City of Cambridge

PURCHASING DEPARTMENT

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Amy L. Witts
Purchasing Agent

TO: **All Bidders**

FROM: **City of Cambridge**

DATE: **March 28, 2016**

RE: **File No. 7132 –Pumping System Improvements at the Walter J. Sullivan Water Purification Facility- Addendum No. 9**

This addendum is comprised of:

1. **Questions and Answers**
2. **Revised Technical Specifications**
3. **Design Plan Revisions**

The following question was asked and answered:

Question: Could you please clarify the bid form items? Our understanding of each of the items is as follows. Item C. "The proposed contact price" is the total contract base bid price, including filed sub-bids. Item C. "For alternate No. 1" is the total Alternate 1 price, including the electrical filed sub-bid Alternate price. Item D.1 "The work of the GC" is all GC base bid work, not including any filed sub-bids or alternate work. And just to further clarify, there isn't a line item on the bid form for Total-Total contract price including all base bid work plus alternate 1.

Answer: Correct

All other details remain the same.

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Responses to Questions and
Technical Specification Revisions

File No. 7132
Pumping System Improvements at the Walter J. Sullivan Water Purification Facility
City of Cambridge, Massachusetts

Prepared by CDM Smith Inc.
March 28, 2016

CONTRACTOR QUESTIONS

Text shown in "italics" indicates question asked. Bold text shown immediately following indicates the response to the question asked.

1. *In Section 41 24 26.10, sub-section 2.25A, there is a description of a "manually operated 4/3 Directional control valve" for the Overflow Storage Basin slide gate. The slide gate is not shown anywhere in the spec and only mentioned in this paragraph.*

   The reference to this equipment has been removed. Please see new specification Section 41 24 26.10 issued as part of this Addendum.

2. *Pertaining to the Pluger Valves specified in Section 40 05 73.23, Paragraph 2.01A "Hydraulic Design Conditions". Is the data shown for a single plunger valve or for both valves? Please provide clarification.*

   The referenced table in Paragraph 2.01A has been removed from the specifications. The specifications now require a minimum Cv value for a fully open plunger valve. See revisions to technical specifications below.

3. *Please confirm the detail on MP-504 is showing both the floor and concrete pump support pad. Are the existing sole plate anchor bolts in a sleeve and can they be used for new work? What are the dimensions of the existing sole plate? What is the estimated depth of the floor and foundation?*

   Detail MP-504 is showing both the floor and concrete pump pad. Existing sole plate anchor bolts and sleeves may not be reused. The existing sole plates on the raw water system are approximately 44 inches in length on each side. The estimated depth of the floor and pump pad are 6 feet and 1.5 feet, respectively. All dimensions are to be field verified by the Contractor.

TECHNCAL SPECIFICATIONS

1. To the Table of Contents, **INSERT** the following after DIVISION 12 (NOT USED):

   "DIVISION 15 MECHANICAL

   23 07 00 Thermal Insulation"

   Note that Section 23 07 00 was added in previously issued Addendum #4.

2. To the Table of Contents, **DELETE** the word "Pump" in 41 24 26.10 Hydraulic Controls for Pump Control Valves.

3. **DELETE** Section 41 24 26 Hydraulic Power Unit in its entirety and **REPLACE WITH** the attached Section 41 24 26 Hydraulic Power Unit consisting of 37 pages.

4. **DELETE** Section 41 24 26.10 Hydraulic Controls for Pump Control Valves in its entirety and **REPLACE WITH** the attached Section 41 24 26.10 Hydraulic Controls for Control Valves consisting of 21 pages.

5. To Section 40 05 73.23 Plunger Valves, **DELETE** Paragraph 2.01.A in its entirety and **REPLACE WITH** the following:

   "2.01

   A. Each plunger valve shall have a fully open Cv value of 8,266 gpm/psi$^{1/2}$ or greater."

6. To Section 40 05 73.23 Plunger Valves, **DELETE** Paragraph 2.02.D in its entirety and **REPLACE WITH** the following:

   "2.02

   D. Valve shaft seals shall prevent the long term potential of water entering into the gear case. The valve operating shaft shall have a minimum of two O-ring seals on the shaft at the shaft at the crank mechanism and three on the shaft at the gear box. The O-ring seals shall maintain a drip tight seal regardless of modulation cycles or inactivity. The O-ring seals will prevent corrosion of the shaft body bore. The seals of the plunger valve shall allow the valve to be drip and bubble tight in both flow directions. The outside of the plunger shall seat against a quad-O-ring sealing ring. The quad-O-ring shall deflect and seal in both axial directions. The quad O-ring shall seal under modulating and open/close services while preventing twist, roll, and point loading of the plunger seal. The seal shall be insensitive to debris. The elastomeric profile sealing ring shall seat leak

tight at the downstream end of the plunger. The elastomeric profile sealing ring shall be mechanically retained in the downstream flange of the valve body by a stainless steel seat ring."

7. To Section 40 05 73.23 Plunger Valves, **DELETE** Paragraph 2.03 in its entirety and **REPLACE WITH** the following:

"2.03 ELASTOMER SEALS

A. O-rings and other seals for valve sealing, shall be constructed of Acrylonitrile Butadiene Rubber (Nitrile or BUNA-N) or EPDM, 60 to 70 Durometer Shore A."

DESIGN PLAN REVISIONS

1. **DELETE** existing Sheet No. MP-501 (Hydraulic Power Unit Schematic) and **REPLACE** with the attached Sheet No. MP-501, Rev. 1.
2. **REVISE** Sheet No. MP-502 (Pump Control Valve Panels Hydraulic Schematic I) as indicated in attached SK#10.
3. **DELETE** hydraulic actuator sizing data, including butterfly valve stroke times and operation schedule of solenoids and timing table, from Sheet No. MP-502 (Pump Control Valve Panels Hydraulic Schematic I).
4. **REVISE** Sheet No. MP-503 (Emergency Valve Panel Hydraulic Schematic II) as indicated in attached SK#11.
5. **DELETE** hydraulic actuator sizing data, including butterfly valve stroke times and operation schedule of solenoids and timing table, from Sheet No. MP-503 (Emergency Valve Panel Hydraulic Schematic II).

SECTION 41 24 26
HYDRAULIC POWER UNIT

PART 1 GENERAL

1.01 DEFINITION OF TERMS

A. Terms defined below shall supplement and clarify those included in the General Conditions and apply to the technical content and services specified herein.

1. Supplier - shall refer to the hydraulic power and control system integrator responsible for the final sizing and purchase of the individual fluid power controls; purchase of the instruments and control components; and layout, mechanical integration, fabrication, assembly and programming of the hydraulic power units (HPU) and hydraulic control panels (HCP).

2. Supplier's Field Installation Technician - shall refer to technicians and engineering personnel, who are employed by the Supplier and have been trained for start-up and commissioning services at the Site.

3. Original Equipment Manufacturer (OEM) - shall refer to the manufacturer of individual components used by the Supplier to assemble the HPU and local control panel systems.

4. OEM Installation Technician - shall refer to technicians and Engineers employed by OEMs and trained for installation, configuration, commissioning services related to their company's products, and training of the Owner's operations and maintenance personnel in their use. The OEM Installation Technician shall only be allowed to perform services at the Site under the supervision of the Contractor and Supplier's Field Installation Technician.

1.02 SCOPE OF WORK

A. The Work of this Section shall include the final design, fabrication, programming, delivery, installation and testing of skid mounted hydraulic power unit(s) (HPUs), as shown on the Drawings and specified herein. The Contractor shall furnish all labor, materials, equipment and incidentals required to install and connect the HPU to the high-pressure fluid power distribution piping as shown on the Drawings and specified herein.

B. The sizing and arrangement of hydraulic controls have been included on the Drawings to establish the configuration and performance requirements of the system. The HPU Supplier shall be responsible for the final hydraulic selection of fluid power components, and furnish all components necessary to commission the system.

1.03 RELATED WORK

A. Submittals are included in Section 01 30 00.

B. Operation and Maintenance Data is included in Section 01 78 23.

C. Specifications for the Work associated with the selection and installation of annealed stainless steel tube and fittings, for use within the limits of the HPU and hydraulic control panels, are included in Section 40 05 23.06.

D. Specifications for the Work associated with selection and installation of fluid power hose assemblies, for use within the limits of the HPU and hydraulic control panels, are included in Section 40 05 30.

E. Hydraulic Controls for Control Valves are included in Section 41 24 26.10.

1.04 SUBMITTALS

A. Shop Drawings including cut-sheets, schematics and operation and maintenance data, shall have text written in English, and all numerical data shall be in the foot-pound-second system of units. Materials for all parts shall be identified with the corresponding mark numbers, codes or serial numbers, and refer to the appropriate material standard which applies to them. Submit the following data in accordance with Section 01 30 00:

1. Calculations for sizing and selecting components in accordance with the design criteria specified below.

2. Hydraulic schematic.

3. Control wiring diagram(s) and control loop descriptions.

4. A complete bill of materials.

5. Descriptive literature, bulletins and/or catalog cut sheets with notations showing selections for all commercially obtained components. Each cut sheet shall be marked with corresponding part numbers from the bill of materials.

6. Detailed shop drawings for all custom designed and fabricated components. The drawings shall include a parts list, including the part number, description, material of construction and weight for each component.

7. Fabrication drawings shall illustrate details of materials, tolerances, connections, and proposed welding sequences which shall clearly differentiate shop welds from field welds, if any.

8. Field erection drawings providing a detailed description of recommended field installation procedures. The description shall include the location and method of support of installation and handling equipment dimensions and location of anchor bolt holes.

9. Description of surface preparation and shop prime painting for ferrous metal components and accessories.

10. Manufacturer’s list of recommended spare parts.

11. Shop testing procedures.

B. O&M data shall be prepared by personnel familiar with the operation and maintenance information for this specific installation and for the specific purpose of educating operating and maintenance personnel unfamiliar with such equipment. The O&M manuals shall be provided in three-ring binders and in accordance with Section 01 78 23 and shall contain the following minimum contents:

1. Installation instructions, including instructions for installing, supporting, checking, and testing equipment under this Section.

2. Startup procedures.

3. Maintenance instructions shall include preventive, corrective, and troubleshooting. Schedules for maintenance are to be included. Provide a list of tools required to service the equipment.

4. Operation instruction for normal startup and shutdown, emergency startup and shutdown, and ongoing normal operations.

C. Motor data shall include complete nameplate data and test characteristics in accordance with NEMA Standard MG1-12.54 "Report of Test Form for Routine Tests on Induction Motors" and, in addition, the following for motors typical of the units furnished:

1. Efficiency at 1/2, 3/4 and full load.

2. Power factor at 1/2, 3/4 and full load.

3. Motor outline, dimensions and weight.

4. Descriptive bulletins, including full description of insulation system.

5. Bearing design data.

6. Special features (i.e., space heaters, temperature detectors, etc.).

7. Manufacturer’s recommended spare parts.

D. Contamination control procedures for the HPU unit shop fabrication describing the procedures utilized to prevent particulate contamination within the interior of the fluid lines and other circuit components.

E. The following descriptive installation and operation information shall be included in the submittal:

1. A narrative of the system operation procedures.

2. A layout drawing and step-by-step description of the field erection and start-up procedures.

1.05 REFERENCE STANDARDS

A. American Gear Manufacturers Association (AGMA)

1. AGMA 922 - Load Classification and Service Factors for Flexible Couplings
2. AGMA 9002 - Bores and Keyways for Flexible Couplings

B. American Society for Testing and Materials (ASTM)

1. ASTM A48 - Standard Specification for Gray Iron Castings
2. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
3. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
4. ASTM A473 - Standard Specification for Stainless Steel Forgings
5. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
6. ASTM B580 - Standard Specification for Anodic Oxide Coatings on Aluminum
7. ASTM D445 - Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity

C. American Society of Mechanical Engineers (ASME)

1. ASME BPVC Section VIII - ASME Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels
2. ASME B1.20.1 - Pipe Threads, General Purpose (Inch)
3. ASME B18.2.1 - Square and Hex Bolts and Screws: Inch Series
4. ASME B40.100 - Pressure Gauges and Gauge Attachments
5. ASME B46.1 - Surface Texture, Surface Roughness, Waviness and Lay
6. ASME Y14.5M-1994 - Dimensioning and Tolerancing

D. International Electrotechnical Commission (IEC)

1. IEC 801 - International Electrotechnical Vocabulary - Chapter 801: Acoustics and electroacoustics

E. Institute of Electrical and Electronics Engineers (IEEE)

1. IEEE C37 - Standard Test Code for High-Voltage Air Switches, Corona Tests

F. International Organization for Standardization (ISO)

1. ISO 4400 - Fluid Power Systems And Components - Three-Pin Electrical Plug Connectors with Earth Contact - Characteristics and Requirements

G. National Electric Manufacturers Association (NEMA)

1. NEMA ICS-2 - Controllers, Contactors and Overload Relays Rated 600 V

H. National Fluid Power Association (NFPA)

1. NFPA T3.16.2 R1 - Hydraulic Fluid Power - Design for Non-Integral Industrial Reservoirs

I. Society of Automotive Engineers (SAE)

1. SAE J514 - Hydraulic Tube Fittings

2. SAE J518 - Hydraulic Fanged Tube, Pipe and Hose Connections, Four Bolt Split-Flange Type

1.06 SUPPLIER'S EXPERIENCE REQUIREMENTS

A. The Work shall be furnished by a Supplier employing a qualified fluid power system integrator having experience in the design and fabrication of hydraulic power systems for civil engineering, valve and water control applications. Suppliers proposed for consideration shall submit a list of at least twenty (20) successful installations of fluid power systems used for control valve and/or water control gate applications. The referenced projects shall be of similar size to the Work specified herein. The list shall be submitted prior to the preparation of Shop Drawings and include customer contact information for each installation.

B. The Supplier shall be responsible for final sizing of all fluid power, instrumentation and control devices. The devices have been specified below. The component models and Suppliers listed shall establish the minimum quality of construction and service durability required for the municipal/industrial environmental conditions at the Site. All surface finishes specified shall be as defined in ASME B46.1. All mechanical Shop Drawings shall be prepared in accordance with ASME Y14.5M.

1.07 HYDRAULIC POWER UNIT - SYSTEM DESCRIPTION

A. The HPU shall be an all-encompassing skid-mounted unit and serve as the power source for all hydraulically operated equipment controlled within the limits of each designated local control panel in the facility as shown on the Drawings. Local hydraulic control system panels are specified in Section 41 24 26.10, and shall include the following:

Local Control Panel	**Process System**	**Motion System**	**Control Regime**	**Loop Number**
PCV1	Finished Water	Double-Acting Hydraulic Cylinder	OPEN/CLOSE Utility Pump Control Valve	511-1

Local Control Panel	Process System	Motion System	Control Regime	Loop Number
PCV2	Finished Water	Double-Acting Hydraulic Cylinder	OPEN/CLOSE Utility Pump Control Valve	511-2
PCV3	Finished Water	Double-Acting Hydraulic Cylinder	OPEN/CLOSE Utility Pump Control Valve	511-3
PCV4	Finished Water	Double-Acting Hydraulic Cylinder	OPEN/CLOSE Utility Pump Control Valve	511-4
Emergency Valve	Finished Water	Double-Acting Hydraulic Cylinder	OPEN/CLOSE Isolation Valve	530

B. Hydraulic schematics and details for the HPU have been included on the Drawings. Specific HPU component designations are referenced in parenthesis for concurrent review of this Section with the schematics shown on the Drawings.

C. The HPU control panel shall operate on 480V, 3-phase, 60 Hz AC utility grid power, and contain the motor starters for HP-101 and HP-102, the control power transformer. The HPU panel controls shall operate on 120V, single phase, 60Hz AC control power.

D. The HPU control panel shall be furnished with a programmable logic controller (PLC) selected, assembled and programmed by the Supplier. The PLC shall be programmed and configured to interact with the facility's central control PLC, providing monitoring signals for alarms and other operations described below. The Owner's operations personnel shall be able to modify settings, obtain detailed information regarding the nature of ALARMS and obtain data from the event register log from the operator interface terminal (OIT). The HPU control panel and its PLCs shall be designed and manufactured in accordance with this Section.

E. The HPU shall be constructed on a fabricated carbon steel containment stand including a bronze drain plug. The HPU shall be furnished with fixed-displacement heavy-duty vane pumps, HP-101 and HP-201. Hydraulic pumps shall be flexibly coupled to electric motors having totally enclosed, fan-cooled, squirrel cage induction type design. Each hydraulic pump train shall have the following installed components as shown on the Drawings:

1. Suction-side in-line isolation ball valves (BV-101 and BV-201)

2. Inline suction strainers (SST-101 and SST-201)

3. Hydraulic pumps (HP-101 and HP-201)

4. Inline pump discharge check valve (CV-101 and CV-201)

5. High-pressure filter (HPF-101 and HPF-201)

6. Flow meter (FI-101 and FI-201)

7. Discharge isolation ball valve (BV-102 and BV-202)

F. The HP-101 and HP-102 connecting fitting on the suction port shall be a low-pressure hose assembly, and on the discharge port shall be a high-pressure hose assembly each specified in Section 40 05 30. The hydraulic pump suction and return lines shall be sized by the Supplier for a maximum fluid velocity of 4 ft/s. The high-pressure pump discharge hose shall be sized for a 15 ft/s maximum velocity. Each hydraulic pump shall have dedicated discharge pressure gauges, PI-101 and PI-201, installed in an accessible location within the containment stand.

G. The hydraulic oil reservoir shall be constructed of fabricated carbon steel installed on a fabricated steel overhead reservoir base mounted within the containment stand such that low pressure leakage is captured by the stand. The height of the base shall allow installation of the HP-101 and HP-102 directly below on the containment stand, creating permanent flooded suction conditions for each hydraulic pump, vents and drain lines. The oil reservoir shall be furnished with the following installed components as a minimum:

1. A multi-float level switch (LS-001, LS-002 & LS-003).

2. Filler breather with desiccant breather cartridge (FB/DB).

3. A standard metal cap filler breather with no desiccant filter, furnished loose (not installed).

4. Hydraulic oil sight level indicator gauge (SLI).

5. Electric self-regulating submersion oil heater (OH).

6. Temperature Switch (TSH-001, TSL-001).

7. Temperature Transmitter (TE-001).

H. The primary pressure control in the system shall be the system relief valve (SRV). The starting and stopping of the lead hydraulic pump (LHP) and standby hydraulic pump (SHP) shall be pressure controls measured at the accumulator porting block manifold. The accumulator manifold shall have pressure gauge PI-001. Calibrated system pressures measured at the transducer (PE-001) shall be the signal used by the PLC to start and stop the LHP and SHP under normal conditions. The system shall also have redundant pressure controls including a redundant low-low pressure switch (PS-001), and high-high pressure switch (PS-002).

