AND SAFETY TEST

- ☐ Verify that hardwired interlocks through the control panel as shown on schematic drawings are functioning. For example, outlet high pressure switch interlock to a pump.
- ☐ Verify that all hardwired safety devices through the control panel is functioning. For example, the pull cord emergency stops of conveyors.

PROJECT NAME:		TEST DATE:	
FACILITY NAME:		TESTED BY:	
PROCESS AREA:		COMPANY:	
NETWORK ID:		PAGE:	
WITNESSED BY:		SIGNATURE:	

5. PLC TEST

A. Components

☐ PLC interior High Temperature alarm is installed, wired to the PLC, and is shown to be functional.

☐ Relays have transient suppression across their coils. This is particularly important for DC coil relays, where diodes in reverse polarity are often used.

☐ TVSS is installed across the main incoming 120 VAC.

PLC and PLC Rack

☐ Verify all cards are securely seated.

☐ Ensure clearance around PLC rack has been met, such that convective heat transfer is not impeded by devices erroneously mounted in the “no encroachment” area. Confirm with manufacturer clearance recommendations.

B. PLC I/O Test

☐ Furnish **I/O test forms** and test all the listed input and output points as follows:

☐ Discrete Inputs: Simulate a field contact closure by “shorting” across the appropriate terminal blocks. Observe the transition between a logical “0” and “1” in the PLC software.

☐ Discrete Outputs: Force the output bit to toggle between logical “0” and logical “1” using the PLC software. Measure contact resistance at the wired terminal blocks using a digital meter selected for the “ohms” setting.

☐ Analog Inputs: Connect a signal generator to the appropriate terminal blocks. Tailor the connection depending on whether a 2-wire or 4-wire simulation is required. Modulate the 4-20mA signal. Observe the associated PLC internal memory register to transition between 0-65535 or if scaled in engineering units, between 0 and the maximum scaled engineering unit. The latter method is preferred.

☐ Analog Outputs: Force the output register to a value between 0-65535 or 0-100%, if the scaling block can be manipulated. Observe the measured 4-20mA value increment and decrement using a digital ammeter.

C. Redundant Controllers (where required) Test

☐ Remove Communication cable from primary PLC to verify switching to backup PLC

☐ Remove Communication cable from backup PLC to verify switching back to primary PLC

☐ Remove Power cable from primary PLC to verify switching to backup PLC

☐ Remove Power cable from backup PLC to verify switching back to primary PLC

D. PLC Control Logic Verification

☐ The PLC control strategy is verified by following the Control Logic Verification Form based on the specifications. Each control strategy will be verified by simulating the process and checking the state or value of PLC outputs. The results of equipment status and alarms and process instrument values and trends shall also be verified on the Plant SCADA graphic screens stored in a temporary SCADA computer. Since all PLC input and output wiring has been verified and some field devices are not available during Factory Acceptance Testing, certain inputs will be simulated either by means of additional hardware and/or software as described below.

☐

☐

☐ DI states are either simulated by hardwired switches or forced inputs using a programming terminal.

☐ For example, when starters and drives are not provided as part of the contract, jumpers may be installed from the output call relays to the running confirmation inputs to simulate the running state of the motors.

PROJECT NAME:		TEST DATE:	
FACILITY NAME:		TESTED BY:	
PROCESS AREA:		COMPANY:	
NETWORK ID:		PAGE:	
WITNESSED BY:		SIGNATURE:	

5. PLC TEST (continued)

D. PLC Control Logic Verification (continued)

Typical Fault Logic

- ☐ If the fault input is high and the disable (if applicable) for the fault is not high and the common disable (if applicable) is not high begin timing. If any of these conditions changes, stop timing and reset the timer. If the timer reaches its preset, activate the alarm output. If the fault alarm is a shutdown alarm stop the associated motor and latch the alarm so that it remains present even if the condition clears.
- ☐ The fault condition must return to normal and the alarm must be reset for a latched alarm to clear.

