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SPECIFICATION DIVISION 22

NUMBER SECTION DESCRIPTION

DIVISION 22 PLUMBING
SECTION 221123 - DOMESTIC-WATER PACKAGED BOOSTER PUMPS

END OF CONTENTS TABLE

SPECIFICATION SECTION ISSUED 7-16-12.

ADDED SECTION 2.7.B, INDICATING THAT ONE VFD PER PUMP IS TO BE PROVIDED. D. KARLE FOR MTT, NOV. 6, 2012.

2014-01-06: IMPROVED LEAD FREE REQUIRMENTS TO REFLECT U.S SAFE DRINKING WATER ACT REQUIREMENTS THAT WENT INTO EFFECT JAN. 4, 2014. D.KARLE FOR MTT.

DIVISION 22 PLUMBING
SECTION 221123 - DOMESTIC-WATER PACKAGED BOOSTER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

INCLUDE PARAGRAPH 1.1.A AND B IN EVERY SPECIFICATION SECTION. EDIT RELATED SECTIONS 1.1.B TO MAKE IT PROJECT SPECIFIC.

A. Drawings and general provisions of the Contract, Standard General and Supplementary General Conditions, Division 1 Specification Sections, and other applicable Specification Sections including the Related Sections listed below, apply to this Section.

SPEC EDITOR: IN ARTICLE BELOW, SELECT PROPER SPEC SECTION NUMBER BY PROJECT. DELETE SUSTAINABLE DESIGN / LEED IF NOT APPLICABLE TO PROJECT.

B. Related Sections:

1. Section 018113 - Sustainable Design Requirements
2. Section 019110/019100 - Commissioning
3. Section 221113- Piping Materials and Methods
4. Section 220523 - Valves
5. Section 220519 - Thermometers, Pressure Gauges, and Accessories
6. Section 220513 - Motors
7. Section 232123 - Pumps
8. Section 220548 – Vibration Control
9. Section 220719 – Mechanical Systems Insulation
10. Section 220514 - Variable Frequency Drives
11. Section 230900 – Mechanical Systems Controls
12. Division 26 – Electrical

1.2 SUMMARY

A. Packaged, skid mounted, domestic water booster pump system including pumps, starters or variable frequency drives (VFDs), controls, piping, valves, hydro-pneumatic tanks, and accessories.

1.3 SUBMITTALS

A. Product Data: Include catalog illustrations, model, rated capacities, performance, weights, dimensions, component sizes, rough-in requirements, piping and wiring diagrams and details, materials of construction, accessories, operating and maintenance clearance requirements. Wiring diagrams shall be project specific, and differentiate between factory wiring and field wiring. Include shop drawings and fabrication drawings for equipment indicating piping connections, power and utility requirements, rigging, installation and support details and instructions. Include written sequence of operations for all controls. Additionally include:

1. Overall dimensional drawing and weight of the pump package
2. Pump submittal including individual pump curves and composite curve for booster package

3. Starter submittal (non-VFD equipped packages)
4. For packages equipped with VFDs:
   a. VFD submittal
   b. Pressure sensor data including installation instructions and calibration procedures
5. Valve, pipe, pressure gauge, and motor submittals
6. Installation, operation, and maintenance manuals
7. Factory test reports
8. Hydro-Pneumatic Tanks:
   a. Tank volume and tank acceptance volume
   b. Bladder replacement instructions

1.4 QUALITY ASSURANCE

A. Manufacturers and Products: The products and manufacturers specified in this Section establish the standard of quality for the Work. Subject to compliance with all requirements, provide specified products from the manufacturers named in Part 2.

B. Reference Standards: Products in this section shall be built, tested, and installed in compliance with the specified quality assurance standards; latest editions, unless noted otherwise.