I. The HPU shall be furnished with accumulators sized to provide emergency hydraulic power during a regional utility grid power outage. The HPU shall have a piston accumulator (ACC-001) and auxiliary gas bottles (GB-001 to GB-003), each one connected to the others by parallel manifold piping. An accumulator safety block (ASB) shall be installed on a SAE 4-bolt flanged port on the “oil side” of ACC-001. The ASB shall have two integral isolation ball valves, one serving to isolate the accumulator from the system, and the other used to discharge the oil volume from the accumulator to the oil reservoir for maintenance. Discharge to the oil reservoir from the ASB shall be regulated by a manually operated flow control valve (FCV-001).

J. The ASB shall also have an integral relief valve, installed in parallel to the drain valve. The relief valve shall be used to control the pressure in the accumulator while charging the auxiliary gas bottles. This discharge shall also be regulated at FCV-001.

K. Nitrogen gas shall be used to pre-charge the gas space above the accumulator piston and the Auxiliary Gas Bottles. Nitrogen shall be introduced and maintained using a charging kit furnished by the Supplier, as specified herein. Nitrogen gas for the first charge of the system shall be provided by the Contractor.

L. A return-line-filter (RLF), having a service indicator and limit switch (PS-003), shall be installed outside the oil reservoir. An inline oil sampling/test port coupling with integral ball valve and dust cap (TP-001) shall be installed on the return line upstream of the RLF. This shall be the primary sample collection point for periodic oil testing performed by the Owners operations personnel.

M. The "P" & "T" connecting ports at the HPU shall be configured with SAE J518 4-Bolt O-ring flanged faces, or SAE J514 straight thread O-ring boss connections. The HPU shall be designed to provide hydraulic power to each local control panel via a high-pressure oil (HPO) header pipe connected to the "P" port; and low-pressure oil (LPO) header connected to the "T" port. Both HPO and LPO header pipes shall be connected to the hydraulic power distribution piping system installed throughout the facility as shown on the Drawings.

N. Fabricated weldments constructed of carbon steel shall receive surface preparation, shop prime and finish painting, in accordance with the requirements specified below, prior to mounting the valve stacks, manifolds and other components that shall not receive shop coatings. The only components to receive shop coatings by the HPU Supplier are the carbon steel framing members, accumulators, nitrogen bottles and other carbon steel fabricated components. Sealing surfaces, elastomer components, control devices, reservoirs, control panels and other stainless steel surfaces shall not receive shop coatings or overspray from the shop coating process.

1.08 HYDRAULIC POWER UNIT CONTROL NARRATIVE

A. In the narrative below HPU PLC ALARMS described for each sub-system shall be coordinated by the HPU PLC. All alarm descriptions shall be accessible at the HPU OIT by the Owners operations personnel without the use of a laptop computer. The HPU PLC shall send an "HPU Common Alarm" signal to the facility SCADA system for each event. The HPU control panel shall be fitted with a beacon, which shall aluminate when a COMMON ALARM is sent. This beacon shall be energized regardless of whether a dedicated panel illuminator is provided for the same alarm. A "yellow" panel-mounted momentary RESET switch shall be provided to acknowledge HPU PLC ALARMS and de-energize panel illuminators and beacons.

B. The HPU PLC shall maintain an event log of system operations and alarms as described below. The event log shall be accessible at the HPU OIT, and/or by download to a laptop computer having the necessary software and cables necessary to access the HPU PLC. Six (6) complete sets of all cables necessary for system access and programming shall be furnished to the OWNER by the Contractor.

C. NORMAL operating regimes shall refer to operation when the primary power utilized by the HPU control panel is accessible and uninterrupted. EMERGENCY operation shall refer to operation when there is a regional utility grid power outage.

D. HP-101and HP-102 shall each have a dedicated HAND-OFF-AUTO selector switch on the face of the HPU control panel. One hydraulic pump shall serve as the lead hydraulic pump (LHP) and the other shall serve as the stand-by hydraulic pump (SHP).

E. Prior to NORMAL system start-up, the Contractor shall fill the ASBs and the space on the gas side of the ACC-001 piston with nitrogen gas using the accumulator charging kit specified in Part 2. The Contractor shall charge the system to the pre-charge pressure specified in the approved Shop Drawings. A proximity sensor (ZS-001) shall be installed on the cap on the gas-end of the piston accumulator. When the accumulator nitrogen pre-charge is set by the Contractor the piston will move to the end of stroke on the oil-end. If the piston is at the extreme gas-end of the cylinder it will be detected by the proximity sensor and prevent the LHP from starting. An ALARM shall be sent to the HPU PLC for "Loss of Accumulator Pre-charge". The ALARM shall terminate when acknowledged, recorded in the event log and indicated on the HPU OIT.

F. The LHP shall transfer hydraulic oil under pressure from hydraulic oil reservoir to the piston accumulator shown on the Drawings. During NORMAL system start-up, HP-101 and HP-201 HAND/OFF/AUTO (HOA) selector switches shall be placed in the AUTO position. The HPU control panel shall be energized by transferring the main power switch from the OFF to the ON position. After the HPU panel is energized the following sequence of operations shall occur:

1. Solenoid S-002 shall be energized and DCV-002 shall shift to the check position and HOLD. This directs LHP flow to the accumulator, and the check position at DCV-002 shall prevent that pressurized fluid from entering the hydraulic oil distribution piping system. The oil shall be stored in the accumulator and used for EMERGENCY operation.

2. Concurrent to S-002, solenoid S-001 shall be energized and DCV-001 shall shift to the all-ports-blocked position preventing pilot drainage from the SRV pilot. This shall allow the SRV to OPEN and protect the system when the system pressure exceeds the adjustable pressure spring-setting.

3. The HPU PLC shall poll the HPU instruments for their set-points and permissives. The ZS-001 contacts shall be open indicating no loss of pre-charge and at ACC-001 and the auxiliary gas bottles.

4. Visual indication of reservoir temperature shall be observable at the sight level indicator (SLI). Reservoir temperature shall be controlled by the self-regulating reservoir heater (OH), and reservoir temperature monitored at TE-001 by the HPU PLC. The HPU PLC shall record reservoir temperature in the event log. The HPU PLC shall be programmed with maximum and minimum permissible reservoir temperatures. At NORMAL start-up the reservoir temperature must be within the minimum and maximum temperature permissive settings in the HPU PLC programming.

5. If the hydraulic oil temperature in the reservoir exceeds the high-temperature set point monitored at TE-001, the LSH shall be STOPPED and a "High Reservoir Temperature"

ALARM shall be sent to the HPU PLC. If the reservoir high-temperature condition is not detected by TE-001 the temperature shall continue to rise to the TSH-001 setting, and its contact shall close, shutting down the LHP and sending a "High Reservoir Temperature" ALARM to the HPU PLC. If the temperature is less than the low-temperature set-point monitored at TE-001 a "Low Reservoir Temperature/OH Fault" ALARM shall be sent to the HPU PLC. The ALARM shall terminate when acknowledged. If the low-temperature setting is not detected at TE-100 the temperature shall close contacts at TSL-001 (at the same set-point) and send a "Low Reservoir Temperature/OH/TE-001 Fault" ALARM to the HPU PLC. The ALARM shall terminate when acknowledged. This ALARM shall not prevent the LHP START.

6. Visual indication of hydraulic oil level in the reservoir shall be observable at the SLI. If the reservoir oil level switch LS-001 has contact closure, the LHP shall not START and a "Reservoir Overfill" ALARM shall be sent to the HPU PLC. If the reservoir level switch LS-002 has contact closure, a red "ADD OIL" panel indicator shall illuminate, until the RESET momentary switch is depressed. If the reservoir oil level switch LS-003 has contact closure, the LHP shall not START and a "Reservoir Low Level" alarm shall be sent to the HPU PLC. The ALARM shall terminate when acknowledged. The Owners operations personnel shall be able to access and trend reservoir levels and alarms stored in the HPU PLC event log from the OIT.

7. Visual indication of the hydraulic oil pressure in the accumulator can be observed at PI-001. Accumulator pressure shall be maintained by the LHP, based on pressure signals monitored by the HPU PLC at PE-001. PE-001 shall be the primary instrument used for pressure control in the system. All other pressure devices serve as back-ups to PE-001. If the monitored pressure is less than or equal to the LHP CUT-OUT setting, the HPU PLC shall automatically select and START the LHP. The LHP shall run until the LHP CUT-OUT setting is measured at PE-001, and the LHP shall be STOPPED by the HPU PLC. The Owners operations personnel shall be able to access and trend system pressure and alarms stored in the HPU PLC event log from the OIT.

8. Visual indication of hydraulic oil flow rate shall be observable at the visual flow indicators (FI-101 and FI-201). FI-101 and FI-201 have normally-open integral flow switches (ZS-101 and ZS-201). HP-101 and HP-201 shall have integral relief valves that discharge to the case-drain when flow is blocked by closed isolation. After LHP START the HPU PLC shall measure the time prior to contact closure at ZS-101 or ZS-201 depending on LHP assignment. If the contact does not close within 15 seconds, the HPU PLC shall STOP the LHP, and a "Closed LHP Isolation Valve" ALARM shall be sent to the HPU PLC.

9. After the first accumulator charge the system pressure shall be held at CV-001 and the HPU PLC shall send a SYSTEM READY signal to all local control panels. S-002 shall remain energized and the accumulator pressure held at DCV-002. S-001 shall be de-energized and the system pressure shall be unloaded to the reservoir upstream of CV-001 through the unloading SRV.

G. After the first successful pump cycle under utility grid power, two signals shall re-start the LHP, a LHP RUN signal from a local control panel, or a LHP CUT-IN pressure signal monitored at PE-001. The HPU PLC shall monitor the system pressure at PE-001. The LHP will be STOPPED once the LHP CUT-OUT pressure is detected by the HPU PLC at PE-001. When the

LHP CUT-IN pressure setting is detected the HPU PLC shall automatically select and START the LHP. If the LHP does not start at the CUT-IN pressure, the pressure will continue to drop until it reaches the contact closure setting at PS-001, which shall start the LHP and send a "PE-001 Fault" ALARM to the HPU PLC. The ALARM shall terminate when acknowledged. Again, the startup and subsequent pump cycle pressures shall be monitored by the HPU PLC and recorded in the event log, available for review by the Owners operations personnel at the OIT.

H. If the LHP does not STOP at the LHP CUT-OUT pressure monitored at PE-001, the pressure shall continue to rise until the pressure setting at PS-002 is reached. PS-002 shall close, shut down the LHP and send a "PE-001 Fault" ALARM to the HPU PLC.

I. If PS-002 does not close, and the SRV pressure setting is reached, and S-001 is energized to HOLD DCV-001 in the all-ports-blocked position, the SRV shall open and circulate pump flow back to the reservoir and the system shall function on the SRV pressure setting. After LHP run time exceeds 20 minutes the HPU PLC shall send a "Common Fault" ALARM to the HPU PLC.

J. As the LHP is running under this common fault, reservoir temperature shall be monitored at TE-001 while the pumped flow by passes over the SRV. If the temperature rise in the reservoir exceeds the maximum set point, the LHP shall be STOPPED and a "Reservoir High Temperature" ALARM shall be sent to HPU PLC.

K. During NORMAL hydraulic equipment operation, with HP-101 and/or HP-201 HOA selector switches in the AUTO position, local control panels shall rely on the LHP to provide hydraulic pressure and flow for a change in rod position at a particular hydraulic actuator or hoist. Each local control panel has a dry contact, which shall close and send a LHP START signal to the HPU PLC. On contact closure the LHP will START and run during operation of the designated equipment. As the START signal is transferred to the HPU PLC the following shall occur:

1. S-001 is energized engaging the spring setting at the SRV.

2. The LHP shall START and flow will be diverted through the SRV until the local control panel DCV shifts to reposition the designated hydraulic actuator or hoist.

3. The local control panel shall open the LHP START contact when the designated equipment completes its operation sequence and the LHP shall STOP.

L. If a hydraulic pump HOA selector switch is moved into the OFF position during NORMAL operations, the pump remaining in AUTO mode shall automatically have LHP assignment. If both pump HOA selector switches are place in the OFF position, the first pump placed back into AUTO mode shall be selected as LHP by the HPU PLC.

M. High-pressure filters HPF-101 and HPF-201 are installed downstream of their designated hydraulic pumps. Each filter is specified to have an integral service indicator, differential pressure switch (PS-101 and PS-201) and bypass spring check valve. When the filter condition develops a differential pressure greater than or equal to the factory set pressure a "Filter Service Required (including tag number)" ALARM shall be sent to the HPU PLC. When the differential

pressure exceeds the factory spring-setting at the integral bypass check valve, flow shall resume prior to filter element replacement.

N. A medium-pressure return-line filter (RLF) is installed on the reservoir return line. The RLF is specified to have an integral service indicator, differential pressure switch (PS-003) and bypass spring check valve. When the filter condition develops a differential pressure greater than or equal to the factory set pressure, a "Filter Service Required (including tag number)" ALARM shall be sent to the HPU PLC. When the differential pressure exceeds the factory spring-setting at the integral bypass check valve, flow shall resume prior to filter element replacement.

O. EMERGENCY operation shall occur during a utility grid power outage. Following loss of power the following sequence of operation shall commence:

1. S-002 shall de-energize and DCV-002 shall shift to the open ports position, allowing flow to and from the accumulator. System pressure will be held in the piping system by CV-001. All local control panels shall operate off accumulator pressure until it is depleted.

2. When power is restored, the system will revert to NORMAL system start-up operation described in paragraph 1.08F above. The local control panels shall not commence operation of any hydraulic equipment until the SYSTEM READY signal is sent by the HPU PLC.

1.09 MAINTENANCE ACCESSORIES AND SPARE PARTS

A. Furnish the following spare parts for each control panel in the quantities specified:

1. One dozen replacement fuses, all types and sizes.

2. Two dozen replacement lamps for pilot lights.

3. One dozen of each color replacement lens caps for pilot lights.

4. One starter coil for each NEMA size furnished.

5. One, 3-pole set of replacement overload heaters of each size range used.

6. One, 3-pole set of starter contacts of each NEMA size used.

7. One can of aerosol touch-up paint.

8. Provide spare processor unit(s) for each unique processor installed.

9. Provide spare OITs for each unique type installed.

10. Provide spare memory cards for each type of card installed.

11. Provide spare I/O cards for each unique I/O module type installed. Provide two or 10 percent of installed quantity, whichever is greater.

12. Provide one spare network interface communication module for each unique communication module installed.

B. Hydraulic controls spare parts included in the list below shall be furnished during start-up and training of facility operations and maintenance personnel.

1. Two (2) high pressure hydraulic oil filters for each HPU.

2. Two (2) hydraulic oil suction strainer elements for each HPU.

3. Four (4) hydraulic oil return filters for each HPU.

4. Four (4) spin-on filter-breather-descant cartridges for each HPU.

5. Six (6) fuses of each type for each HPU.

C. Spare parts shall be properly bound and labeled for easy identification without opening the packaging and be suitably protected for long term storage in a humid environment.

D. The Supplier shall furnish a charging and gauging kit suitable for maintaining the nitrogen bottle pre-charge. The kit shall include connection fitting, adapters, 10-feet of hose and a plastic carrying case. The kit shall be:

1. Model 087040 manufactured by Parker Hannifin, Greenville, Tennessee; or equal.

E. The Supplier shall furnish an oil sampling kit suitable for with the specified sampling connections. The kit shall include sampling connection fitting, sampling hose and a plastic carrying case. The kit shall be:

1. Model SFSK manufactured by Stauff USA, Waldwick, New Jersey

2. Model 087040 manufactured by Parker Hannifin, Greenville, Tennessee; or equal.

1.10 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be covered for protection against physical damage, such as rubbing, abrasion and exposure to sunlight where it can be detrimental to coatings or elastomer products during shipping and after delivery to the site. All hydraulic fluid lines shall be plugged prior to shipping to prevent entry of contaminants.

PART 2 PRODUCTS

2.01 PROGRAMMABLE LOGIC CONTROLLER

A. The Supplier’s HPU control system shall be programmable logic controller (PLC) based. The Supplier shall furnish PLC equipment with the required memory and functional capacity to perform the specified sequence of operation included in the control description described in paragraph 1.08. Processor Systems shall include integral processor, power supply, input/output modules, communication modules, and remote interface modules as required to meet system requirements.

B. The PLC shall support expansion I/O modules but not be chassis based in design. Products shall be listed and classified by Underwriters Laboratories (UL) and/or CSA approval as required for installation location and intended service.

C. All equipment and devices furnished hereunder shall be designed for continuous industrial and municipal service. The system shall contain products of a single PLC OEM and shall consist of equipment models that are currently in production. All equipment furnished shall be designed and constructed so that in the event of power interruption the systems shall go through an orderly shutdown with no loss of memory, and resume normal operation without manually resetting when power is restored. This requirement shall be strictly enforced.

D. The PLCs shall communicate between transducers, switches, controllers, and process actuators. Communications protocol shall be completely transparent to process operators at the operator interface terminal (OIT). The PLC shall be capable of stand-alone operation in the event of failure of the communication link to the OIT subsystem.

E. Electrical supply voltage to the PLC shall be 120 VAC, plus or minus 15 percent, 48 - 63 Hz. PLC system power supplies shall be fused for overload protection. The PLC contacts shall have a current rating for direct operation of all solenoids in the HPU system, without the use of low voltage interposing relays. The PLC shall have a storage temperature range of -25 to 70 degrees C (-40 to 185 degrees F) at an altitude of 0 - 9,800 feet; and a continuous operating temperature range of 0 to 60 degrees C (32 to 140 degrees F) at an ambient relative humidity range of 10 to 95%, non-condensing, at an altitude range of 0 - 6,500 feet. The degree of protection shall be NEMA 1 (IP20).

F. The PLC shall be capable of withstanding 3.5 mm Peak-to-Peak, 5 - 9 Hz: 1.0G, 9 - 150 Hz vibration in accordance with IEC 68-2-6 and/or JIS C 0911 standards for vibration. The system shall be operational during and after testing.

G. The PLC shall have vibration rating of 2.0G maximum peak acceleration for 10 to 500Hz. in accordance with at least one of the following:

1. DIN rail mounted PLC: 10 - 57 Hz, amplitude 0.075 mm, acceleration 25 - 100 Hz.

H. The PLC shall be capable of withstanding a 15G, 11 msec shock load based on IEC 68-2-27 and/or JIS C 0912 standards for shock. The system shall be operational during and after testing.

I. The PLC system shall be designed and tested to operate in the high electrical noise environment of an industrial plant as governed by IEEE 472; IEC 801; MILSTD 461B; IEC 255-4, NEMA ICS 2-230.40, and ANSI/IEEE C-37.90A-1978.