Typical Fail to Start Logic

- ☐ If the motor is called to run (call output high) and no running feedback is received (running input is low) and the fail to start and common alarm disables (if applicable) are not high start timing. If any of these conditions changes, stop timing and reset the timer. If the timer reaches its preset, activate the alarm output, stop calling the motor and latch the alarm.

6. HMI OR OIT TEST

HMI / OIT Functionality

- ☐ Communication with PLC
- ☐ Screen Layouts
- ☐ Screen Navigation
- ☐ Set Point Entry
- ☐ Animation
- ☐ Color Correctness (Green=Run, Red=Off, Amber=Alarm, or the agreed upon convention)
- ☐ Alarms
- ☐ Acknowledge and Reset
- ☐ Security / Access Levels / Passwords

7. NETWORK COMMUNICATION TEST

A. Network Components

- ☐ Fiber optic cabling terminates in a patch panel
- ☐ Media converters are installed and functional
- ☐ Terminating resistors have been installed for trunk/tap topologies or where required
- ☐ Wire and cable bending limitations have not been violated

B. Networking Functions

- ☐ Verify data transfer via the network to different PLCs as shown on the Network Block Diagrams
- ☐ Verify network traffic rate and error margin is acceptable

PROJECT NAME:		TEST DATE:	
FACILITY NAME:		TESTED BY:	
PROCESS AREA:		COMPANY:	
NETWORK ID:		PAGE:	
WITNESSED BY:		SIGNATURE:	

8. FAT DOCUMENTATION AND RECORD

Panel Documentation

- ☐ As-built panel drawings showing actual panel construction and devices arrangement and c/w Bill of Material.
- ☐ Panel schematic and interconnection drawings.
- ☐ P&ID drawings and schematic drawings for the process area controlled by the panel that is to be tested.
- ☐ I/O list test forms of the process area to be tested.
- ☐ FAT procedure of the process area to be tested.
- ☐ Test record forms of the process area to be tested. Forms shall include area for signature of responsible test personnel.
- ☐ Hard copy of the PLC application program of the process area to be tested.
- ☐ Hard copy of the HMI/OIT graphic screens of the process area to be tested.

9. FAT TOOLS AND SOFTWARE

- ☐ Simulation software if required
- ☐ Digital volt meter Fluke 87
- ☐ Process meter Fluke 787
- ☐ Laptop computer with PLC application program
- ☐ Temporary SCADA computer with HMI software and applicable graphic screens
- ☐ Jumper wires

PROJECT NAME:		TEST DATE:	
FACILITY NAME:		TESTED BY:	
PROCESS AREA:		COMPANY:	
NETWORK ID:		PAGE:	
WITNESSED BY:		SIGNATURE:	

ATTACHMENT B - INSTALLATION AND CERTIFICATION CHECKLIST DOCUMENTATION

	INSTALLATION AND CERTIFICATION CHECKLIST DOCUMENTATION	

INSTRUMENT LOOP NO. _____

SERVICE DESCRIPTION _____

A COPY OF LATEST ISSUE OF THE FOLLOWING DOCUMENTS ARE INCLUDED IN THIS INSTRUMENT INSTALLATION CERTIFICATION FILE:

☐ INSTRUMENT SPECIFICATION SHEETS (FOR ALL INSTRUMENTS IN THE LOOP)

☐ INSTRUMENT INSTALLATION DETAILS (FOR ALL INSTRUMENTS IN THE LOOP)

☐ INSTRUMENT LOOP WIRING DIAGRAMS

☐ INSTRUMENT INSTALLATION CERTIFICATION CHECKLIST

☐ SIZING CALCULATIONS

☐ INSTRUMENT INSTALLATION SCHEDULE (APPLICABLE PART)

☐ NAMEPLATE SCHEDULE (APPLICABLE PART)

☐ VENDOR LITERATURE CALIBRATION INFORMATION

	☐ No	☐ Yes
INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS?		