1. American Water Works Association
2. ANSI/HI 9.6.1-1998, NPSH Margin
3. ANSI/HI 9.6.3-1997 Operating Region
4. NEC-National Electrical Code
5. National Electrical Manufacturers Association
6. National Sanitation Foundation NSF/ANSI-61 (potable drinking water) and NSF-61 Annex G (listed as ≤ 0.25% weighted average lead content) (and/or NSF/ANSI-372) and Annex F.
7. U.S Safe Drinking Water Act.
8. Underwriters Laboratories Inc. listed as a manufacturer of packaged pumping systems under UL/CUL Category QCZJ.
9. Underwriters Laboratories Inc. listed as a manufacturer of control panels under UL/CUL 508a.

C. The pumping package shall be assembled by the acceptable manufacturers listed in Part 2. Manufacturers shall assume "Unit Responsibility" for the complete pumping package. Unit responsibility shall be defined as responsibility for interface and successful operation of all system components supplied by the pumping system manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Ship the pump package with entire skid in weather-proof wrap for storage outdoors. Protect control panels, pipe openings, and other sensitive components with heavy plastic or other durable means to ensure cleanliness and prevent damage during shipping and storage. Maintain protection during installation. Comply with protection requirements for variable frequency drives (VFD) described in Related Section.

1.6 WARRANTY

A. Provide a complete warranty for parts and labor for a minimum of one year from the date of Substantial Completion.

PART 2 - PRODUCTS

SPEC EDITOR: SCHEDULE THE PUMP SKID PERFORMANCE DATA ON THE DRAWINGS, INCLUDING QUANTITY OF PUMPS, VFD.S, AND REMOTE PRESSURE SENSORS. CONSIDER CONSTANT VOLUME STAGED PUMP CONTROL WHEN FRICTION LOSSES ARE LOW RELATIVE TO FIXED HEAD (STATIC HEAD AND RESIDUAL PRESSURE) REQUIREMENTS.

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable Manufacturers:

1. Armstrong
2. Bell & Gossett
3. Canariis
4. Grundfos
5. Paco

2.2 GENERAL

A. Provide, as indicated and scheduled on the drawings, a UL labeled domestic water booster pump packaged system consisting of pumps, motors, controls, suction and discharged piping, hydro-pneumatic tanks, and all required accessories, mounted on a unitized structural steel support frame (“skid”). Hydro-pneumatic tank(s) shall be provided mounted on the skid when indicated on the drawings.

B. Skid frame shall consist of welded A-36 structural steel support members designed to support all equipment, and rigid enough to withstand transportation to site, rigging, installation, and operation. Skid frame shall be suitable for floor mounting, and painted with two coat system consisting of oxide primer and alkyd enamel finish, minimum 3 mils dry film thickness. Provide holes in the base for the installation of anchor bolts and leveling of skid. Bolts to mount equipment components shall be stainless steel or zinc plated and shall meet ASTM Grade A193 B7.

C. Pumps, valves and all wetted components shall be manufactured in compliance with NSF/ANSI-61 and NSF-61 Annex G.

D. All elastomeric seals utilized in the skid including pump seals shall be immune from chloramine degradation.

E. All components provided on the skid shall comply with Related Sections.

F. Packaged system shall be rated for 300 PSIG working pressure at 250°F, or the system’s maximum operating pressure and temperature at point where installed, whichever is greater, with a 3 to 1 pressure safety factor.

G. Piping shall be in compliance with Related Section, either type L copper or (minimum) Schedule 10 type 304 stainless steel. Dissimilar metal piping shall not be used, ancillary piping including that associated with sensors shall be the same material as the suction and discharge manifolds. Provide welded or brazed flange connections at pumps, butterfly valves, and at suction and discharge connections (both ends of each manifold) to skid piping. Piping shall be sized to provide a maximum fluid velocity of 10 ft./sec. at the scheduled design flow rate. Header piping shall be easily removable to facilitate moving package through doorways.

H. Provide isolation valves in compliance with Related Section. Valves 2-1/2″ and larger shall be butterfly valves. Valves less than 2-1/2″ shall be full-port ball valves. Provide isolation valves on the suction and discharge of each pump, and for each pressure gauge.

I. Provide pressure gauges per related section, located on the suction and discharge of each pump.

J. Provide a self-contained high temperature relief valve on the discharge of each pump, located between the pump and the downstream pump isolation valve. Factory set as required for project conditions.