J. The PLC shall be furnished with all necessary cables included. All cables and connectors shall be as specified by the manufacturer. Cables shall be assembled and installed per the manufacturer recommendations. All major assemblies and sub-assemblies, circuit boards, and devices shall be identified using permanent labels or markings indicating the following as a minimum:

1. Modules catalog number.

2. Modules major revision number.

3. Modules minor revision number.

4. Module manufacturer vendor.

5. Module serial number.

K. The PLC central processing unit (CPU) shall be a 16-bit microprocessor, as a minimum, which provides system timing and scheduling of I/O updates, with no user programming required to ensure discrete or analog update. The CPU shall execute user relay ladder logic programs, communicate with intelligent I/O modules, and perform on-line diagnostics. The CPU shall consist of a single module which solves application logic; stores the application program, stores numerical values related to the application processes and logic; and interfaces to the I/O.

L. CPU shall sample all discrete and analog inputs and outputs, including internal coils and registers, and service special function modules every scan. The CPU shall process the I/O with user program(s) stored in memory, then control the outputs based on the results of the logic operation. The CPU shall have battery-backed time of day clock and calendar and allow for user program transportability from one CPU model to another.

M. The CPU shall perform on-line diagnostics that monitor the internal operation of the PLC. All diagnostic information shall be accessible to the host communications interfaces and to the PLC program. If a failure is detected, the CPU shall initiate system shutdown and fail-over. The following parameters shall be monitored, as a minimum, shall be monitored:

1. Memory failure.

2. Memory battery low.

3. General fault.

4. Communications port failure.

5. Scan time over run.

6. I/O failure.

7. Analog or special function I/O module failure.

N. PLC shall have indicators and on board status area to indicate the following conditions as a minimum:

1. CPU run.

2. CPU error or fault.

3. I/O failure or configuration fault.

4. Status of Battery or back-up power module.

5. Communications indicator.

O. Operating system shall be contained in non-volatile firmware. The memory containing the operating system shall be field updateable via a separate update tool.

P. User programming and data shall be contained in non-volatile battery backed memory of type CMOS RAM program memory or equivalent. The memory backup system shall have lithium battery backup or equivalent capable of retaining all memory for a minimum of three months, as a minimum. The backup battery or module shall be capable of being replaced without disrupting memory integrity. Provide a visual indication of low battery voltage or module error, and an alarm in the PLC program.

Q. The PLC shall have a Flash memory system capable of reloading program in the event of memory loss. Flash or SD Memory Card: Memory card storage capacity shall be equal to or greater than processor memory capacity. Memory cards shall be installed in processors for factory testing.

R. The PLC shall utilize a USB, or Ethernet port for programming. Application programs shall be modifiable and/or stored while the CPU is running, with minimal impact on the scan time. The Supplier shall verify that communication signals, 4-20 mA signals (including those with embedded HART), are properly conditioned for the PLC and protected from all sources of radiated energy or harmonics. The Supplier shall arrange connections to I/O modules such that failure of a single I/O module shall not disable the redundant system. This shall apply to all I/O types.

S. The PLC shall include embedded I/O and/or expansion I/O modules to accommodate project needs. The PLC shall support a variety of discrete and analog modules to meet required project I/O. The PLC shall include minimum of one 10/100 Mbps Ethernet communications port. The CPU shall be expandable and supplied with additional modules to support the required communication interfaces.

T. The Supplier shall furnish a PLC configuration and application development software package complete with documentation and original software compact disks. The PLC software package associated licensing and/or activation shall be made in the name of the Owner. The software package shall include license agreement allowing the Owner the right to use the software as required for any current or future modification, documentation, or development of the PLCs furnished for this project.

U. The software package shall allow on-line/off-line program development, annotation, monitoring, debugging, uploading, and downloading of programs to the PLCs. The software shall be Microsoft Windows-based and capable of the following IEC 61131-3 functions:

1. Ladder logic.

2. Function block.

3. Sequential function chart.

4. Structure text.

V. In addition to the above editors, an add-on instruction editor shall work with any of the above-mentioned editors to create custom reusable function blocks. This software shall allow any of the derived function blocks to be modified on-line. The software shall include a security feature to prevent unauthorized personnel from modifying and downloading the programs.

W. The Supplier shall furnish an I/O simulator which allows the PLC application program to be tested on a PC with simulated analog and digital inputs and outputs, allowing I/O testing and debugging to be performed in a safe, isolated environment without the need for running the PLC CPU and process I/O boards. The PLC system shall be one of the following:

1. MicroLogix® manufactured by Rockwell, Automation, Milwaukee, Wisconsin.

2.02 OPERATOR INTERFACE TERMINAL

A. The HPU shall have an operator interface terminal (OIT) mounted on the control panel door. The terminal shall operate on 120V, 60Hz AC power. The HPU control panel shall have a lockable momentary switch allowing interruption of the branch circuit feeding power to the OIT for a hard system reboot in the case of a screen locks up. Operator Interface Terminal shall be pre-packaged with all configuration and programming software necessary to perform functions as shown on drawings and within the specifications. Integrated OIT software shall have the following features:

1. Trending

2. Data Logging

3. Alarms

4. Graphic Symbols

5. Animations

B. OIT shall have a minimum of one Ethernet 10/100 Mbps for connectivity or programming.

C. OIT shall have a minimum of one Serial RS232 port. OIT shall have a minimum of one USB port. Compact flash ports shall be Type 2. The Supplier shall include the following communication expansion modules in the selected OIT:

1. Modbus Plus

2. PROFIBUS

D. OIT display size shall be 6". Type of display for the OIT shall be Color Active Matrix TFT. Display resolution shall be a minimum of 320 x 240. Display shall support touch screen input. OIT shall be rated to maintain the rating of the control panel it will be mounted in. Temperature: Operating temperature range of the OIT shall range 0 - 50 degrees C. The OIT shall be:

1. Allen-Bradley PanelView® Plus 7 series manufactured by Rockwell Automation, Milwaukee, Wisconsin.

2.03 CONTROL PANEL CABINET

A. The Supplier shall coordinate size and configuration of the control panel enclosure to meet the dimensional requirements of the project. The interior layout shall comply with the PLC OEM's required spacing between components to ensure adequate cooling. The air within the control panel enclosure surrounding the PLC shall be conditioned to maintain the required temperature and humidity range.

B. The control panel shall operate on 480 Volts, 3-Phase, 60 Hz power. The overall withstand and interrupting rating of the equipment and devices shall be determined by the Supplier, in amperes R.M.S. symmetrical at 480 Volts. All circuit breakers and combination motor starters shall be fully rated for the above fault current interrupting capacity. Series connected short circuit ratings will not be acceptable.

C. The complete control panel assembly shall be UL certified or carry a UL 508A listing for industrial control panels. The control panel shall meet all applicable requirements of the National Electrical Code. The control panel enclosure shall be rated as indicated in accordance with the electrical area classification indicated on the Drawings.

D. The control panel specified herein shall be NEMA 12 and be painted carbon steel with gasket.

E. Carbon steel panel enclosures shall be 14 gauge thickness as a minimum and constructed with continuously welded seams. The panel door(s) shall have continuous hinge and neoprene gasket. Door clamps shall be provided.

F. The panel enclosure shall incorporate a removable back panel on which control components shall be mounted. The back panel shall be secured to the enclosure with collar studs. The enclosure door shall be interlocked with the main circuit breaker by a door mounted operating mechanism. The back panel shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any components.

G. Wires entering and exiting the PLC and other components shall be sized to comply with the PLC OEM requirements. Access doors on all components shall be able to be fully closed with adequate clearance when all the wires are installed. For chassis mounted PLCs, no wiring, wire ducts, or other devices shall obstruct the removal of cards from the rack.

H. PLC lights, keys, communication ports, and memory card slots shall be accessible at all times when the enclosure doors are open. Lights shall be visible at all times when enclosure door is opened. Control panel designer shall provide independent line fuses or circuit breakers, per the PLC manufacturer recommendation, for each power supply, input module, output module, and other modules with separately derived power requirements. Document storage pockets shall be provided on the inside of the panel. Overload tables shall be laminated and adhered to the inside of the door.

2.04 MAIN CIRCUIT BREAKER

A. The main circuit breaker shall be a thermal-magnetic molded case breaker. Provide a flange mounted main power disconnect operating handle with mechanical interlock having a bypass that will allow the panel door to open only when the switch is in the OFF position.

2.05 MOTOR STARTERS

A. A mechanical disconnect mechanism, with bypass, shall be installed on each motor circuit protector, capable of being locked in the "OFF" position to provide a means of disconnecting power to the motor.

B. An open frame, full voltage non-reversing, NEMA rated magnetic motor starter, shall be furnished for each pump motor. Motor starters shall be provided with motor circuit protectors and equipped to provide under-voltage release and overload protection on all three phases. Overload reset push-buttons shall be located on the exterior of the control panel door.

2.06 PUSH-BUTTONS, SWITCHES AND INDICATORS

A. All operating control devices and instruments shall be securely mounted on the exterior door. All controls shall be clearly labeled to indicate function and shall be rated in accordance with the electrical area classification indicated on the Drawings. Push-buttons shall be manufactured by:

1. Allen-Bradley

2. Crouse-Hinds (NEMA 7)

3. Or equal

B. Push-buttons shall be heavy-duty, industrial type with momentary or detented (latched) contacts as required, rated for 120 VAC at 10 Amps continuous. Units shall have standard size, legend plates having a black filed and white markings, as indicated. The contact arrangement shall be as required by the Supplier. Push-button colors shall be as follows:

1. EMERGENCY STOP or START: Red

2. STOP Green

C. Selector switches shall be the heavy-duty, industrial type with contacts rated for 120 VAC at 10 Amps continuous. Selector Switches shall have standard size, black field legend plates with white markings, as indicated. Operators shall be black knob type. Units shall have the number of positions and contact arrangements, as required. Units shall be single-hole mounting, accommodating panel thicknesses from 1/16-in minimum to 1/4-in maximum.

D. Indicator lamps shall be heavy duty, industrial type, high-visibility LED, full voltage type. Units shall have screw on (or factory sealed for NEMA 7 applications) plastic lenses and shall have factory engraved legend plates as required. Lens color shall be green for OFF, red for ON and amber for FAIL or ALARM. For all control applications, except NEMA 7, indicator lamps shall incorporate a push-to-test feature. A separate single lamp test push-button shall be incorporated on NEMA 7 control panels.

2.07 ELAPSED TIME METER

A. The Supplier shall include a six digit, non-resettable elapsed time meter for each hydraulic pump. The meter shall record in hour units and shall operate on 120 VAC, 60Hz, single phase

power. The operating temperature range shall be -54 to 68 degrees C (-65 to 154 degrees F). The meter enclosure shall have a round enclosure constructed of polycarbonate and sealed to IP65. The meter shall be connected to each motor starter. Elapsed time meters shall be:

1. Hobbs 82400 Series manufactured by Honeywell, Golden Valley, Minnesota.

2. Model 240 733 ACAE manufactured by Yokogawa, Newnan, Georgia.

3. Or equal.

2.08 ALARM SOUNDER AND BEACONS

A. The control panel shall include a failure alarm sounder. The sounder shall have piezoelectric operation and operate on 120 VAC, 60Hz, single phase power. The sounder shall provide an intermittent and continuous tone for 2 levels of alarm controllable by independent contacts. The enclosure rating shall be NEMA 3R and IP65. Alarm beacon shall be:

1. Model PMAMT-048-240 manufactured by Federal Signal, Oak Brook, Illinois.

2. Or equal.

B. The control panel shall include a failure alarm beacon light. The beacon light shall have a transparent polycarbonate dome. The dome color shall be RED and operate on 120 VAC, 60Hz, single phase power. The beacon shall use 100,000 hour light emitting diodes (LEDs). The beacon shall have 3 channels for flashing light only; flashing light and emitted sound; and steady light and continuous sound. The enclosure rating shall be NEMA 3R and IP65. Alarm beacon shall be:

1. Model PMC manufactured by Federal Signal, Oak Brook, Illinois.

2. Or equal.

2.09 LIGHTNING AND SURGE PROTECTION

A. The control panel shall be furnished with a lightning and surge protection unit on the line side of the main circuit breaker. The surge protector shall be:

1. Tranquell® Series manufactured by General Electric, Chicago, Illinois.

2. Or equal.

B. All interfaces between control panel and remote devices shall be isolated via an interposing relay. Interposing relays shall have contacts rated for 250 VAC and 10 Amps continuous. Relays shall be manufactured by:

1. Potter and Brumfield, Berwyn, Pennsylvania

2. Or equal

2.10 CONDENSATION PREVENTION HEATERS

A. A strip heater shall be mounted inside the control panel. The strip heater terminals shall be guarded by a protective terminal cover. Heater shall operate on 120 Volt, 60 Hz, single phase power and have a minimum power rating of 150 watts.

B. Heaters shall be furnished with a rust resisting iron sheath. A control thermostat shall be mounted inside the panel. The strip heater terminals shall be guarded by a protective terminal cover.

C. High-temperature connecting lead wire shall be used between the thermostat and the heater terminals. Wire shall be No. 12 AWG stranded, nickel-plated copper with Teflon glass insulation.

2.11 PANEL WIRING, ROUTING ACCESSORIES AND HARDWARE

A. Power and control wire shall be 600 Volt class, Type MTW insulated stranded copper and shall be of the sizes required for the current to be carried, but not smaller than No. 14 AWG. All wiring shall be enclosed in PVC wire trough with slotted side openings and removable cover. All interconnecting wires between panel mounted equipment and external equipment shall be terminated at numbered terminal blocks. All control panel wiring shall be numbered at both ends with type written heat shrinkable wire markers.

2.12 TERMINAL BLOCKS

A. Terminal blocks shall be one-piece molded plastic blocks with screw type terminals and barriers rated for 600 volts. Terminals shall be double sided and supplied with removable covers to prevent accidental contact with live circuits. Terminals shall have permanent, legible identification, clearly visible with the protective cover removed. Each terminal block shall have 20 percent spare terminals, but not less than two spare terminals.

B. Wires shall be terminated to the terminal blocks with crimp type, pre-insulated, ring-tongue lugs. Lugs shall be of the appropriate size for the terminal block screws and for the number and size of the wires terminated. Provide an intrinsically safe ground terminal bar isolated from the control panel enclosure. Provide 20 percent spare terminals but not less than two spare terminals. Terminal points for current transformer leads shall be provided with a shorting bar.

2.13 HYDRAULIC OIL

A. The Contractor shall be responsible for furnishing all of the hydraulic oil required to commission the system, including flushing oil. Hydraulic oil used to fill the system shall be pre-filtered to 10 microns (ISO 16/13) by the Supplier prior to shipping to the site. Hydraulic oil drained from the HPU and fluid power piping system shall be removed of the site and lawfully disposed of, in accordance with all statutes the codes having jurisdiction vicinity of the Site.

B. The hydraulic oil shall have documented compliance with the requirements EPA 560/6-82-003 for ultimate biodegradability. The test procedure shall be a 96 hour acute survival toxicity test performed using the Water Accommodated Fraction in accordance with EPA/821/R-02/012 or equivalent test which presents No-Observed-Adverse-Effect Concentration (NOAEC) results, meeting the EPA requirements for acute toxicity.

C. The oil shall have a viscosity of 30.6 mm^2/s at 40 degrees C, and 5.89 mm^2/s at 100 degrees C in accordance with ASTM D445. The pour point shall be -58 degrees C or better. Hydraulic oil shall be:

1. HLP Synth 32 Biodegradable Hydraulic, manufactured by Panolin America, Inc., Ventura, California.

2. Or equal.

2.14 HPU CONTAINMENT STAND

A. The Supplier shall install the HPU components, including the control panel, on a fabricated steel containment stand. The stand shall have an integral containment tray configured to drain to a single low-point along its perimeter. The containment wall shall be fitted with a drain having internal threads in accordance with ASME B1.20.1, and square head pipe plug. The stand shall be installed on fabricated steel feet drilled to allow installation on concrete anchors and dry-pack grout.

B. The containment stand shall have mounts configured to support a fabricated steel overhead reservoir support. The reservoir support shall be constructed of welded carbon steel structural tube, and have adequate height to create flooded suction conditions for the hydraulic pumps. The containment stand and reservoir support shall be manufactured by:

1. LDI Industries, Manitowoc, Wisconsin.

2. Hydro-Craft, Rochester Hills, Michigan.

3. Magnaloy Coupling Company, Alpena, Michigan.

2.15 HYDRAULIC PUMPS (HP-101 & HP-201)

A. The pumps for the hydraulic system shall be electric-motor-driven, fixed displacement axial piston pumps. The pump shall deliver the design flowrate up to the maximum operating pressure shown on the Drawings, operating with the specified oil within the temperature range shown on the Drawings. The pumps shall be mounted on top of the HPU frame below the reservoir providing flooded suction to the pump at all times.

B. The pump housing shall be constructed of ASTM A48, Grade 40 cast iron. The pump seals shall be constructed of Buna-N. The pump housing shall have two-piece construction for ease of disassembly and maintenance. The pump housing shall be fitted with a shouldered lifting eye in the top center position for rigging the pump from the motor with an overhead hoist. Housing assembly hardware shall be ASTM A193, Grade B8M stainless steel socket-head cap screws having 60 degree UNC coarse threads in accordance with ASME B18.2.1. The pump shaft shall be constructed of AISI 4140 carbon steel or equivalent and be furnished in a keyed configuration. The pump shall be furnished with a hydrodynamic cylinder bearing constructed of SAE 660 bearing bronze, or equivalent.

C. The operating temperature range for the pump shall be -40 to 160 degrees F. The pump inlet port maximum pressure rating shall be 25 psi. The pump outlet port maximum pressure rating shall be 3000 psi as a minimum. The pump control drain port maximum pressure rating shall be

600 psi, capable of use with a filtered drain line. The pump torque control adjustment sensitivity shall be 800 in-lb per turn. Pressure compensation sensitivity shall be 800 psi per turn.

D. The pump shall be furnished with SAE J518 Code 61 four-bolt flanged inlet and outlet connections as shown on the drawings. The pump inlet and outlet ports shall be connected to the system using hydraulic hose and fittings, as specified in Section 40 05 30. Signal and drain ports shall be drilled, tapped and faced for SAE J514 O-ring Boss (ORB) threaded straight thread adapter fittings.

E. The pump shall be furnished with a SAE C 2-bolt flange mount. The pump shall mount to the drive by use of a flanged horizontal bell-housing. The bell housing shall connect to the pump at the SAE C 2-bolt flange on one side, and connect to a NEMA C-face electric motor flange on the other. The bell housing shall be constructed of welded carbon steel.