REMARKS: _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

ATTACHMENT C - SWITCHES INSTALLATION AND CALIBRATION CHECKLIST

	SWITCHES **INSTALLATION AND CALIBRATION CHECKLIST**	

INSTRUMENT LOOP NO. _____

SERVICE DESCRIPTION _____

CHECK BELOW, WHEN COMPLETED:

☐ BENCH CALIBRATED PER SPECIFICATION SHEET NO. _____

☐ VERIFIED PER P&ID NO. _____

☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____

☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____

☐ INSTALLATION CORRECT PER DETAIL NO. _____

☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED

☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL

☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

	☐ No	☐ Yes
INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS?		

FIELD CALIBRATION CHECK

CONTACT NO.	FUNCTION	FOR SIGNAL	CONTACT IS TO	AT SPECIFIED VALUE FOR		ACTUAL TRIP POINT WAS	
1	☐ ALARM	☐ INCR	☐ OPEN	SET PT =		SET PT =	
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET =		RESET =	
2	☐ ALARM	☐ INCR	☐ OPEN	SET PT =		SET PT =	
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET =		RESET =	
3	☐ ALARM	☐ INCR	☐ OPEN	SET PT =		SET PT =	
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET =		RESET =	
4	☐ ALARM	☐ INCR	☐ OPEN	SET PT =		SET PT =	
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET =		RESET =	

NOTE: PERM IS ABBREVIATION FOR PERMISSIVE

	SWITCHES INSTALLATION AND CALIBRATION CHECKLIST	

REMARKS: _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

ATTACHMENT D - TRANSMITTER/CONTROLLER/INDICATOR INSTALLATION AND CALIBRATION CHECKLIST

	TRANSMITTER/CONTROLLER/INDICATOR INSTALLATION AND CALIBRATION CHECKLIST	

☐ ☐

INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS? No Yes

INSTRUMENT TYPE ☐ TRANSMITTER ☐ CONTROLLER ☐ INDICATOR

☐ OTHER DESCRIPTION _____

INSTRUMENT TAG NO. _____ SERIAL NO. _____

SERVICE DESCRIPTION _____

BENCH CALIBRATION CHECK

INPUT RANGE = _____ OUTPUT RANGE = _____

HEAD CORRECTION = _____ ☐ LINEAR

CALIBRATED SPAN = _____ ☐ SQUARE ROOT

% CALIB SPAN	DESIRED VALUE	ACTUAL VALUE	EXPECTED VALUE	ACTUAL VALUE
0				
50				
100				

CHECK BELOW, WHEN COMPLETED:

☐ BENCH CALIBRATED PER SPECIFICATION SHEET NO. _____

☐ VERIFIED PER P&ID NO. _____

☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____

☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____

☐ INSTALLATION CORRECT PER DETAIL NO. _____

☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED

☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL

☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

FIELD CALIBRATION CHECK

INPUT RANGE = _____ OUTPUT RANGE = _____

% CALIB SPAN	DESIRED VALUE	ACTUAL VALUE	EXPECTED VALUE	ACTUAL VALUE
0				
50				
100				

	TRANSMITTER/CONTROLLER/INDICATOR INSTALLATION AND CALIBRATION CHECKLIST	

☐ DIRECT ☐ REVERSE

☐ ACTION VERIFIED AT 50% SPAN

☐ ACTION VERIFIED AT _____ SPAN

CONTROLLER SETTINGS								
SETTING	**GAIN**	**PB**	**RESET (INTEGRAL)**	**DERIV. (RATE)**	**HIGH LIMIT**	**LOW LIMIT**	**ELEV. ZERO**	**ZERO SUPP**
PRE-TUNE								
POST-TUNE								

PRE-TUNE SETTINGS					
	GAIN	**PB**	**RESET (REPEAT/MIN)**	**RESET (MIN/REPEAT)**	**DERIVATION (MINUTES)**
FLOW	1.0	100	10	0.1	N/A
LEVEL	1.0	100	MIN.	MAX.	N/A
PRESSURE	2.0	50	2.0	0.5	N/A
TEMP.	4.0	25	0.1	10	OFF

REMARKS _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

ATTACHMENT E - ANALYZERS INSTALLATION AND CALIBRATION CHECKLIST

	ANALYZERS INSTALLATION AND CALIBRATION CHECKLIST	

☐ No ☐ Yes

INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS?