F. The pump shaft shall be connected to the driver shaft using a flexible coupling. Exposed flexible couplings shall be furnished with coupling guards in conformance with OSHA regulations. Couplings shall be selected and sized in accordance with AGMA 922 and AGMA 9002. Exposed rotating parts shall be fitted with stainless steel safety guards. Flexible couplings shall be manufactured by:

1. Lovejoy, Inc., Downers Grove, Illinois.

2. TB Wood's, Inc. Chambersburg, Pennsylvania.

3. Magnaloy Coupling Company, Alpena, Michigan.

G. The pump motors shall operate on 480V, 3-ph, 60-Hz power. Nominal motor speed shall be 1800 rpm. Electric motors shall be horizontal, totally enclosed, fan cooled squirrel-cage induction type, NEMA Design B. Electric motors shall be manufactured by:

1. Pump Series manufactured by Baldor Electric Company, Fort Smith, Arkansas.

2. WEG Electric Motors Corporation, Suwanee, Georgia.

3. U.S. Motors, St. Louis, Missouri.

4. TECO Westinghouse.

H. The pumps shall be rated for continuous operation at a discharge pressure equal to or greater than the system design pressure. The rated discharge capacity of each pump shall not be less than indicated when the pump is operated at the design input speed and discharge pressure. Hydraulic pumps shall be:

1. Model PAVC 38 manufactured by Parker Hannifin Corporation, Greenville, Tennessee.

2.16 HYDRAULIC OIL RESERVOIR

A. The reservoir shall be horizontal type configured to meet the space limitations shown on the Drawings. The reservoir shall be fabricated of welded carbon steel plate stock of 3/16 inch minimum thickness. The reservoir shall be primed and finished with the high-performance

coating system specified below. The general configuration of the reservoir is shown on the Drawings.

B. The reservoir design shall conform to the requirements of NFPA T3.16.2 R1. The reservoir shall be equipped with a baffle, with hole for circulation, between the intakes and return line to facilitate the separation of air and foreign matter from the pumped hydraulic fluid. The reservoir shall be equipped with two clean-out end-covers as a minimum. Clean-out end-cover gaskets shall be constructed of Buna-N.

C. The reservoir shall serve as the base for the hydraulic pumps and be fitted with mounting plates constructed of carbon steel plate stock of ¾ inch minimum thickness. The mounting plate shall be installed with screws and posts providing a minimum 1 inch clearance between the mounting plate and the welded top of the reservoir. Variable volume hydraulic pump drain lines shall be terminated 1 inch below the LOW operating level in the reservoir. Reservoirs shall be manufactured by:

1. LDI Industries, Manitowoc, Wisconsin

2. Hydro-Craft, Rochester Hills, Michigan

3. Vescor Corporation, Huntley, Illinois

4. Magnaloy Coupling Company, Alpena, Michigan

5. Standard Technologies, Freemont, Ohio

2.17 RESERVOIR IMMERSION HEATER (OH)

A. The reservoir shall be fitted with an electric immersion heater. The immersion heater shall have a self-regulating thermostat calibrated to maintain the hydraulic oil volume at 60 degrees F. The electrical terminations shall be housed in a NEMA 4X rated enclosure. The heater shall operate on 120V, 60 Hz single-phase power. The immersion heater shall be manufactured by:

1. Chromalox, Pittsburgh, Pennsylvania.

2. Warren Electric, Warren, Rhode Island.

3. Watlow Electric Manufacturing, St Louis, Missouri.

2.18 RESERVOIR FILLER BREATHER (FB)

A. The reservoir shall be furnished with a metal filler-breather to remove dirt and moisture from the incoming air, and incoming oil when filling the system. The filler-breather shall have an operating temperature range of -22 to +195 degrees F.

B. The maximum working pressure shall be 5 psi. The filtration element shall be constructed of 10 micron expanded polyurethane foam. Seals shall be constructed on Buna-N. The cap and flange plate shall be constructed of nickel-chrome plated steel. The filler breather shall be:

1. Pressurized flange type manufactured by Parker Hannifin Filtration Group, Cleveland, Ohio.

2. Or equal.

2.19 RESERVOIR DESSICANT BREATHER (DB)

A. The filler-breather shall be capable of accommodating a spin-on type desiccant type breather. The filter-breather shall be the spin-on type installed by adapter fitting in the flange plate of a metal breather strainer. The casing and cap shall be constructed of polypropylene or equivalent. The stand pipe shall be constructed of PVC or equivalent. The desiccant breather shall have an operating temperature range of -20 to 250 degrees F. The maximum allowable working pressure shall be 5 psi.

B. The incoming air shall first pass through a desiccant bed to remove the moisture, and then pass through a minimum 3-µm filter to eliminate the solid contaminants before entering the reservoir. Outgoing air shall pass directly to the atmosphere through a check valve. The breather shall also provide visual indication of the desiccant and filter condition. The desiccant breather shall be:

1. TriCepter® manufactured by Parker Hannifin Filtration Group, Cleveland, Ohio.

2. Standard DC Series Breathers manufactured by Des-Case, Goodlettsville, Tennessee.

3. D-AB manufactured by Schroeder Industries, Pittsburgh, Pennsylvania.

2.20 LINE-MOUNTED SUCTION STRAINERS (SST-101 & SST-201)

A. A line-mounted low pressure strainer shall be installed upstream of each hydraulic pump. The filter shall have a cleanable 80 mesh wire screen cartridge element. Wire mesh shall be constructed of Alloy 400 (Monel). The head and cartridge housing shall be constructed of cast 6061-T6 aluminum, or equivalent.

B. The head shall be fitted with a bypass check valve. The filter head ports shall have female 7/16 inch -20 60 degree UNC straight-thread O-ring boss in accordance with SAE J514. Line-mounted low-pressure filters shall be:

1. Model 1300 manufactured by Marvel Engineering Company, Melrose Park, Illinois.

2. Or equal.

2.21 HIGH-PRESSURE FILTERS (HPF-101 & HPF-201)

A. The high pressure filter shall have an in-line configuration, located in the pump discharge line as shown in the schematic. The filter housing shall have an anodized 6061-T6 aluminum bowl and head. The head shall be fitted with a bypass and visual single pole pressure switch (PS-101, PS-201) service indicator to provide a service alarm to the PLC based control system.

B. The filter element shall be 10-µm size, have a minimum silt control rating of $\beta 10 = 1500$ at 15-gpm/100-psi differential pressure per ISO 16889. The filter shall be rated for use with hydraulic

oil and the pressure drop should not exceed 6-psi in the clean condition. Filters shall have SAE J518 Code 61 four-bolt flanged connections as shown on the drawings. High pressure oil filters shall be:

1. Series 15P manufactured by Parker Hannifin Corporation, Greenville, Tennessee.

2. Or equal.

2.22 RETURN-LINE FILTERS (RLF)

A. A low-pressure filter shall be in line mounted. The filter housing shall have a steel bowl and die cast aluminum head. The head shall be fitted with a bypass and visual single pole pressure switch (PS-003) service indicator to provide a service alarm to the HPU panel PLC. The filter element shall be 10-µm size, have a minimum silt control rating of β10 = 200 at 40-gpm/50-psi differential pressure per ISO 16889.

B. The pressure drop should not exceed 5-psi in the clean condition. The low pressure return filter shall be furnished with an anti-siphon check valve feature. Low pressure oil filters shall be:

1. Moduflow® Series manufactured by Parker Hannifin Corporation, Greenville, Tennessee.

2. Model FIK manufactured by Donaldson Company, Inc., Bloomington, Minnesota.

3. Or equal.

2.23 RESERVOIR SITE LEVEL INDICATOR (SLI)

A. The reservoir shall be furnished with a back-mounted sight level indicator with integral thermometer. The level gage shall have a housing constructed of aluminum and a minimum pressure rating of 70 psi. Connecting fittings shall be constructed of stainless steel. The sight level gauge shall have a Pyrex® sight glass. Level gauge seals shall be constructed of Buna-N.

B. The sight level gauge shall be sized to indicate the HIGH, ADD and LOW oil levels. The reservoir shall be furnished with nameplates engraved with the text HIGH, ADD and LOW with indicator arrows installed at the designated locations. The sight gauge shall not require access to the reservoir for installation and removal. The sight gauge connections shall be installed in holes tapped with threads having the form and fit for the connecting fittings. Sight level gauges shall be:

1. Series ALG manufactured by Vescor Corporation, Huntley, Illinois.

2. Series HSG-66 manufactured by Hydro-Craft, Rochester Hills, Michigan.

3. Or equal.

2.24 PRESSURE GAUGES (PI-101, PI-201 & PI-001)

A. Pressure gauges shall be installed within the HPU where shown on the Drawings. All gauges specified herein shall be designed, manufactured, tested and meet the accuracy grades included in ASME B40.100. The materials of construction for the bourdon tube and all wetted parts shall

be ASTM A167, Grade 308 or 309; and/or ASTM A473, Type 316L (UNS S31603) or equivalent, unless otherwise noted.

B. Pressure gauges shall be used for applications having pressures up to 6000 psi at ambient up to 140 degrees F. The gauge shall be Accuracy Grade A (+/- 2%/1%/2% of span), in accordance with ASME B40.100. The span of the gauge shall not exceed 60 percent of the maximum hydraulic system operating pressure. The temperature error shall not exceed +/- 0.4 percentage of span for every 18 degrees F rising or falling from a reference temperature of 68 degrees F.

C. The gauge shall be furnished with a stainless steel or die cast brass case, sealed with a fluorocarbon or Buna-N rubber seal. The window shall be constructed of laminated shatter-proof glass in compliance with ANSI Z26.1. The case shall be weather-proof and have a NEMA 4X and IP65 rating. The gauge dial shall be constructed of ABS plastic or aluminum and have black lettering with a solid white background. The indicator needle shall be black and constructed of aluminum and be adjustable. The case shall be liquid filled for pressure pulsation and vibration dampening effects on the movement. The fill fluid shall be 99.7 percent glycerin.

D. The gauge shall be furnished with a helical-type Bourdon tube and movement constructed of copper alloy. The pressure connection shall be fitted with male 7/16 inch -20 60 degree UNC straight-thread O-ring boss with washer and lock-nut in accordance with SAE J514. Pressure gauges for hydraulic power units shall be:

1. Type 213.53S manufactured by Wika Instrument Corporation, Lawrenceville, Georgia.

2. 300 Series manufactured by Noshok, Inc., Berea, Ohio.

3. Series SAEG manufactured by Dwyer Instruments, Inc., Michigan City, Indiana.

2.25 PRESSURE SWITCHES (PS-001 & PS-002)

A. The pressure switch shall have a continuous duty rating of 2 Amps at 110 Volt, 60 Hz, single pole, double throw contacts and an average differential of contact action no greater than 1 percent of range. Set point shall be adjustable.

B. The pressure connection shall be fitted with male 7/16 inch -20 60 degree UNC straight-thread O-ring boss with washer and lock-nut in accordance with SAE J514. Pressure indicator, pressure switch and pulsation dampers shall be:

1. Model H426V3000 manufactured by Ashcroft, Inc., Stratford, Connecticut.

2. Model 100-3000-2-1-9-7 manufactured by Noshok, Inc., Berea, Ohio.

3. Or equal.

2.26 PRESSURE TRANSMITTERS (PE-001)

A. The HPU shall be furnished with a system pressure transmitter, which shall be used to display system pressures on the OIT, and collect system pressure data for troubleshooting following a system failure. The pressure transducer shall be a heavy duty industrial model having an operating temperature range of -40 to 257 degrees F (-40 to 125 degrees F) and an ambient

relative humidity of 0 to 95%, non-condensing. The transmitter shall be capable of withstanding the following vibration conditions:

1. Shock: 100g Peak, 11ms

2. Random: 10g RMS, 20-2000Hz

3. Sweep: 50-2000Hz, 5g peak

B. The transmitter enclosure shall be constructed of Type 304 stainless steel and have all welded construction having zero and span access. All wetted materials and the pressure port shall be constructed of Type 316 stainless steel. The pressure port connection shall be male 7/16 inch - 20 60 degree UNC straight-thread O-ring boss in accordance with SAE J514.

C. The transducer shall have a presser range of 30 to 3000 psig at an accuracy of 0.25%/ <= 1.0% at an operating temperature range of -20 to 85 degrees C. The output signal shall be 4-20 mA. The signal cable termination shall be Hirschmann Style Form A, in accordance with DIN 43650-A. Pressure transmitter shall be:

1. Model A2-Y-A-MEK-##-30-G manufactured by Ashcroft, Inc., Stratford, Connecticut.

2. Model 100-3000-2-1-9-7 manufactured by Noshok, Inc., Berea, Ohio.

3. Or equal.

2.27 TEMPERATURE SWITCH (TSH-001, TSL-001)

A. An adjustable temperature switch with auxiliary capillary tube and thermo-well shall be installed in the hydraulic oil reservoir. The switch shall have wetted parts constructed of Type 316 stainless steel. The process connection shall have ¼ inch MNPT threads in accordance with ASME B1.20.1.

B. The operating voltage range shall be 9.6 to 32 VDC. The switch shall have to PNP normally open switching DC output contacts; non-latching short circuit protection; overload and reverse polarity protection. The switch shall have a pressure rating of 4350 psi. The set-point scale shall be -4 to 285 degrees F (-20 to 140 degrees C), and an accuracy of +/- 3 degrees C as a minimum. The enclosure shall be constructed of Type 316 stainless steel and have an IP 68, IP69K, Class II rating. The temperature switch shall be:

1. Prosense® Model TSD25N manufactured by Automation Direct, Atlanta, Georgia.

2. Effector 600® Series Model TK7330 manufactured by IFM Efector, Inc., Malvern, Pennsylvania.

3. Model STW-C####-NO4-NO manufactured by Stauff USA, Waldwick, New Jersey.

2.28 TEMPERATURE TRANSMITTER (TE-001)

A. A temperature transmitter and thermo-well shall be installed in the hydraulic oil reservoir. The switch shall have an enclosure and all wetted parts constructed of Type 316 stainless steel. The process connection shall have ¼ inch MNPT threads in accordance with ASME B1.20.1.

B. Transmitters shall have a measuring range of 32 to 250 degrees F. Pressure rating shall be 8700 psig as a minimum. The measuring element shall be PT100 Class B, having Class B accuracy. +/- 1.5 percent of full scale. The output signal shall be 4 to 20 mA, 2 wire connection. Failure signal shall be 23 mA burnout and 3.3 mA short circuit.

C. The enclosure shall be constructed of Type 316 stainless steel and have an IP 68, IP69K, Class II rating. Maximum ambient operating temperature shall be 185 degrees F as a minimum. The temperature transmitter shall be:

1. Model 810-0/250-1-1-2-25-020-6 manufactured by Noshok, Inc., Berea, Ohio.

2. Model TR40 manufactured by WIKA Instrument Corporation, Lawrenceville, Georgia.

3. Model STC-C####-NO4-420A-1-50-F manufactured by Stauff USA, Waldwick, New Jersey.

D. The Supplier may choose a combination transmitter/switch at his/her discretion such as Model SPWF-B####-B0100-N04-4, manufactured by Stauff USA, Waldwick, New Jersey.

2.29 RESERVOIR LEVEL SWITCH ASSEMBLY (LS-001, LS-002 & LS-003)

A. The reservoir shall be fitted with a combination oil level and temperature switch assembly to indicate low reservoir level shutdown (LS-001), add oil (LS-002) and overfill shutdown (LS-003). The float switch assembly shall be fitted with Type 316 stainless steel floats, stem, mounting and wetted parts. The floats and mount shall have a temperature rating in oil of -40 degrees F to +230 degrees F, and a minimum pressure rating of 150 psi.

B. The float stem shall be fitted with a temperature switch thermostat probe shall be SPDT rated for 5A resistive and 2A inductive on 120/240V AC. The switch shall have a temperature rating in oil of 70 to 230 degrees F, and a pressure rating of 350 psi. The switch shall be furnished with a DIN 43650A Hirschman style cable connection. Combination oil level and temperature switch shall be:

1. Model LS-800 manufactured by Gems Sensors, Plainville, Connecticut.

2. Model F7-MQ manufactured by Dwyer, Michigan City, Indiana.

3. Model MLS-4EX manufactured by Magtech, Pearland, Texas.

2.30 HYDRAULIC OIL FLOWMETERS (FI-101 & FI-201)

A. Flowmeters shall be the variable annular orifice type with compression spring recoil. The measurement accuracy shall be +/- 2.5 percent of full scale in the center third of the measuring range, and +/-4 percent in the upper and lower thirds, and +/- 1.0 percent of full scale

repeatability. The meter shall be calibrated for hydraulic oil having a specific gravity of 0.873. The accuracy shall not be restricted to inlet or outlet straight length piping requirements, or restricted to vertical or horizontal operation.

B. Each flow meter shall have casing end-ports, floating orifice discs, and all other internal parts constructed of Type 303 stainless steel. Seal components shall be constructed of fluorocarbon (FKM). The gauge window shall be constructed of Pyrex® glass. The meter shall have a working pressure of 6000 psig, and maximum operating temperature of 180 degrees F.

C. The flowmeter shall have a NEMA 4X enclosure housing a single-pole double-throw flow switch (ZS-101 and ZS-201). The switch shall be UL listed and have a 120V, 60Hz single-phase 10A current rating and ISO 4400 DIN 43650 (Hirschman style) connectors. The flow meter shall be:

1. Hedland Model H701S-030-F1 with Flow-Alert Housing manufactured by Badger Meter, Inc., Racine, Wisconsin.

2. Style M manufactured by Lake Monitors, Franksville, Wisconsin.

3. Or Equal.

2.31 PISTON ACCUMULATORS (ACC-001)

A. Hydraulic accumulators shall be the piston type configured for use with auxiliary gas bottles. Accumulators shall have minimum pressure rating of 3000-psi. The final number and size of accumulators and gas bottles shall be determined by the Supplier, but the capacity shown on the Drawings shall be provided as a minimum. The accumulator port connections shall be SAE J518 Code 61 four-bolt flanged. Accumulators shall be connected by manifold as shown on the Drawings and a standard charging valve shall be installed permitting maintenance of the pre-charge by the Owners operations and maintenance personnel. The charging gas shall be nitrogen. The accumulator shall have an integral proximity switch (ZS-001), which shall indicate loss of pre-charge to the HPU PLC.

B. The accumulators shall be designed in accordance with ASME BPVC Section VIII, Division 1 for the required working pressure range, each accumulator shall be furnished with the ASME approval stamp. The accumulator body and caps shall be constructed of the same high-strength alloy steel material. Pistons shall be constructed of machined carbon steel or cast ductile iron. All seals shall be compatible with the specified hydraulic oil. Gas bottles shall be:

1. Greer® Series 3000 manufactured by Parker Hannifin Corporation, Greenville, Tennessee.

2. SK Series manufactured by Hydac Corporation, Bethlehem. Pennsylvania.

3. Olaer® Model PA# manufactured by Oil Air Hydraulics, Houston, Texas.

2.32 AUXILIARY GAS BOTTLES (GB-001, GB-002 & GB-003)

A. Hydraulic accumulators shall be the piston type configured for use with auxiliary gas bottles. Accumulators and nitrogen bottles shall have minimum pressure rating of 3000-psi. The final number and size of accumulators and gas bottles shall be determined by the manufacturer. The

accumulator and gas bottle port connections shall be SAE J518 Code 61 four-bolt flanged. Gas bottles shall be connected by manifold as shown on the Drawings and a standard charging valve shall be installed permitting maintenance of the pre-charge by the Owner's maintenance personnel. The charging gas shall be nitrogen. Hydraulic accumulators shall be:

1. Greer® Series 3000 manufactured by Parker Hannifin Corporation, Greenville, Tennessee.

2. SN Series manufactured by Hydac Corporation, Bethlehem. Pennsylvania.

3. Olaer® Model TB-##-100-2 manufactured by Oil Air Hydraulics, Houston, Texas.

2.33 INLINE HYDRAULIC BALL VALVES (BV-001 TO BV-008, BV-101, BV-102, BV-201, BV-202)

A. Ball valves for the hydraulic piping shall be full bore, fire-safe, and rated for a minimum line pressure of 5000 psig at a maximum temperature of 200 degrees F. Valves shall be furnished with SAE J514 straight thread O-ring boss ports or SAE J518 Code 61 four-bolt flanged connections as shown on the Drawings.