TYPE OF INSTRUMENT _____

INSTRUMENT TAG NO. _____ SERIAL NO. _____

SERVICE DESCRIPTION _____

CHECK BELOW, IF TRUE

☐ BENCH CALIBRATED PER SPECIFICATION SHEET NO. _____

☐ VERIFIED PER P&ID NO. _____

☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____

☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____

☐ INSTALLATION CORRECT PER DETAIL NO. _____

☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED

☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL

☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

REMARKS _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

ATTACHMENT F - CONTROL VALVES
INSTALLATION AND CALIBRATION CHECKLIST

	CONTROL VALVES INSTALLATION AND CALIBRATION CHECKLIST	

☐ No ☐ Yes

INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS?

☐ VALVE TAG NO. _____ SERIAL NO. _____

☐ TRANSDUCER TAG NO. _____ SERIAL NO. _____

☐ SOLENOID TAG NO. _____ SERIAL NO. _____

☐ VOLUME BOOSTER TAG NO. _____ SERIAL NO. _____

☐ POSITIONER _____ SERIAL NO. _____

SERVICE DESCRIPTION _____

TRANSDUCER CHECK					
INPUT RANGE =			OUTPUT RANGE =		
CALIBRATED SPAN =			CALIBRATED SPAN =		
BENCH					
SPAN	DESIRED	ACTUAL	SPAN	EXPECTED	ACTUAL
0%			0%		
50%			50%		
100%			100%		
FIELD					
SPAN	DESIRED	ACTUAL	SPAN	EXPECTED	ACTUAL
0%			0%		
50%			50%		
100%			100%		

CHECK BELOW, IF TRUE:

☐ BENCH CALIBRATED PER ABOVE _____

☐ VERIFIED PER P&ID NO. _____

☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____

- ☐ VALVE SPECIFICATION NO. _____
- ☐ TRANSDUCER SPECIFICATION NO. _____
- ☐ SOLENOID SPECIFICATION NO. _____

☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____

☐ INSTALLATION CORRECT PER INSTRUMENT INSTALLATION DETAILS _____

- ☐ VALVE DETAIL NO. _____
- ☐ TRANSDUCER DETAIL NO. _____
- ☐ SOLENOID DETAIL NO. _____

	CONTROL VALVES INSTALLATION AND CALIBRATION CHECKLIST	

☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED

☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL

☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

VALVE CHECK			
FLOW CHECK	☐ PROCESS FLOW DIRECTION THROUGH THE VALVE IS CORRECT		
SAFETY CHECK	ON LOSS OF AIR VALVE FAILS ☐ OPEN ☐ CLOSE	ON LOSS OF POWER SOLENOID FAILS ☐ TO VENT ☐ TO VALVE	
TRAVEL CHECK	FULL OPEN AT _____ PSI	FULL CLOSED AT _____ PSI	MEASURED TRAVEL _____ INCHES
SEATING CHECK	☐ ON BENCH ☐ IN-LINE	RESULTS	ACTUATOR BENCH SET
POSITIONER CHECK			
VALVE FULL OPEN AT _____ PSI TO POSITIONER			
VALVE FULL CLOSED AT _____ PSI TO POSITIONER			
VOLUME BOOSTER CHECK			
BYPASS VALVE (GAIN) ADJUSTING SCREW BACKED OUT _____ TURNS FROM CLOSED TO ENSURE QUICK BUT STABLE OPERATION (TYPICALLY 1-1/2 TO 2 TURNS)			

REMARKS _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

ATTACHMENT G - DEVICENET INSTALLATION TESTING

	DEVICENET INSTALLATION TESTING	

DeviceNet Network _____

Network Installation Characteristics

Architecture	Baud Rate	Trunk Media	Drop Media
☐ Single Controller	☐ 125 kBaud	☐ Thick Round	☐ Thick Round, Unshielded
or			
☐ Multi Controller	☐ 250 kBaud	☐ Thin Round	☐ Thin Round, Shielded
☐ Redundant Power Supplies	☐ 500 kBaud		☐ Thick Round, Shielded

☐ Per Network

Installed Node List

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15

☐ 16 ☐ 17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23 ☐ 24 ☐ 25 ☐ 26 ☐ 27 ☐ 28 ☐ 29 ☐ 30 ☐ 31

☐ 32 ☐ 33 ☐ 34 ☐ 35 ☐ 36 ☐ 37 ☐ 38 ☐ 39 ☐ 40 ☐ 41 ☐ 42 ☐ 43 ☐ 44 ☐ 45 ☐ 46 ☐ 47

☐ 48 ☐ 49 ☐ 50 ☐ 51 ☐ 52 ☐ 53 ☐ 54 ☐ 55 ☐ 56 ☐ 57 ☐ 58 ☐ 59 ☐ 60 ☐ 61 ☐ 62 ☐ 63

☐ All nodes present and in accordance with network drawings/specifications

☐ ODVA approved devices

☐ Nodes/devices accessible for inspection and maintenance

☐ Nodes/devices properly addressed

Comments: _____

Media Inspection

Trunk Cable	Drop Cable	Installation
☐ ODVA approved	☐ ODVA approved	☐ No evidence of physical damage
☐ Labeling complete	☐ Labeling complete	☐ Installed in protective raceway
☐ Cable/conductor terminations	☐ Cable/conductor terminations	☐ Bending radius not exceeded
☐ Terminating resistors at ends	☐ Maximum drop length < 20'	☐ Cable supports in place
		☐ V- and shield are grounded
		☐ Clearance from high temperature/voltage sources
		☐ No installation subject to vibration

Comments: _____

Network Power Supplies

Power Supply Equipment	Supply Source (120 VAC)	Network Power Tap (24 VDC)
☐ ODVA compliant	☐ Overcurrent protection	☐ Overcurrent protection
☐ Quantity and ratings	☐ Conductor size	☐ Conductor size

Comments: _____

CHECKED BY (COMPANY)	ACCEPTED BY (COMPANY)
SIGNATURE	SIGNATURE
DATE	DATE

ATTACHMENT H - PROFIBUS INSTALLATION QUALIFICATION AND TESTING

PROFIBUS
INSTALLATION QUALIFICATION AND TESTING

General Network Description

The Profibus network serves the RO pretreatment, blended water, and concentrate processes and consists of both DP and PA agent devices. The controller is located in programmable logic controller, PLC-900. Profibus DP repeaters are deployed in the network to essentially support a radial network topology from each process control panel.

Network Design Characteristics

ARCHITECTURE

CONTROLLER	☐ SINGLE	☐ REDUNDANT
TOTAL NODE COUNT ≤ 126	☐	
REPEATER COUNT	_____	
CASCADED REPEATER COUNT <9	_____	
NODE COUNT PER DP SEGMENT <32	☐	
DP/PA SEGMENT COUPLERS	_____	
REDUNDANCY (DP/PA COUPLERS	_____	
ACTIVE TERMINATORS	☐	
PROFIBUS DIAGNOSTICS	☐ PA ONLY	☐ DP & PA

BAUD RATE (kbits/sec)