B. The design of the valve shall provide suitable seating in both directions. Low pressure valves used for isolation on hydraulic pump suction lines shall have a minimum pressure rating of 500 psi and body, ball and stem constructed of Type 316 stainless steel. Hand levers shall be Type 304 stainless steel. Seats shall be reinforced Teflon. The fully open port area shall be approximately 100 percent of the nominal pipe area. Low-pressure ball valves shall be:

1. LV2B-N-##-2T Series manufactured by Anchor Fluid Power, Cincinnati, Ohio.

2. Or equal.

C. Medium pressure ball valves shall provide suitable seating in both directions. Ball valves for the hydraulic piping shall be full bore, fire-safe, and rated for a minimum line pressure of 3000 psig at a maximum temperature of 200 degrees F. Valves shall have a body, ball and stem constructed of Type 316 stainless steel. Hand levers shall be Type 304 stainless steel. Seats shall be reinforced Teflon. The fully open port area shall be approximately 100 percent of the nominal pipe area. High-pressure ball valves shall be:

1. Model BVHP-##-S-K-2-V manufactured by Parker Hannifin Corporation, Greenville, Tennessee.

2. Model BBV-2-###-1-1-0-1-M manufactured by Stauff USA, Waldwick, New Jersey.

3. Model AE2-S##-2-2-X-V Series manufactured by Anchor Fluid Power, Cincinnati, Ohio.

4. Model BVH-####-S-2-6-2-4 manufactured by DMIC, Wheatfield, New York.

2.34 INLINE FLOW CONTROL VALVE (FCV-001)

A. Flow control valves shall be constructed of carbon steel and configured for line mounting with SAE J514 straight thread O-ring boss ports. The valves shall be unidirectional with the appropriate markings for installation in the correct orientation. The valves shall be designed for

a minimum system operating pressure of 3000 psi, and be capable of being locked in position to prevent an unintentional adjustment. Adjustment knobs shall be furnished with calibrated graduations. Flow control valves shall be:

1. Model N-####-SS-T-V manufactured by Parker Hannifin Corporation, Greenville, Tennessee.

2. Model DV-##-V-S-SS manufactured by Stauff USA, Waldwick, New Jersey.

3. Or equal.

2.35 ADJUSTABLE INSTRUMENT SNUBBER VALVES (SNV-001 TO SNV-004, SNV-101, SNV-201)

A. Adjustable instrument snubber valves shall be installed between all pressure instruments and process lines. Snubber valves shall be constructed of Type 303 stainless steel with Type 416 trim. Valve seals shall be constructed of PTFE. Snubber valves and have SAE J514 straight thread O-ring boss male x female port connections.

B. Adjustment knobs shall be constructed of glass filled nylon and fitted with a spurred locknut. The male port shall be adjustable allowing positioning of the adjustment knot at any position 360 degrees relative to the valve port centerline. The maximum operating pressure shall be 6000 psi. Adjustable instrument snubber valves shall be:

1. Model NSAB-KXN-HS manufactured by Sun Hydraulics,

2.36 INLINE CHECK VALVES (CV-001, CV-002, CV-101, CV-201)

A. Check valves shall be inline mounted constructed of stainless steel construction and shall be the ball or poppet type with a body designed for high shock and 3000 psi service. The valve shall be stainless steel and have SAE J514 straight thread O-ring boss port connections. Check valves shall be:

1. Model C-####-SS-V manufactured by Parker Hannifin Corporation, Greenville, Tennessee.

2. Model RV-##-07-S-SS manufactured by Stauff USA, Waldwick, New Jersey.

3. Or equal.

2.37 PILOT-OPERATED VENTABLE BALANCED SYSTEM RELIEF VALVES (SRV)

A. The system relief valve for the HPU shall be cartridge type, installed directly to the HPU manifold block, adjustable, with an optional locking feature to prevent readjustment by unauthorized personnel. The valve shall have a minimum operating pressure of 3000 psi and constructed of

B. Unloading system relief valves shall be:

1. Model HVCA8DN manufactured by Sun Hydraulics, Sarasota, Florida.

2. Or Equal.

2.38 2-POSITION 2-WAY DIRECTIONAL CONTROL VALVES (DCV-001)

A. Solenoid-operated two-way, two-position directional control cartridge valves shall be solenoid operated. The valve body shall be machined from aluminum bar-stock. O-rings and seals shall be constructed of Buna-N.

B. The valves shall be opened by a single “Open” solenoid and spring-returned to the “normally open” de-energized position. The valve shall have wet-armature type solenoids operated on 120V, single-phase, 60 Hz power and ISO 4400 DIN 43650 (Hirschman style) connectors. Solenoid operated two-way directional control valves shall be:

1. Model DAALXCN manufactured by Sun Hydraulics, Sarasota, Florida.

2. Or equal.

2.39 2-POSITION 2-WAY DIRECTIONAL POPPET VALVES WITH CHECK (DCV-002)

A. Solenoid-operated two-way, two-position directional control cartridge valves with check spool shall be solenoid operated with manual-override. The valve body shall be machined from aluminum bar-stock. O-rings and seals shall be constructed of Buna-N.

B. The valves shall be opened by a single “Open” solenoid and spring-returned to the “normally open” de-energized position. The valve shall have wet-armature type solenoids operated on 120V, single-phase, 60 Hz power and ISO 4400 DIN 43650 (Hirschman style) connectors. Solenoid operated two-way directional control valves shall be:

1. Model DAALXCN manufactured by Sun Hydraulics, Sarasota, Florida.

2. Or equal.

2.40 ACCUMULATOR SAFETY SHUT-OFF BLOCK (ASB)

A. Accumulator safety shut-off blocks shall be furnished where shown on the Drawings. The safety shut-off blocks shall be designed to protect, shut off and discharge the hydraulic accumulator. The shut-off block design shall include integral pressure relief valve, main shutoff valve and a manually operated bleed valve. The safety shut-off block shall be furnished with a manual and solenoid operated discharge valve to unload the accumulator.

B. The safety shut-off block shall be constructed of carbon steel and have Buna-N elastomer seats.

C. The safety shut-off block shall be:

1. SBA Series manufactured by Parker Hannifin Corporation Hydraulics Group, Machesney Park, Illinois.

2. SAF Series manufactured by Hydac Corporation, Bethlehem. Pennsylvania.

3. Or equal.

2.41 HYDRAULIC OIL SAMPLING PORTS (TP-001, TP-002, TP-003 & TP-004)

A. Hydraulic oil sampling ports shall be installed within the HPU limits at the locations shown on the Drawings. Sampling ports shall have an integral check valve and protection cap. The end connection shall be male 7/16-20 60 degree UNC straight-thread O-ring boss in accordance with SAE J514. Sampling connections shall be:

1. Model SMK20 as manufactured by Stauff USA, Waldwick, New Jersey.

2. Or equal.

2.42 HYDRAULIC MANIFOLD BLOCKS, PORTING BLOCKS AND SUB-PLATES

A. Parallel manifold blocks and sub-plates shall be constructed of carbon steel. The manifold shall be machined to contain both sandwich and cartridge type valves as selected by the Integrator. Manifold blocks shall be manufactured by:

1. Parker Hannifin Corporation, Greenville, Tennessee.

2. Bosch Rexroth Corporation, Bethlehem, Pennsylvania.

3. Sun Hydraulics, Sarasota, Florida.

4. Daman Products, Mishawaka, Indiana.

2.43 NAMEPLATES, MARKINGS AND IDENTIFICATION

A. Provide 2-in by 5-in, nominal, engraved lamicoid master nameplate on the control panel fastened with stainless steel screws or rivets. Nameplate shall be black with white core, 3/8-in high lettering and shall indicate equipment designation as shown on the Drawings.

B. Provide legend plates or 1-in by 3-in engraved nameplates with 1/4-in lettering for identification of door mounted control devices, pilot lights and meters.

C. Provide permanent warning signs as follows:

1. “DANGER - HIGH VOLTAGE - KEEP OUT”, on all doors.

2. "WARNING - HAZARD OF ELECTRIC SHOCK - DISCONNECT POWER BEFORE OPENING OR WORKING ON THIS UNIT", on main power disconnect.

2.44 HIGH-PERFORMANCE LIQUID EPOXY PROTECTIVE COATING SYSTEM

A. Prior to assembly the Manufacturer shall be prepared the interior (non-sealing) and exterior surfaces of the castings to receive a high-performance coating system. The manufacturer shall apply the coating system according to the coatings manufacturer's instructions. The color shall be Brown.

B. The valve exterior primer, intermediate and top coat shall be one of following systems:

1. One coat of Hydro-Zinc® Series 91-H2O® moisture-cured zinc-rich primer to 3.0 mils DFT; one intermediate coat and one topcoat of N69 Hi-Build Epoxyline II polyamidoamine epoxy to 4.0 mils DFT each, manufactured by TNEMEC, Kansas City, Missouri.

2. One coat 5.0 mils DFT of Carbozinc® 859 zinc-rich primer; one intermediate coat and one topcoat of Carboguard® 888 epoxy polyamide to 5.0 mils DFT each, manufactured by Carboline, St. Louis, Missouri.

3. Or equal.

2.45 ACCUMULATOR CHARGING KIT

A. The Supplier shall furnish a charging and gauging kit suitable for maintaining the nitrogen bottle pre-charge. The kit shall include connection fitting, adapters, 8-feet of hose, as a minimum, and a plastic carrying case. Accumulator charging kit shall be:

1. Model 087040 manufactured by Parker Hannifin, Greenville, Tennessee; or equal.

2. Model FPS-250-F-2.5-G4-K manufactured by Hydac Corporation, Bethlehem. Pennsylvania.

2.46 INTEGRATED HYDRAULIC MANIFOLD BLOCKS

A. Integrated hydraulic manifold blocks for use with cartridge valves and NFPA modular valves shall be constructed of 6061-T6 aluminum, in accordance with ASTM B221.

B. The surfaces of the manifold block and accessory aluminum components shall be treated for application of a Type A bright engineering hard anodic coating, clear or gold, to a minimum thickness of .002 inches accordance with ASTM B580. The manifold shall be machined as necessary to accommodate both modular (CETOP, ISO, NFPA, etc.) and cartridge type valve cavities, where specified and shown on the drawings.

C. Porting for the manifold fluid line connections shall be SAE J514 straight thread O-ring boss, or SAE J518 Code 61 four-bolt flanged. Threads shall be 60 degree UNF or UNC in accordance with ASME B18.2.1. O-ring boss ports shall be spot-faced to a 0.031 inch depth as a minimum. Surfaces used as sealing faces shall have a minimum 70 µinch Ra surface finish, having 0.002 inch flatness as a minimum.

D. Manifold blocks shall be manufactured by:

1. Parker Hannifin Corporation, Greenville, Tennessee.

2. Vickers/Eaton Corporation, Eden Prairie, MN.

3. Sun Hydraulics, Sarasota, Florida.

4. Daman Products, Mishawaka, Indiana.

PART 3 EXECUTION

3.01 QUALITY CONTROL AND QUALITY ASSURANCE

A. Quality control (QC) and quality assurance (QA) for the design, fabrication, and delivery of the equipment specified herein shall be the responsibility of the Supplier and Contractor, including all QC and QA procedures in the shop and field required to comply with this Section. The Owner and/or Engineer shall verify QC or QA with independent testing, herein referred to as QA verification, when noted herein Part 3. All QA verification inspections, examination, and testing will be completed after QC and QA procedures have been performed by the Supplier. The Supplier shall notify the Owner and Engineer 3 weeks prior to testing.

B. Equipment testing shall be conducted on consecutive days so that all testing may be completed during a single trip. In the event that equipment furnished as part of this Section is provided in multiple deliveries to facilitate the construction schedule, then QA verification inspections shall be completed on the equipment provided in each delivery. The Owner shall retain the services of an industry specialist and the Engineer to perform all QA verification inspections. The Supplier shall allow unhindered access to the Engineer, inspection staff, and the Supplier’s personnel, including access for progress photographs and video documentation of the work.

C. If work is rejected after QA verification inspection, examination, or testing, then additional QA verification inspections and examinations performed on corrected work shall be paid for by the Contractor. In addition, the Contractor shall reimburse Owner for all repeat testing and/or inspection related costs, including costs associated with inspection staff; laboratory analysis; and testing or inspection result analysis by the Engineer, Owner, or Owner’s representative.

D. If there are difficulties in operation of the equipment due to the Integrator's fabrication additional service to correct the deficiencies shall be provided at no change in Contract Price or Contract Time to correct the problems and meet the acceptance testing requirements specified herein.

E. Inspection by the Owner’s representative or failure to inspect shall not relieve the Supplier of responsibility to provide materials and perform the work in accordance with the contract documents.

F. The Owner and Engineer reserve the right to sample and test any materials after delivery and to reject all components represented by a sample that fails to comply with the specified requirements.

3.02 SHOP TEST - HYDRAULIC SYSTEM HYDROSTATIC TEST

A. The hydraulic piping system shall be hydrostatically tested to not less than 150 percent of the design working pressure. Any equipment that may be damaged by this pressure shall be isolated or removed to prevent damage. The contractor is to provide all test equipment.

B. The hydrostatic test pressure shall be maintained for 12 hours. All welded, flanged, flared, and threaded connections shall be carefully examined for leakage, and all lines shall be inspected for evidence of deflection caused by inadequate anchorage. No leakage or deflection shall be allowed.

END OF SECTION

SECTION 41 24 26.10
HYDRAULIC CONTROLS FOR CONTROL VALVES

PART 1 GENERAL

1.01 DEFINITION OF TERMS

A. Terms defined below shall supplement and clarify those included in the General Conditions and apply to the technical content and services specified herein.

1. Supplier – shall refer to the hydraulic power and control system integrator responsible for the final sizing and purchase of the individual fluid power controls; purchase of the instruments and control components; and layout, mechanical integration, fabrication, assembly, and programming of the control valve panels (CVP).

2. Supplier's Field Installation Technician – shall refer to technicians and engineering personnel, who are employed by the Supplier and have been trained for start-up and commissioning services at the Site.

3. Original Equipment Manufacturer (OEM) – shall refer to the manufacturer of individual components used by the Supplier to assemble the CVP systems.

4. OEM Installation Technician – shall refer to technicians and Engineers employed by OEMs and trained for installation, configuration, commissioning services related to their company's products, and training of the Owner's operations and maintenance personnel in their use. The OEM Installation Technician shall only be allowed to perform services at the Site under the supervision of the Contractor and Supplier's Field Installation Technician.

1.02 SCOPE OF WORK

A. The Work of this Section shall include the final design, fabrication, programming, delivery, installation, and testing of control valve panels (CVPs) as shown on the Drawings and specified herein.

1.03 RELATED WORK

A. Specifications for the Work associated with the selection and installation of annealed stainless steel tube and fittings, for use within the limits of the CVPs, are included in Section 40 05 23.06.

B. Specifications for the Work associated with selection and installation of fluid power hose assemblies, for use within the limits of the CVPs, are included in Section 40 05 30.

1.04 SUBMITTALS

A. Shop Drawings including cut-sheets, schematics and operation and maintenance data, shall have text written in the English, and all numerical data shall be in the foot-pound-second system of units. Materials for all parts shall be identified with the corresponding mark numbers, codes or serial numbers, and refer to the appropriate material standard which applies to them. Submit the following data in accordance with Section 01 30 00:

1. Calculations for sizing and selecting components in accordance with the design criteria specified below.

2. Hydraulic schematic.

3. Control wiring diagram(s) and control loop descriptions.

4. A complete bill of materials.

5. Descriptive literature, bulletins and/or catalog cut sheets with notations showing selections for all commercially obtained components. Each cut sheet shall be marked with corresponding part numbers from the bill of materials.

6. Detailed shop drawings for all custom designed and fabricated components. The drawings shall include a parts list, including the part number, description, material of construction and weight for each component.

7. Fabrication drawings shall illustrate details of materials, tolerances, connections, and proposed welding sequences which shall clearly differentiate shop welds from field welds, if any.

8. Field erection drawings providing a detailed description of recommended field installation procedures. The description shall include the location and method of support of installation and handling equipment dimensions and location of anchor bolt holes.

9. Description of surface preparation and shop prime painting for ferrous metal components and accessories.

10. Manufacturer's list of recommended spare parts.

11. Shop testing procedures.

B. O&M data shall be prepared by personnel familiar with the operation and maintenance information for this specific installation and for the specific purpose of educating operating and maintenance personnel unfamiliar with such equipment. The O&M manuals shall be provided in three-ring binders and in accordance with Section 01 78 23 and shall contain the following minimum contents:

1. Installation instructions, including instructions for installing, supporting, checking, and testing equipment under this Section.

2. Startup procedures.

3. Maintenance instructions shall include preventive, corrective, and troubleshooting. Schedules for maintenance are to be included. Provide a list of tools required to service the equipment.

4. Operation instruction for normal startup and shutdown, emergency startup and shutdown, and ongoing normal operations.

C. Contamination control procedures for shop fabrication describing the procedures utilized to prevent particulate contamination within the interior of the fluid lines and other circuit components.