☐ 9.6	☐ 187.5	☐ 3,000
☐ 19.2	☐ 50	☐ 6,000
☐ 93.75	☐ 1,500	☐ 12,000

SURGE PROTECTION FOR AGENTS LOCATED OUTSIDE ☐

SURGE PROTECTION FOR MEDIA ENTERING THE CONTROLLER CABINET ☐

INTRINSIC SAFETY WIRING: REQUIRED FOR ANY PA NETWORK ☐

INSTALLED NODE LIST

☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8	☐ 9	☐ 10	☐ 11	☐ 12	☐ 13	☐ 14	☐ 15																	
☐ 16	☐ 17	☐ 18	☐ 19	☐ 20	☐ 21	☐ 22	☐ 23	☐ 24	☐ 25	☐ 26	☐ 27	☐ 28	☐ 29	☐ 30	☐ 31															
☐ 32	☐ 33	☐ 34	☐ 35	☐ 36	☐ 37	☐ 38	☐ 39	☐ 40	☐ 41	☐ 42	☐ 43	☐ 44	☐ 45	☐ 46	☐ 47															
☐ 48	☐ 49	☐ 50	☐ 51	☐ 52	☐ 53	☐ 54	☐ 55	☐ 56	☐ 57	☐ 58	☐ 59	☐ 60	☐ 61	☐ 62	☐ 63															
☐ 64	☐ 65	☐ 66	☐ 67	☐ 68	☐ 69	☐ 70	☐ 71	☐ 72	☐ 73	☐ 74	☐ 75	☐ 76	☐ 77	☐ 78	☐ 79															
☐ 80	☐ 81	☐ 82	☐ 83	☐ 84	☐ 85	☐ 86	☐ 87	☐ 88	☐ 89	☐ 90	☐ 91	☐ 92	☐ 93	☐ 94	☐ 95															
☐ 96	☐ 97	☐ 98	☐ 99	☐ 100	☐ 101	☐ 102	☐ 103	☐ 104	☐ 105	☐ 106	☐ 107	☐ 108	☐ 109	☐ 110	☐ 111															
☐ 112	☐ 113	☐ 114	☐ 115	☐ 116	☐ 117	☐ 118	☐ 119	☐ 120	☐ 121	☐ 122	☐ 123	☐ 124	☐ 125	R 126	R 127															

☐ ALL NODES PRESENT IN ACCORDANCE WITH NETWORK DESIGN DOCUMENTS.

LEGEND

- **M** CONTROLLER NODE PRESENT AT THIS ADDRESS
- **D** PROFIBUS DP NODE PRESENT AT THIS ADDRESS
- **P** PROFIBUS PA NODE PRESENT AT THIS ADDRESS
- **R** RESERVED ADDRESS
- ☐ NO DEVICE PRESENT AT THIS ADDRESS

COMMENTS *(Comments referenced by number. Refer to the Comments, Observations, and Recommendations Summary.)*

PROJECT NAME: _____ TEST DATE: _____

FACILITY NAME: _____ TESTED BY: _____

PROCESS AREA: _____ COMPANY: _____

NETWORK ID: _____ PAGE: _____

WITNESSED BY: _____ SIGNATURE: _____

PROFIBUS
INSTALLATION QUALIFICATION AND TESTING

Media Inspection

CABLING	DP NETWORK	PA NETWORK SEGMENTS			
PI COMPLIANT	☐	☐	☐	☐	☐
LABELING COMPLETE	☐	☐	☐	☐	☐
GROUNDING	☐	☐	☐	☐	☐
CABLE AND CONDUCTOR TERMINATIONS	☐	☐	☐	☐	☐
NO STUB LINES (DP ONLY)	☐	☐	☐	☐	☐
TERMINATING RESISTORS (IN PLACE)	☐	☐	☐	☐	☐
DEDICATED DIAGNOSTICS BUS	☐	☐	☐	☐	☐
INSTALLATION					
NO EVIDENCE OF PHYSICAL DAMAGE	☐	☐	☐	☐	☐
INSTALLATION IN PROTECTIVE RACEWAY	☐	☐	☐	☐	☐
CLEARANCES FROM HIGH TEMPERATURE SOURCES	☐	☐	☐	☐	☐
CLEARANCES FROM HIGH VOLTAGE SOURCES	☐	☐	☐	☐	☐
BEND RADIUS	☐	☐	☐	☐	☐
NO INSTALLATION SUBJECT TO VIBRATION, SHOCK, HIGH FLEX, CHEMICALS, OR MOISTURE	☐	☐	☐	☐	☐
TERMINATING RESISTORS TURNED ON AT CORRECT LOCATION	☐	☐	☐	☐	☐