D. The following descriptive installation and operation information shall be included in the submittal:

1. A narrative of the system operation procedures.

2. A layout drawing and step-by-step description of the field erection and start-up procedures.

1.05 REFERENCE STANDARDS

A. American Society of Mechanical Engineers (ASME)

1. ASME B18.2.1 - Square and Hex Bolts and Screws: Inch Series

2. ASME B40.100 - Pressure Gauges and Gauge Attachments

3. ASME B46.1 - Surface Texture, Surface Roughness, Waviness and Lay

4. ASME Y14.5M - Dimensioning and Tolerancing

B. American Society for Testing and Materials (ASTM)

1. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

2. ASTM B580 - Standard Specification for Anodic Oxide Coatings on Aluminum

3. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel

C. International Electrotechnical Commission (IEC)

1. IEC 801 - International Electrotechnical Vocabulary - Chapter 801: Acoustics and electroacoustics

D. International Organization for Standardization (ISO)

1. ISO 4401 - Hydraulic Fluid Power - Four-Port Directional Control Valves - Mounting Surfaces

E. National Electric Manufacturers Association (NEMA)

1. NEMA ICS 2 - Controllers, Contactors and Overload Relays Rated 600 V

2. NEMA ICS 6 - Adjustable Speed Electrical Power Drive Systems, Part 6: Guide for Determination of Types of Load Duty and Corresponding Current Ratings

F. Society of Automotive Engineers (SAE)

1. SAE J514 - Hydraulic Tube Fittings

2. SAE J518 - Hydraulic Fanged Tube, Pipe and Hose Connections, Four Bolt Split-Flange Type

G. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.06 SUPPLIER'S EXPERIENCE REQUIREMENTS

A. The Work shall be furnished by a Supplier employing a qualified fluid power system integrator having experience in the design and fabrication of hydraulic power systems for civil engineering valve and water control gate applications. Suppliers proposed for consideration shall submit a list of at least twenty (20) successful installations of fluid power systems used for control valve and/or water control gate applications. The referenced projects shall be of similar size to the Work specified herein. The list shall be submitted prior to the preparation of Shop Drawings and include customer contact information for each installation.

B. The Supplier shall be responsible for final sizing of all fluid power, instrumentation and control devices. The devices have been specified below. The component models and Suppliers listed shall establish the minimum quality of construction and service durability required for the municipal/industrial environmental conditions at the Site. All surface finishes specified shall be as defined in ASME B46.1. All mechanical Shop Drawings shall be prepared in accordance with ASME Y14.5M.

1.07 LOCAL CONTROL PANEL SYSTEM DESCRIPTIONS

A. The equipment specified herein shall replace the existing water-operated Parco pump control valve system and serve as the primary means of surge control for the finished water pumping system. Hydraulic system schematics and details are shown on the Drawings and should be reviewed concurrently with this Section.

B. Each finished water pump shall have its pump control valve replaced with new valves, FW-201, FW-202, FW-203, and FW-204. The facility also has an emergency valve used to prevent flooding of the plant during abnormal operations and/or a utility power outage. This valve will be replaced with a new emergency valve (FW-301), which shall have a designated hydraulic control panel. The new valves shall be AWWA C504 butterfly valves specified in Section 40 05 64.16.

C. The new butterfly valves shall be actuated by scotch yoke or link-lever actuator drives positioned by a double-acting stainless steel hydraulic cylinders specified in Section 41 24 26.03. The drive shall include a mechanical position indicator on its exterior. At each end-of-stroke position an adjustable proximity switch shall be installed on the gearbox, and a metal proximity stem installed on the external position indicator to transmit an OPEN and CLOSE signal to the system controls specified below. This entire assembly shall comprise each pump control valve and the emergency valve.

D. Each pump control valve shall have a local control panel, PCVP-511-1, PCVP-511-2, PCVP-511-3 and PCVP-511-4. FW-301 shall have also have a dedicated local control panel, EVP-530. Each local control panel shall have a dedicated programmable logic controller (PLC) furnished and programmed to perform all of the functions described herein by the Supplier. Each panel shall have an OPEN-CLOSE-REMOTE selector switch. In remote the panel shall be controlled from LCP-2. The hydraulic power source for all local hydraulic control valve panels shall be the hydraulic power unit specified in Section 41 24 26. Communication between the HPU, the local control panels, and LCP-2 shall be through hardwired signals for reliable operation of the control valves.

E. Hydraulic schematics and details for the FW-20# and FW-301 control valve panels have been included on the Drawings. The Drawings reflect the arrangement of fluid power components to establish the configuration and minimum equipment performance requirements of the system.

F. Fabricated weldments constructed of carbon steel shall receive surface preparation, shop prime, and finish painting in accordance with the requirements specified below, prior to mounting the valve stacks and other components that shall not receive shop coatings. The only components to receive shop coatings are the steel framing members and other carbon steel fabricated components. Sealing surfaces, elastomer components, control devices, reservoirs, control panels, and other stainless steel surfaces shall not receive shop coatings or overspray from the shop coating process.

1.08 PUMP CONTROL VALVE CONTROL NARRATIVE

A. Three control regimes are described for pump control valve panels below, NORMAL PUMP START, NORMAL PUMP STOP, and EMERGENCY PUMP STOP. The following narrative explains the sequence of operation for pump train P-511-1, but applies to all four trains. All control regimes shall be based on programming at pump control valve panel PCVP-511-1 PLC, and communication with LCP-2 and the HPU PLC.

B. During NORMAL PUMP START the OPEN-CLOSE-REMOTE selector switch HS-511-F shall be placed in the REMOTE position. Finished Water Pump P-511-1 will be signaled to START and FW-201 signaled to OPEN from the LCP-2 panel following contact closure of PSH-511-1. The PCVP-511-1 PLC shall send a signal to the HPU PLC to start the lead hydraulic pump (LHP), which shall pressurize the LPO header. PCVP-511-1 PLC shall energize S101 and S102 shifting DCV101 and DCV102 to the all-ports blocked position. This will direct flow from the HPO and LPO piping system headers to the “P” and “T” ports of DCV103.

C. PCVP-511-1 shall energize S104 shifting DCV103 to the OPEN position, directing hydraulic oil from the HPO header through the “P” port to the rod-end of the FW-201 hydraulic cylinder, retracting the rod and stroke the butterfly valve to the fully OPEN position. The stroke time to OPEN shall be 90 seconds. Stroke time shall be controlled at FCV101. At the end-of-stroke, the position indicator stem shall close contacts at the OPEN limit switch ZS101 mounted to the actuator drive. This contact closure shall signal the HPU PLC to shut down the LHP. If there are two pumps starting simultaneously, the LHP shall not stop until both end-of-stroke limit switches have contact closure. S101 and S102 shall remain energized.

D. During NORMAL PUMP STOP the OPEN-CLOSE-REMOTE selector switch HS-511-F shall be in the REMOTE position. Finished Water Pump P-511-1 will be called to STOP by the LCP-

2 panel for shutdown. LCP-2 shall send a signal to VFD-511-1 to ramp the pump motor speed down to zero. During the speed ramp PSH-511-1 shall open contacts and LCP-2 shall signal PCVP-511-1 PLC to CLOSE FW-201.

E. PCVP-511-1 PLC shall send a signal the HPU PLC to start the LHP and pressurize the LPO header. PCVP-511-1 PLC shall energize S103 to shift DCV101 to the CLOSE position directing hydraulic oil from the "P" port to the cap end of FW-201 hydraulic cylinder extending the rod to the CLOSED position. The stroke time to CLOSE shall be 90 seconds. Stroke time shall be controlled at FCV102. At the end-of-stroke, the position indicator stem shall close contacts at the CLOSE limit switch ZS102 mounted to the actuator drive. This contact closure shall signal the HPU PLC to shut down the LHP. If there are two pumps shutting down simultaneously, the LHP shall not stop until both end-of-stroke limit switches have contact closure. S101 and S102 shall remain de-energized.

F. EMERGENCY PUMP STOP shall occur during a regional utility power outage. Upon loss of power, solenoid S-002 at the HPU shall be de-energized engaging the reserve power in the HPU accumulator to the HPO header. In PCVP-511-1 solenoids S101 and S102 shall be de-energized to CLOSE FW-201. This shall direct unregulated pressure and flow from the HPO header through DCV101 to the cap-end of the FW-201 hydraulic cylinder, and regulated flow shall be directed from the rod-end of the cylinder through DCV102. Stroke time to CLOSE shall be 90 seconds. Stroke time shall be controlled at FCV103. At the end-of-stroke, the position indicator stem shall close contacts at the CLOSE limit switch ZS102 mounted to the actuator drive. This contact closure shall signal the LCP-2 successful valve closure at LCP-2 following utility grid power restoration. This signal shall be a permissive to prevent pump RESTART following restoration of power. S101 and S102 shall remain de-energized.

1.09 EMERGENCY VALVE CONTROL NARRATIVE

A. The emergency valve shall OPEN manually by shifting the OPEN-CLOSE-REMOTE switch to REMOTE and selecting the VALVE OPEN command at the HMI under control loop 530 signaled from LCP-2 PLC to the EVP-530 PLC. The EVP-530 PLC shall send a signal to the HPU PLC to start the lead hydraulic pump (LHP), which shall pressurize the LPO header. EVP-530 PLC shall energize S501 and S502 shifting DCV501 and DCV502 to the all-ports blocked position. This will direct flow from the HPO and LPO piping system headers to the "P" and "T" ports of DCV503.

B. EVP-530 shall energize S504 shifting DCV503 to the OPEN position, directing hydraulic oil from the HPO header through the "P" port to the rod-end of the FW-301 hydraulic cylinder, retracting the rod and stroke the butterfly valve to the fully OPEN position. The stroke time to OPEN shall be 90 seconds. Stroke time shall be controlled at FCV501. At the end-of-stroke, the position indicator stem shall close contacts at the OPEN limit switch ZS501 mounted to the actuator drive. This contact closure shall signal the HPU PLC to shut down the LHP. If there are two pumps starting simultaneously, the LHP shall not stop until both end-of-stroke limit switches have contact closure. S501 and S502 shall remain energized.

C. The emergency valve shall CLOSE manually by shifting the OPEN-CLOSE-REMOTE switch to REMOTE and selecting the VALVE CLOSE command at the HMI under control loop 530 signaled from LCP-2 PLC to the EVP-530 PLC. The EVP-530 PLC shall send a signal to the HPU PLC to start the lead hydraulic pump (LHP), which shall pressurize the LPO header.

D. EVP-530 PLC shall send a signal the HPU PLC to start the LHP and pressurize the LPO header. EVP-530 PLC shall energize S503 to shift DCV501 to the CLOSE position directing hydraulic oil from the "P" port to the cap end of FW-30 hydraulic cylinder extending the rod to the CLOSED position. The stroke time to CLOSE shall be 90 seconds. Stroke time shall be controlled a FCV502. At the end-of-stroke, the position indicator stem shall close contacts at the CLOSE limit switch ZS502 mounted to the actuator drive. This contact closure shall signal the HPU PLC to shut down the LHP. S501 and S502 shall remain de-energized.

E. EMERGENCY CLOSE of the emergency valve shall occur during a regional utility power outage. Upon loss of power, solenoid S-002 at the HPU shall be de-energized engaging the reserve power in the HPU accumulator to the HPO header. In EVP-530 solenoids S501 and S502 shall be de-energized to CLOSE FW-301. This shall direct unregulated pressure and flow from the HPO header through DCV501 to the cap-end of the FW-301 hydraulic cylinder, and regulated flow shall be directed from the rod-end of the cylinder through DCV502. Stroke time to CLOSE shall be 300 seconds. Stroke time shall be controlled at FCV503. At the end-of-stroke, the position indicator stem shall close contacts at the CLOSE limit switch ZS102 mounted to the actuator drive. This contact closure shall signal the LCP-2, VALVE CLOSED, at LCP-2 following utility grid power restoration. This signal shall be a permissive to prevent pump RESTART following restoration of power. S101 and S102 shall remain de-energized.

F. This valve shall be re-opened manually as described above following power restoration, closing contacts at ZS501, which shall be a permissive for restarting all finished water pumps.

1.10 MAINTENANCE ACCESSORIES AND SPARE PARTS

A. Provide the following spare parts for each control panel in the quantities specified:

1. One dozen replacement fuses, all types and sizes.

2. Two dozen replacement lamps for pilot lights.

3. One dozen of each color replacement lens caps for pilot lights.

4. One can of aerosol touch-up paint.

5. Provide spare processor unit(s) for each unique processor installed.

6. Provide spare OITs for each unique type installed.

7. Provide spare memory cards for each type of card installed.

8. Provide spare I/O cards for each unique I/O module type installed. Provide two or 10 percent of installed quantity, whichever is greater.

9. Provide one spare network interface communication module for each unique communication module installed.

B. Spare parts shall be properly bound and labeled for easy identification without opening the packaging and be suitably protected for long term storage in a humid environment.

1.11 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be covered for protection against physical damage, such as rubbing, abrasion and exposure to sunlight where it can be detrimental to coatings or elastomer products during shipping and after delivery to the site. All hydraulic fluid lines shall be plugged prior to shipping to prevent entry of contaminants.

PART 2 PRODUCTS

2.01 PROGRAMMABLE LOGIC CONTROLLER

A. The Supplier's hydraulic control system shall be programmable logic controller (PLC) based. The Supplier shall furnish PLC equipment with the required memory and functional capacity to perform the specified sequence of operation included in the control description described herein. Processor Systems shall include integral processor, power supply, input/output modules, communication modules, and remote interface modules as required to meet system requirements.

B. The PLC shall support expansion I/O modules but not be chassis based in design. Products shall be listed and classified by Underwriters Laboratories (UL) and/or CSA approval as required for installation location and intended service.

C. All equipment and devices furnished hereunder shall be designed for continuous industrial and municipal service. The system shall contain products of a single PLC OEM and shall consist of equipment models that are currently in production. All equipment furnished shall be designed and constructed so that in the event of power interruption the systems shall go through an orderly shutdown with no loss of memory, and resume normal operation without manually resetting when power is restored. This requirement shall be strictly enforced.

D. The PLCs shall communicate between transducers, switches, controllers, and process actuators. Communications protocol shall be completely transparent to process operators at the Human Machine Interface (HMI). The PLC shall be capable of stand-alone operation in the event of failure of the communication link to the HMI subsystem.

E. Electrical supply voltage to the PLC shall be 24 VDC, plus or minus 15 percent, 48 - 63 Hz. PLC system power supplies shall be fused for overload protection. The PLC shall have a storage temperature range of -25 deg. to 70 deg. C (-40 deg. to 185 deg. F) at an altitude of 0 to 9,800 feet; and a continuous operating temperature range of 0 deg. to 60 deg. C (32 deg. to 140 deg. F) at an ambient relative humidity range of 10 to 95%, non-condensing, at an altitude range of 0 to 6,500 feet. The degree of protection shall be NEMA 1 (IP20).

F. The PLC shall be capable of withstanding 3.5 mm Peak-to-Peak, 5 - 9 Hz: 1.0G, 9 - 150 Hz vibration in accordance with IEC 68-2-6 and/or JIS C 0911 standards for vibration. The system shall be operational during and after testing.

G. The PLC shall have vibration rating of 2.0G maximum peak acceleration for 10 to 500Hz. in accordance with at least one of the following:

1. DIN rail mounted PLC: 10 - 57 Hz, amplitude 0.075 mm, acceleration 25 - 100 Hz.

H. The PLC shall be capable of withstanding a 15G, 11 msec shock load based on IEC 68-2-27 and/or JIS C 0912 standards for shock. The system shall be operational during and after testing.

I. The PLC system shall be designed and tested to operate in the high electrical noise environment of an industrial plant as governed by IEEE 472; IEC 801; MILSTD 461B; IEC 255-4, NEMA ICS 2-230.40, and ANSI/IEEE C-37.90A-1978.

J. The PLC shall be furnished with all necessary cables shall be included. All cables and connectors shall be as specified by the manufacturer. Cables shall be assembled and installed per the manufacturer recommendations. All major assemblies and sub-assemblies, circuit boards, and devices shall be identified using permanent labels or markings indicating the following as a minimum:

1. Modules catalog number.

2. Modules major revision number.

3. Modules minor revision number.

4. Module manufacturer vendor.

5. Module serial number.

K. The PLC central processing unit (CPU) shall be a 16-bit microprocessor, as a minimum, which provides system timing and scheduling of I/O updates, with no user programming required to ensure discrete or analog update. The CPU shall execute user relay ladder logic programs, communicate with intelligent I/O modules, and perform on-line diagnostics. The CPU shall consist of a single module which solves application logic; stores the application program, stores numerical values related to the application processes and logic; and interfaces to the I/O.

L. CPU shall sample al discrete and analog inputs and outputs, including internal coils and registers, and service special function modules every scan. The CPU shall process the I/O with user program(s) stored in memory, then control the outputs based on the results of the logic operation. The CPU shall have battery-backed time of day clock and calendar and allow for user program transportability from one CPU model to another.

M. The CPU shall perform on-line diagnostics that monitor the internal operation of the PLC. All diagnostic information shall be accessible to the host communications interfaces and to the PLC program. If a failure is detected, the CPU shall initiate system shutdown and fail-over. The following parameters shall be monitored, as a minimum, shall be monitored:

1. Memory failure.

2. Memory battery low.

3. General fault.

4. Communications port failure.

5. Scan time over run.

6. I/O failure.

7. Analog or special function I/O module failure.

N. PLC shall have indicators and on board status area to indicate the following conditions as a minimum:

1. CPU run.

2. CPU error or fault.

3. I/O failure or configuration fault.

4. Status of Battery or back-up power module.

5. Communications indicator.

O. Operating system shall be contained in non-volatile firmware. The memory containing the operating system shall be field updateable via a separate update tool.

P. User programming and data shall be contained in non-volatile battery backed memory of type CMOS RAM program memory or equivalent. The memory backup system shall have lithium battery backup or equivalent capable of retaining all memory for a minimum of three months, as a minimum. The backup battery or module shall be capable of being replaced without disrupting memory integrity. Provide a visual indication of low battery voltage or module error, and an alarm in the PLC program.

Q. The PLC shall have a Flash memory system capable of reloading program in the event of memory loss. Flash or SD Memory Card: Memory card storage capacity shall be equal to or greater than processor memory capacity. Memory cards shall be installed in processors for factory testing.

R. The PLC shall utilize a USB, or Ethernet port for programming. Application programs shall be modifiable and/or stored while the CPU is running, with minimal impact on the scan time. The Supplier shall verify that communication signals, 4-20 mA signals (including those with embedded HART), are properly conditioned for the PLC and protected from all sources of radiated energy or harmonics. The Supplier shall arrange connections to I/O modules such that failure of a single I/O module shall not disable the redundant system. This shall apply to all I/O types.

S. The PLC shall include embedded I/O and/or expansion I/O modules to accommodate project needs. The PLC shall support a variety of discrete and analog modules to meet required project I/O. The PLC shall include minimum of one 10/100 Mbps Ethernet communications port. The CPU shall be expandable and supplied with additional modules to support the required communication interfaces.

T. The Supplier shall furnish a PLC configuration and application development software package complete with documentation and original software compact disks. The PLC software package associated licensing and/or activation shall be made in the name of the Owner. The software package shall include license agreement allowing the Owner the right to use the software as

required for any current or future modification, documentation, or development of the PLCs furnished for this project.

U. The software package shall allow on-line/off-line program development, annotation, monitoring, debugging, uploading, and downloading of programs to the PLCs. The software shall be Microsoft Windows-based and capable of the following IEC 61131-3 functions:

1. Ladder logic.

2. Function block.

3. Sequential function chart.

4. Structure text.

V. In addition to the above editors, an add-on instruction editor shall work with any of the above-mentioned editors to create custom reusable function blocks. This software shall allow any of the derived function blocks to be modified on-line. The software shall include a security feature to prevent unauthorized personnel from modifying and downloading the programs.

W. The Supplier shall furnish an I/O simulator which allows the PLC application program to be tested on a PC with simulated analog and digital inputs and outputs, allowing I/O testing and debugging to be performed in a safe, isolated environment without the need for running the PLC CPU and process I/O boards. The PLC system shall be one of the following:

1. MicroLogix® manufactured by Rockwell, Automation, Milwaukee, Wisconsin.

2.02 OPERATOR INTERFACE TERMINAL

A. The CVP shall have an operator interface terminal (OIT) mounted on the control panel door. Operator Interface Terminal shall be pre-packaged with all configuration and programming software necessary to perform functions as shown on drawings and within the specifications. Integrated OIT software shall have the following features:

1. Trending

2. Data Logging

3. Alarms

4. Graphic Symbols

5. Animations

B. OIT shall have a minimum of one Ethernet 10/100 Mbps for connectivity or programming. OIT shall have a minimum of one Serial RS232 port. OIT shall have a minimum of one USB port. Compact flash ports shall be Type 2. The Supplier shall include the following communication expansion modules in the selected OIT:

1. Modbus Plus

2. PROFIBUS

C. OIT display size shall be 6". Type of display for the OIT shall be Color Active Matrix TFT. Display resolution shall be a minimum of 320 x 240. Display shall support touch screen input. OIT shall be rated to maintain the rating of the control panel it will be mounted in. Temperature: Operating temperature range of the OIT shall range 0 - 50 °C. The OIT shall be:

1. Allen-Bradley PanelView® Plus 7 series manufactured by Rockwell Automation, Milwaukee, Wisconsin.

2.03 CONTROL PANEL CABINET

A. The Supplier shall coordinate size and configuration of the control panel enclosure to meet the dimensional requirements of the project. The interior layout shall comply with the PLC OEM's required spacing between components to ensure adequate cooling. The air within the control panel enclosure surrounding the PLC shall be conditioned to maintain the required temperature and humidity range.

B. The control panel shall operate on 480 Volts, 3-Phase, 60 Hz power. The overall withstand and interrupting rating of the equipment and devices shall be determined by the Supplier, in amperes R.M.S. symmetrical at 480 Volts. All circuit breakers and combination motor starters shall be fully rated for the above fault current interrupting capacity. Series connected short circuit ratings will not be acceptable.

C. The complete control panel assembly shall be UL certified or carry a UL 508A listing for industrial control panels. The control panel shall meet all applicable requirements of the National Electrical Code. The control panel enclosure shall be rated as indicated in accordance with the electrical area classification indicated on the Drawings.

D. The control panel specified herein shall be NEMA 12 and be painted carbon steel with gasket.

E. Carbon steel panel enclosures shall be 14 gauge thickness as a minimum and constructed with continuously welded seams. The panel door(s) shall have continuous hinge and neoprene gasket. Door clamps shall be provided.

F. The panel enclosure shall incorporate a removable back panel on which control components shall be mounted. The back panel shall be secured to the enclosure with collar studs. The enclosure door shall be interlocked with the main circuit breaker by a door mounted operating mechanism. The back panel shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any components.

G. Wires entering and exiting the PLC and other components shall be sized to comply with the PLC OEM requirements. Access doors on all components shall be able to be fully closed with adequate clearance when all the wires are installed. For chassis mounted PLCs, no wiring, wire ducts, or other devices shall obstruct the removal of cards from the rack.

H. PLC lights, keys, communication ports, and memory card slots shall be accessible at all times when the enclosure doors are open. Lights shall be visible at all times when enclosure door is opened. Control panel designer shall provide independent line fuses or circuit breakers, per the

PLC manufacturer recommendation, for each power supply, input module, output module, and other modules with separately derived power requirements. Document storage pockets shall be provided on the inside of the panel. Overload tables shall be laminated and adhered to the inside of the door.

2.04 MAIN CIRCUIT BREAKER

A. The main circuit breaker shall be a thermal-magnetic molded case breaker. Provide a flange mounted main power disconnect operating handle with mechanical interlock having a bypass that will allow the panel door to open only when the switch is in the OFF position.

2.05 PUSH-BUTTONS, SWITCHES AND INDICATORS

A. All operating control devices and instruments shall be securely mounted on the exterior door. All controls shall be clearly labeled to indicate function and shall be rated in accordance with the electrical area classification indicated on the Drawings. Push-buttons shall be manufactured by:

1. Allen-Bradley

2. Or equal.

B. Push-buttons, shall be heavy-duty, industrial type with momentary or detented (latched) contacts as required, rated for 120 VAC at 10 Amps continuous. Units shall have standard size, legend plates having a black filed and white markings, as indicated. The contact arrangement shall be as required by the Supplier. Push-button colors shall be as follows:

1. EMERGENCY STOP or START: Red

2. STOP Green

C. Selector switches shall be the heavy-duty, industrial type with contacts rated for 120 VAC at 10 Amps continuous. Selector Switches shall have standard size, black field legend plates with white markings, as indicated. Operators shall be black knob type. Units shall have the number of positions and contact arrangements, as required. Units shall be single-hole mounting, accommodating panel thicknesses from 1/16-in minimum to 1/4-in maximum.

D. Indicator lamps shall be heavy duty, industrial type, high-visibility LED, full voltage type. Units shall have screw on plastic lenses and shall have factory engraved legend plates as required. Lens color shall be green for OFF, red for ON and amber for FAIL or ALARM. Indicator lamps shall incorporate a push-to-test feature.

2.06 ALARM SOUNDER AND BEACONS

A. The control panel shall include a failure alarm sounder. The sounder shall have piezoelectric operation and operate on 120 VAC, 60Hz, single phase power. The sounder shall provide an intermittent and continuous tone for 2 levels of alarm controllable by independent contacts. The enclosure rating shall be NEMA 3R and IP65. Alarm beacon shall be:

1. Model PMAMT-048-240 manufactured by Federal Signal, Oak Brook, Illinois.

2. Or equal.

B. The control panel shall include a failure alarm beacon light. The beacon light shall have a transparent polycarbonate dome. The dome color shall be RED and operate on 120 VAC, 60Hz, single phase power. The beacon shall use 100,000 hour light emitting diodes (LEDs). The beacon shall have 3 channels for flashing light only; flashing light and emitted sound; and steady light and continuous sound. The enclosure rating shall be NEMA 3R and IP65. Alarm beacon shall be:

1. Model PMC manufactured by Federal Signal, Oak Brook, Illinois.

2. Or equal.

2.07 LIGHTNING AND SURGE PROTECTION

A. The control panel shall be furnished with a lightning and surge protection unit on the line side of the main circuit breaker. The surge protector shall be:

1. Tranquell® Series manufactured by General Electric, Chicago, Illinois.

2. Or equal.

B. All interfaces between control panel and remote devices shall be isolated via an interposing relay. Interposing relays shall have contacts rated for 250 VAC and 10 Amps continuous. Relays shall be manufactured by

1. Potter and Brumfield, Berwyn, Pennsylvania

2. Or equal.

2.08 CONDENSATION PREVENTION HEATERS

A. A strip heater shall be mounted inside the control panel. The strip heater terminals shall be guarded by a protective terminal cover. Heater shall operate on 120 Volt, 60 Hz, single phase power and have a minimum power rating of 150 watts.

B. Heaters shall be furnished with a rust resisting iron sheath. A control thermostat shall be mounted inside the panel. The strip heater terminals shall be guarded by a protective terminal cover.

C. High-temperature connecting lead wire shall be used between the thermostat and the heater terminals. Wire shall be No. 12 AWG stranded, nickel-plated copper with Teflon glass insulation.

2.09 PANEL WIRING, ROUTING ACCESSORIES AND HARDWARE

A. Power and control wire shall be 600 Volt class, Type MTW insulated stranded copper and shall be of the sizes required for the current to be carried, but not smaller than No. 14 AWG. All wiring shall be enclosed in PVC wire trough with slotted side openings and removable cover. All interconnecting wires between panel mounted equipment and external equipment shall be

terminated at numbered terminal blocks. All control panel wiring shall be numbered at both ends with type written heat shrinkable wire markers.

2.10 TERMINAL BLOCKS

A. Terminal blocks shall be one-piece molded plastic blocks with screw type terminals and barriers rated for 600 volts. Terminals shall be double sided and supplied with removable covers to prevent accidental contact with live circuits. Terminals shall have permanent, legible identification, clearly visible with the protective cover removed. Each terminal block shall have 20 percent spare terminals, but not less than two spare terminals.

B. Wires shall be terminated to the terminal blocks with crimp type, pre-insulated, ring-tongue lugs. Lugs shall be of the appropriate size for the terminal block screws and for the number and size of the wires terminated. Provide an intrinsically safe ground terminal bar isolated from the control panel enclosure. Provide 20 percent spare terminals but not less than two spare terminals. Terminal points for current transformer leads shall be provided with a shorting bar.

2.11 INLINE HYDRAULIC BALL VALVES (BV)

A. Ball valves for the hydraulic piping shall be full bore, fire-safe, and rated for a minimum line pressure of 5000 psig at a maximum temperature of 200ºF. Valves shall be furnished with SAE J514 straight thread O-ring boss ports, or SAE J518 Code 61 four-bolt flanged connections as shown on the Drawings.

B. Medium pressure ball valves shall provide suitable seating in both directions. Ball valves for the hydraulic piping shall be full bore, fire-safe, and rated for a minimum line pressure of 3000 psig at a maximum temperature of 200ºF. Valves shall have a body, ball and stem constructed of Type 316 stainless steel. Hand levers shall be Type 304 stainless steel. Seats shall be reinforced Teflon. The fully open port area shall be approximately 100 percent of the nominal pipe area. High-pressure ball valves shall be:

1. Model BVHP-##-S-K-2-V manufactured by Parker Hannifin Corporation, Greenville, Tennessee.

2. Model BBV-2-###-1-1-0-1-M manufactured by Stauff USA, Waldwick, New Jersey.

3. Model AE2-S##-2-2-X-V Series manufactured by Anchor Fluid Power, Cincinnati, Ohio.

4. Model BVH-####-S-2-6-2-4 manufactured by DMIC, Wheatfield, New York.

4. Or equal.

2.12 ADJUSTABLE INSTRUMENT SNUBBER VALVES (SNV)

A. Adjustable instrument snubber valves shall be installed between all pressure instruments and process lines. Snubber valves shall be constructed of Type 303 stainless steel with Type 416 trim. Valve seals shall be constructed of PTFE. Snubber valves and have SAE J514 straight thread O-ring boss male x female port connections.

B. Adjustment knobs shall be constructed of glass filled nylon and fitted with a spurred locknut. The male port shall be adjustable allowing positioning of the adjustment knot at any position 360 degrees relative to the valve port centerline. The maximum operating pressure shall be 6000 psi. Adjustable instrument snubber valves shall be:

1. Model NSAB-KXN-HS manufactured by Sun Hydraulics, Sarasota, Florida.

2. Or equal.

2.13 PRESSURE GAUGES (PI)

A. Pressure gauges shall be installed within the CVP where shown on the Drawings. All gauges specified herein shall be designed, manufactured, tested and meet the accuracy grades included in ASME B40.100. The materials of construction for the bourdon tube and all wetted parts shall be ASTM A167, Grade 308 or 309; and/or ASTM A473, Type 316L (UNS S31603) or equivalent, unless otherwise noted.

B. Pressure gauges shall be used for applications having pressures up to 6000 psi at ambient up to 140 degrees F. The gauge shall be Accuracy Grade A (+/- 2%/1%/2% of span), in accordance with ASME B40.100. The span of the gauge shall not exceed 60 percent of the maximum hydraulic system operating pressure. The temperature error shall not exceed +/- 0.4 percentage of span for every 18 degrees F rising or falling from a reference temperature of 68 degrees F.

C. The gauge shall be furnished with a stainless steel or die cast brass case, sealed with a fluorocarbon or Buna-N rubber seal. The window shall be constructed of laminated shatter-proof glass in compliance with ANSI Z26.1. The case shall be weather-proof and have a NEMA 4X and IP65 rating. The gauge dial shall be constructed of ABS plastic or aluminum and have black lettering with a solid white background. The indicator needle shall be black and constructed of aluminum and be adjustable. The case shall be liquid filled for pressure pulsation and vibration dampening effects on the movement. The fill fluid shall be 99.7 percent glycerin.

D. The gauge shall be furnished with a helical-type Bourdon tube and movement constructed of copper alloy. The pressure connection shall be fitted with male 7/16 inch -20 60 degree UNC straight-thread O-ring boss with washer and lock-nut in accordance with SAE J514. Pressure gauges for hydraulic power units shall be:

1. Type 213.53S manufactured by Wika Instrument Corporation, Lawrenceville, Georgia.

2. 300 Series manufactured by Noshok, Inc., Berea, Ohio.

3. Series SAEG manufactured by Dwyer Instruments, Inc., Michigan City, Indiana.

4. Or equal.

2.14 CARTRIDGE TYPE FLOW CONTROL VALVES (FCV<u>X</u>03)

A. Flow control valves shall be the cartridge type constructed of carbon steel and configured for screwed manifold mounting. The valves shall be bidirectional. Adjustment knobs shall be furnished with calibrated graduations and locking mechanism.

B. The adapter shall be constructed of carbon steel, and all exterior components shall be zinc-plated by electroplating process with a Type II supplemental yellow chromate satin finish, Class SC3 thickness, in accordance with ASTM B633.

C. Flow control valves shall be:

1. Model NFBC-HCV and/or Model NFDC-HCV manufactured by Sun Hydraulics, Sarasota, Florida.

2. Or equal.

2.15 FLOW CONTROL CARTRIDGE VALVE WITH CHECK FEATURE (FCVX01 & FCVX02)

A. Cartridge type flow control valves having a check feature shall be constructed of carbon steel. The cartridge components shall constructed of hardened carbon steel and have fluorocarbon (FKM, Viton) seals. Adjustment knobs shall be furnished with calibrated graduations and locking mechanism.

B. The exposed metal parts shall be constructed of carbon steel, and be zinc-plated by electroplating process with a Type II supplemental yellow chromate satin finish, Class SC3 thickness, in accordance with ASTM B633.

C. Cartridge type flow control valves shall be:

1. NC*B-HCV manufactured by Sun Hydraulics, Sarasota, Florida.

2. Or equal.

2.16 PILOT-OPERATED CHECK CARTRIDGE VALVES (PCVX01 & PCVX02)

A. Cartridge type pilot-to-open check valves hall be constructed of carbon steel. The valve shall have fluorocarbon (FKM, Viton) seals. Valve shall have a standard (non-sealed) pilot. The valve shall have a minimum flow capacity of 5 gpm and minimum pressure rating of 5,000 psi.

B. The exposed metal parts shall be constructed of carbon steel, and be zinc-plated by electroplating process with a Type II supplemental yellow chromate satin finish, Class SC3 thickness, in accordance with ASTM B633.

C. Cartridge type pilot-to-open check valves shall be:

1. CK*B manufactured by Sun Hydraulics, Sarasota, Florida.

2. Or equal.

2.17 SOLENOID-OPERATED 2/2 DIRECTIONAL CONTROL CARTRIDGE VALVE (DCVX01 & DCVX02)

A. Two-way, two position, solenoid operated directional control cartridge valve used as a pilot valve for the SRV vent, and the emergency closure valves for the pump control valves, shall be

the cartridge type. The valve shall be constructed of carbon steel and configured for screwed manifold mounting. The valves shall be bidirectional.

B. The exterior components of the valve shall be constructed of carbon steel, and be zinc-plated by electroplating process with a Type II supplemental yellow chromate satin finish, Class SC3 thickness, in accordance with ASTM B633.

C. Solenoids used for two-way, two position directional control valves shall have a one-piece molded epoxy design. All valves shall operate on120V, 60Hz (110V, 50Hz) power, unless otherwise scheduled and have a continuous duty rating regardless of the application. Solenoids shall meet the requirements of NEMA ICS 6, and have a "General Use" listing in the UL Gas and Oil Equipment Directory; and/or the UL Hazardous Location Equipment List.

D. Solenoids shall be furnished with Class F insulation for ambient temperatures up to 125 degrees F. Solenoids shall have a Type 4X enclosure rating (watertight, corrosion resistant), as defined in NEMA 250, as a minimum. Type 4X solenoids shall be furnished with "Hirschman" style pinned connectors in accordance with DIN 43650.

E. 2/2 Solenoid operated directional valves shall be:

1. Model DLDA-MHV-211 manufactured by Sun Hydraulics, Sarasota, Florida.

2. Or equal.

2.18 SOLENOID-OPERATED 4/3 DIRECTIONAL CONTROL CARTRIDGE VALVE (DCVX03)

A. Solenoid-operated four-way, three position (4/3) directional control cartridge valves shall have a NFPA D05 manifold mount. The valve shall be three-position, spring-centered with OPEN and CLOSE solenoids and manual override buttons as shown on the hydraulic schematic. The valve shall be the stack type with porting conforming to ISO 4401, having a maximum operating pressure of 3000 psi.

B. Solenoids used for directional control valves shall have a one-piece molded epoxy design. All valves shall operate on120V, 60Hz/(110V, 50Hz) power, unless otherwise scheduled and have a continuous duty rating regardless of the application. Solenoids shall meet the requirements of NEMA ICS 6, and have a "General Use" listing in the UL Gas and Oil Equipment Directory; and/or the UL Hazardous Location Equipment List.

C. Solenoids shall be furnished with Class F insulation for ambient temperatures up to 125 degrees F. Solenoids shall have a Type 4X enclosure rating (watertight, corrosion resistant), as defined in NEMA 250, as a minimum. Type 4X solenoids shall be furnished with "Hirschman" style pinned connectors in accordance with DIN 43650.

D. Solenoid operated four-way directional control valves shall be:

1. Model D3W1CVYPRK manufactured by Parker Hannifin Corporation, Greenville, Tennessee.

2. Or equal.

2.19 INTEGRATED HYDRAULIC MANIFOLD BLOCKS

A. Integrated hydraulic manifold blocks for use with cartridge valves and NFPA modular valves shall be constructed of 6061-T6 aluminum, in accordance with ASTM B221.

B. The surfaces of the manifold block and accessory aluminum components shall be treated for application of a Type A bright engineering hard anodic coating, clear or gold, to a minimum thickness of .002 inches accordance with ASTM B580. The manifold shall be machined as necessary to accommodate both modular (CETOP, ISO, NFPA, etc.) and cartridge type valve cavities, where specified and shown on the drawings.

C. Porting for the manifold fluid line connections shall be SAE J514 straight thread O-ring boss, or SAE J518 Code 61 four-bolt flanged. Threads shall be 60 degree UNF or UNC in accordance with ASME B18.2.1. O-ring boss ports shall be spot-faced to a 0.031 inch depth as a minimum. Surfaces used as sealing faces shall have a minimum 70 µinch Ra surface finish, having 0.002 inch flatness as a minimum.