COMMENTS *(Comments referenced by number. Refer to the Comments, Observations, and Recommendations Summary.)*

Device Inspection

DEVICE QUANTITY/TYPE	INSTALLATION
☐ TOTAL AGENT COUNT	☐ NO EVIDENCE OF PHYSICAL DAMAGE
☐ MOST UPDATED DEVICE DRIVER INSTALLED?	☐ ACCESSIBLE FOR INSPECTION AND MAINTENANCE
☐ INSTALLED DEVICES COMPLY WITH DRAWINGS AND SPECIFICATIONS	☐ FDT COMPLIANT DEVICES
☐ PI COMPLIANCE DEVICES	
☐ DIAGNOSTICS MODULE INSTALLED	

COMMENTS *(Comments referenced by number. Refer to the Comments, Observations, and Recommendations Summary.)*

Power Supplies

ACTIVE TERMINATIONS	COUPLERS	REPEATERS
☐ SOURCE LOCATION	☐ SOURCE LOCATION	☐ SOURCE LOCATION
☐ OVERCURRENT PROTECTION	☐ OVERCURRENT PROTECTION	☐ OVERCURRENT PROTECTION
☐ CONDUCTOR SIZE	☐ CONDUCTOR SIZE	☐ CONDUCTOR SIZE
☐ GROUNDING	☐ GROUNDING	☐ GROUNDING

COMMENTS *(Comments referenced by number. Refer to the Comments, Observations, and Recommendations Summary.)*

PROJECT NAME: _____ TEST DATE: _____

FACILITY NAME: _____ TESTED BY: _____

PROCESS AREA: _____ COMPANY: _____

NETWORK ID: _____ PAGE: _____

WITNESSED BY: _____ SIGNATURE: _____

PROFIBUS
INSTALLATION QUALIFICATION AND TESTING

DP Network Media Testing

DESCRIPTION	SEGMENT ID					
TRUNK LENGTH (feet)						
ALLOWABLE TRUNK LENGTH AT SPECIFIED DATA RATE:						
MEASURED TRUNK LENGTH:						
SPARE TRUNK LENGTH						
RESISTANCE MEASUREMENTS (ohms)						
NETWORK CABLE: NO TERMINATIONS						
ONE TERMINATION						
TWO TERMINATIONS						
POWER SUPPLY VOLTAGE (volts DC)						
ACTIVE TERMINATOR						
REPEATER CP1100-RPT1						
REPEATER CP1000-RPT1						
REPEATER CP1000-RPT2						
REPEATER CP2700-RPT1						

CABLE TEXTS	SEGMENT ID PASS	SEGMENT ID FAIL	SEGMENT ID PASS	SEGMENT ID FAIL	SEGMENT ID PASS	SEGMENT ID FAIL	SEGMENT ID PASS	SEGMENT ID FAIL	SEGMENT ID PASS	SEGMENT ID FAIL	SEGMENT ID PASS	SEGMENT ID FAIL
TESTED FOR SHORT CIRCUIT BETWEEN SIGNAL LINES	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
TESTED FOR SHORT CIRCUIT BETWEEN SIGNAL LINES AND SHIELD	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
TESTED FOR SHIELD CONTINUITY	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
TESTED FOR OPEN SIGNAL LINES	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
TESTED FOR CROSSED SIGNAL LINES	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
TESTED FOR CORRECT TERMINATOR POSITION	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
CORRECT CABLE TYPE AND LENGTH	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
TESTED FOR SECURE AND TIGHT CONNECTORS	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

COMMENTS *(Comments referenced by number. Refer to the Comments, Observations, and Recommendations Summary.)*

PROJECT NAME: _____ TEST DATE: _____

FACILITY NAME: _____ TESTED BY: _____

PROCESS AREA: _____ COMPANY: _____

NETWORK ID: _____ PAGE: _____

WITNESSED BY: _____ SIGNATURE: _____