D. Manifold blocks shall be manufactured by:

1. Parker Hannifin Corporation, Greenville, Tennessee.

2. Vickers/Eaton Corporation, Eden Prairie, MN.

3. Sun Hydraulics, Sarasota, Florida.

4. Daman Products, Mishawaka, Indiana.

5. Or equal.

2.20 NAMEPLATES, MARKINGS AND IDENTIFICATION

A. Provide 2-in by 5-in, nominal, engraved lamicoid master nameplate on the control panel fastened with stainless steel screws or rivets. Nameplate shall be black with white core, 3/8-in high lettering and shall indicate equipment designation as shown on the Drawing.

B. Provide legend plates or 1-in by 3-in engraved nameplates with 1/4-in lettering for identification of door mounted control devices, pilot lights and meters.

C. Provide permanent warning signs as follows:

1. “DANGER - HIGH VOLTAGE - KEEP OUT”, on all doors.

2. “WARNING – HAZARD OF ELECTRIC SHOCK – DISCONNECT POWER BEFORE OPENING OR WORKING ON THIS UNIT”, on main power disconnect.

2.21 HIGH-PERFORMANCE LIQUID EPOXY PROTECTIVE COATING SYSTEM

A. Prior to assembly the Manufacturer shall be prepared the interior (non-sealing) and exterior surfaces of the castings to receive a high-performance coating system. The manufacturer shall

apply the coating system according to the coatings manufacturer's instructions. The color shall be Safety Gray.

B. The valve exterior primer, intermediate and top coat shall be one of following systems:

1. One coat of Hydro-Zinc® Series 91-H2O® moisture-cured zinc-rich primer to 3.0 mils DFT; one intermediate coat and one topcoat of N69 Hi-Build Epoxyline II polyamidoamine epoxy to 4.0 mils DFT each, manufactured by TNEMEC, Kansas City, Missouri.

2. One coat 5.0 mils DFT of Carbozinc® 859 zinc-rich primer; one intermediate coat and one topcoat of Carboguard® 888 epoxy polyamide to 5.0 mils DFT each; manufactured by Carboline, St. Louis, Missouri.

3. Or equal.

PART 3 EXECUTION

3.01 QUALITY CONTROL AND QUALITY ASSURANCE

A. Quality control (QC) and quality assurance (QA) for the design, fabrication, and delivery of the equipment specified herein shall be the responsibility of the Supplier and Contractor, including all QC and QA procedures in the shop and field required to comply with this Section. The Owner and/or Engineer shall verify QC or QA with independent testing, herein referred to as QA verification, when noted herein Part 3. All QA verification inspections, examination, and testing will be completed after QC and QA procedures have been performed by the Supplier. The Supplier shall notify the Owner and Engineer 3 weeks prior to testing.

B. Equipment testing shall be conducted on consecutive days so that all testing may be completed during a single trip. In the event that equipment furnished as part of this Section is provided in multiple deliveries to facilitate the construction schedule, then QA verification inspections shall be completed on the equipment provided in each delivery. The Owner shall retain the services of an industry specialist and the Engineer to perform all QA verification inspections. The Supplier shall allow unhindered access to the Engineer, inspection staff, and the Supplier's personnel, including access for progress photographs and video documentation of the work.

C. If work is rejected after QA verification inspection, examination, or testing, then additional QA verification inspections and examinations performed on corrected work shall be paid for by the Contractor. In addition, the Contractor shall reimburse Owner for all repeat testing and/or inspection related costs, including costs associated with inspection staff; laboratory analysis; and testing or inspection result analysis by the Engineer, Owner, or Owner's representative.

D. If there are difficulties in operation of the equipment due to the Integrator's fabrication additional service to correct the deficiencies shall be provided at no change in Contract Price or Contract Time to correct the problems and meet the acceptance testing requirements specified herein.

E. Inspection by the Owner's representative or failure to inspect shall not relieve the Supplier of responsibility to provide materials and perform the work in accordance with the contract documents.

F. The Owner and Engineer reserve the right to sample and test any materials after delivery and to reject all components represented by a sample that fails to comply with the specified requirements.

3.02 SHOP TEST - HYDRAULIC SYSTEM HYDROSTATIC TEST

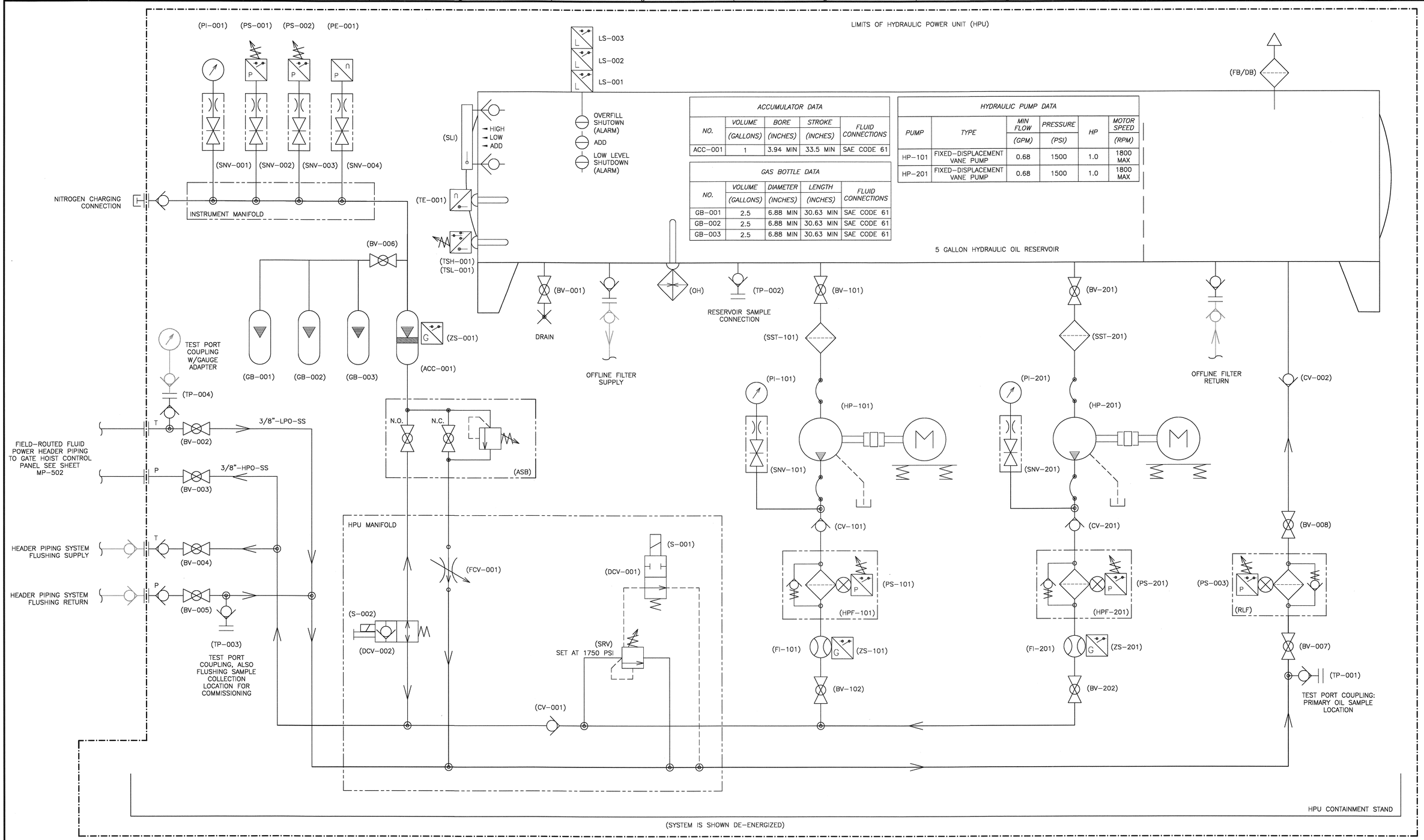
A. The hydraulic piping system shall be hydrostatically tested to not less than 150 percent of the design working pressure. Any equipment that may be damaged by this pressure shall be isolated or removed to prevent damage. The contractor is to provide all test equipment.

B. The hydrostatic test pressure shall be maintained for 15 minutes. All welded, flanged, flared, and threaded connections shall be carefully examined for leakage, and all lines shall be inspected for evidence of deflection caused by inadequate anchorage. No leakage or deflection shall be allowed.

3.03 FIELD TEST - TESTING PRIOR TO STARTUP

A. Test the functionality of hydraulically-operated equipment using the supplied controls to simulate the control descriptions herein. Temporary connections to the hydraulically-operated equipment shall be made with hose assemblies as specified in Section 40 05 30. Provide all oil, man power, temporary connections, and performance monitoring manpower.

END OF SECTION



ACCUMULATOR DATA

NO.	VOLUME (GALLONS)	BORE (INCHES)	STROKE (INCHES)	FLUID CONNECTIONS
ACC-001	1	3.94 MIN	33.5 MIN	SAE CODE 61

GAS BOTTLE DATA

NO.	VOLUME (GALLONS)	DIAMETER (INCHES)	LENGTH (INCHES)	FLUID CONNECTIONS
GB-001	2.5	6.88 MIN	30.63 MIN	SAE CODE 61
GB-002	2.5	6.88 MIN	30.63 MIN	SAE CODE 61
GB-003	2.5	6.88 MIN	30.63 MIN	SAE CODE 61

HYDRAULIC PUMP DATA

PUMP	TYPE	MIN FLOW (GPM)	PRESSURE (PSI)	HP	MOTOR SPEED (RPM)
HP-101	FIXED-DISPLACEMENT VANE PUMP	0.68	1500	1.0	1800 MAX
HP-201	FIXED-DISPLACEMENT VANE PUMP	0.68	1500	1.0	1800 MAX

REV. NO.	DATE	DRWN	CHKD	REMARKS
1	3/16	MDR	NJH	REISSUED SHEET – ADDENDUM #9

DESIGNED BY: E. GLOMSKI
DRAWN BY: Z. STEELE
SHEET CHK'D BY: N. HAMPTON
CROSS CHK'D BY: E. GLOMSKI
APPROVED BY: N. HAMPTON
DATE: JAN 2016

CDM Smith
75 State Street, Suite 701
Boston, MA 02109
Tel: (617) 452-6000

CITY OF CAMBRIDGE, MASSACHUSETTS
WALTER J. SULLIVAN
WATER PURIFICATION FACILITY

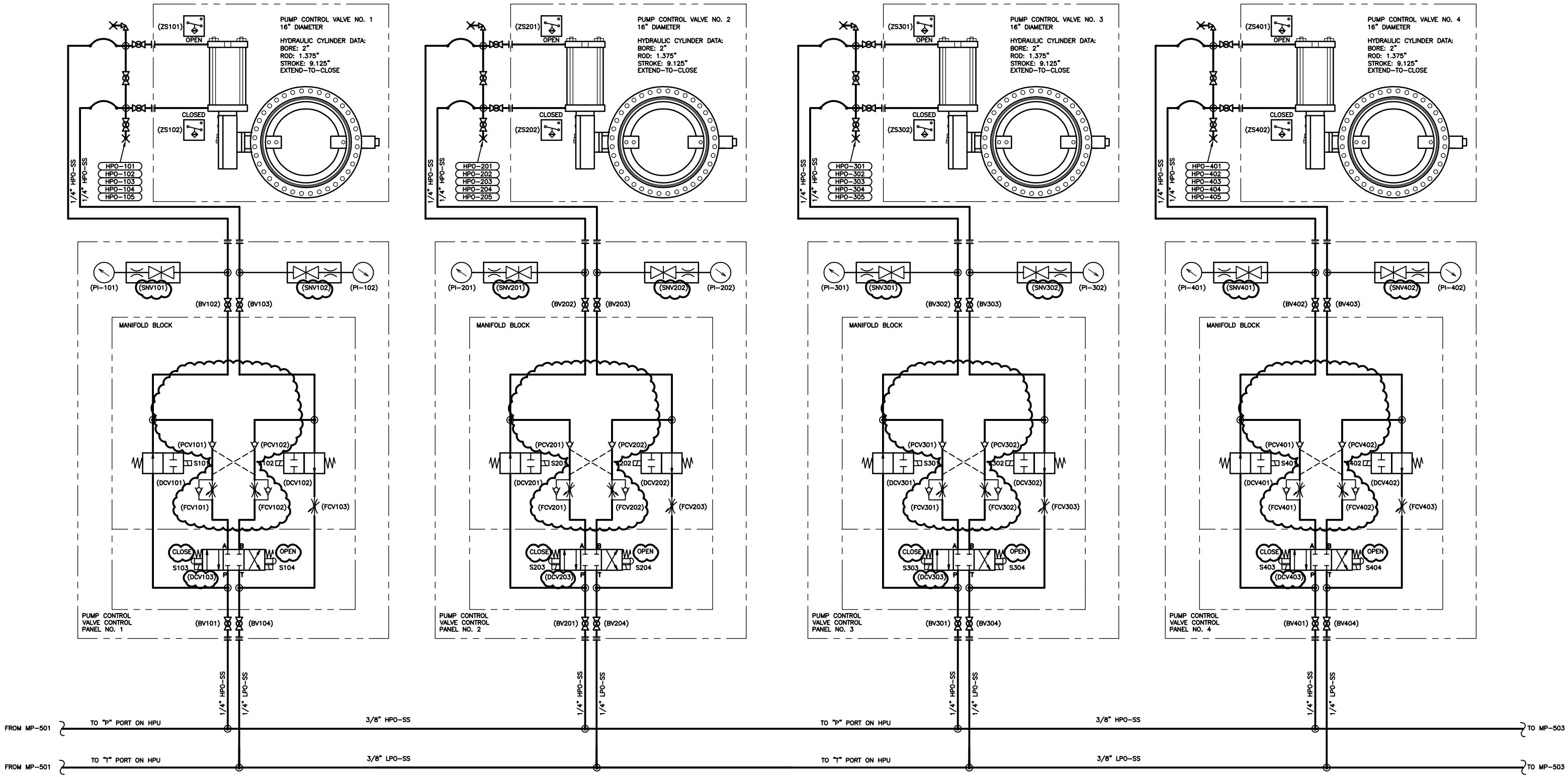
PUMPING SYSTEM IMPROVEMENTS

HYDRAULIC POWER UNIT SCHEMATIC

PROJECT NO. 0139-95558
FILE NAME: MP501SD.DWG

SHEET NO.
MP-501

COMMONWEALTH OF MASSACHUSETTS
NEILL J. HAMPTON
CIVIL
No. 43043
REGISTERED PROFESSIONAL ENGINEER
3-24-2016



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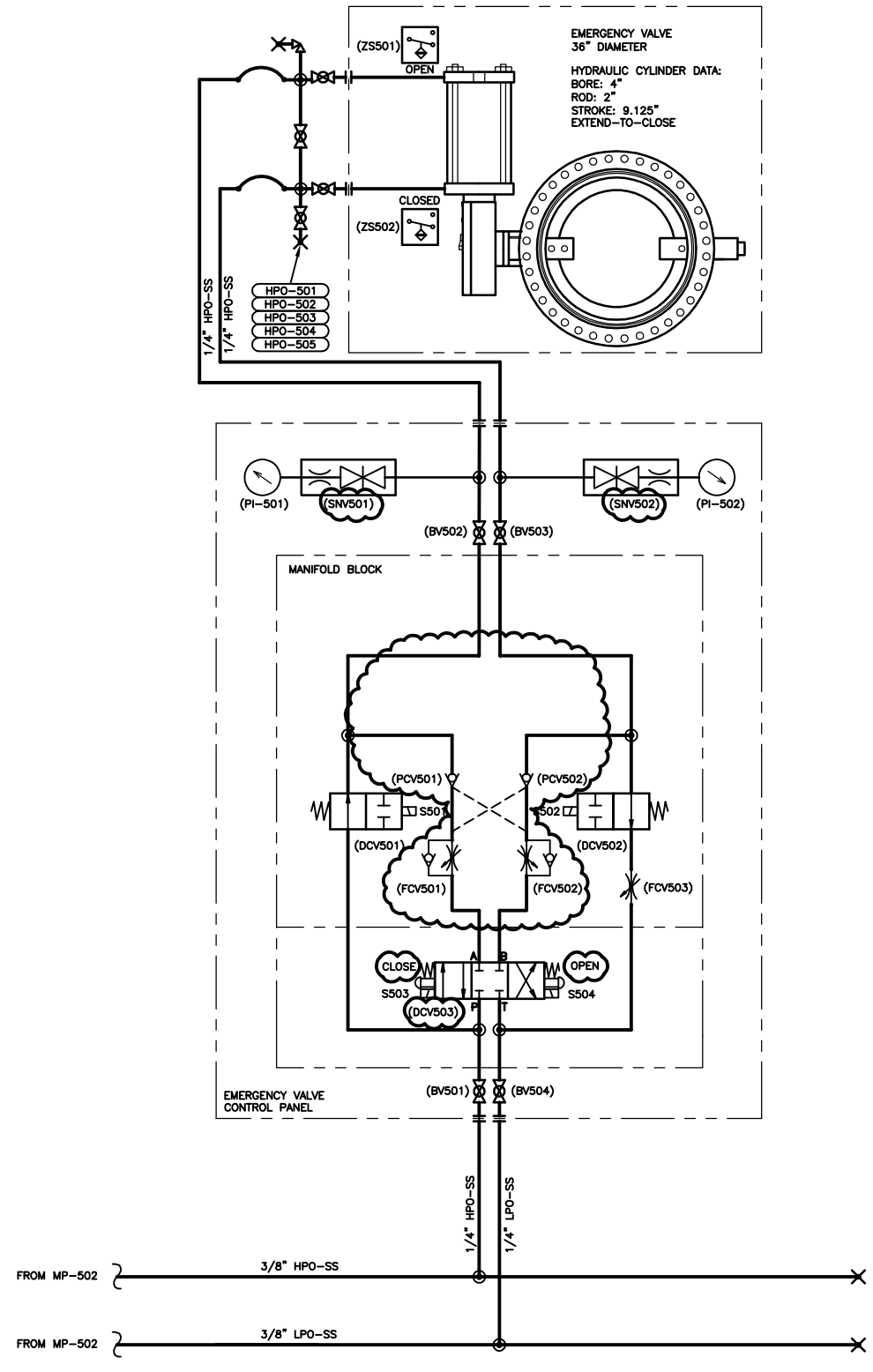
CITY OF CAMBRIDGE, MASSACHUSETTS
WALTER J. SULLIVAN
WATER PURIFICATION FACILITY
PUMPING SYSTEM IMPROVEMENTS

SK #10 - MODIFICATIONS TO SHEET MP-502

MARCH 2016



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PUMPING SYSTEM IMPROVEMENTS

SK #11 - MODIFICATIONS TO SHEET MP-503

MARCH 2016