K. Provide a low point drain consisting of a ball valve and hose thread connection, in the suction and discharge header.

SPEC EDITOR: FOR VFD CONTROLLED PUMPS WHEN THE VFD IS EQUIPPED WITH A BYPASS, SPECIFY THE APPROPRIATE RELIEF VALVE PRESSURE SETTING IN THE PARAGRAPH BELOW. DRIVE BYPASSES ARE TYPICALLY NOT RECOMMENDED ON DOMESTIC BOOSTER PUMP APPLICATIONS.

L. For VFD controlled pumps when the VFD is equipped with a bypass: Provide a pressure relief valve between the pump discharge and the pump downstream isolation valve, factory set at 125 PSIG.

M. All control and power wiring shall be factory prewired on the skid. All exposed wiring shall be installed to minimize potential damage, and all power wiring, 110V and higher, shall be in a NEC compliant conduit system.

N. Starters and variable frequency drives shall be mounted on the skid and configured to provide electrical clearances in compliance with the NEC. Examine installation area of skid and also adjust mounting locations in consideration of structures adjacent to the skid to provide NEC electrical clearances.

2.3 PUMPS

A. Provide pumps of capacity and performance scheduled.

SPEC EDITOR: SELECT CLOSED COUPLE PUMP SPEC OR MULTISTAGE PUMP SPEC, BELOW, OR EDIT TO SPECIFY THE PUMP TYPE REQUIRED FOR YOUR PROJECT.

B. Provide close coupled end suction pumps per Related Section with the following additional features:

1. Lead free per NSF/ANSI-61 and NSF-61 Annex G.

2. Casing Construction: Bronze or stainless steel.
3. Impeller Construction: Bronze or stainless steel.
4. Replaceable casing wear rings.
5. Stainless steel shaft with replaceable bronze or stainless steel shaft sleeve completely covering the wetted area of the shaft under the seal.
6. Seals: Mechanical seals consisting of carbon rotating ring, stainless steel spring, ceramic seat, and flexible bellows and gasket.
7. Pump motors shall be secured to mounting frame, not supported by the volute alone.
8. Back pull-out design allowing servicing of pump internals without disturbing piping.

C. Provide multistage vertical mounted pumps.

1. Lead free per NSF/ANSI-61 and NSF-61 Annex G.
2. Casing Construction: Bronze or stainless steel.
3. Impeller Construction: Bronze or stainless steel.
4. Stainless steel shaft with replaceable bronze or stainless steel shaft sleeve completely covering the wetted area of the shaft under the seal.
5. Mechanical seal shall be silicon carbide/carbon with Viton or peroxide cured EPDM elastomers.
6. Pump motor coupler design shall allow seal replacement without having to remove motor.

SPEC EDITOR: TO REDUCE SPEC SIZE IT IS RECOMMENDED THAT THE CHECK VALVE TYPE (BELOW) NOT APPLICABLE TO THE PROJECT BE DELETED.

2.4 PUMP CHECK VALVES

A. For constant volume pump packages provide in-line combination pressure reducing/regulating/check valve as manufactured by Cla-Val Company.

1. Pilot operated, adjustable, spring-loaded, normally open diaphragm type valve.
2. Valve shall be sized for a maximum pressure drop of 10 PSIG at the scheduled flow rate for its respective pump.
3. Designed to permit flow when controlled pressure is less than the spring setting.
4. Suitable for working pressures up to 150 psig at 180°F.
5. Certified for potable water service and lead free, per NSF/ANSI-61 and NSF-61 Annex G. (Use of a fusion bonded epoxy barrier coating is permitted to provide conformance to NSF ANSI-61/NSF-61 Annex G.)
6. Flanged in accordance with ANSI B16.1, Class 125.
7. Valve body equal to nominal pipe diameter at all points through the valve(full port design).
8. Valve body and cover shall be constructed of ASTM A536 ductile iron.
9. Hydrostatically tested and seat tested to demonstrate zero leakage.
10. Locate check valves between the pump discharge and the pump downstream isolation valve.

B. For variable speed pump packages provide non-slam resiliently hinged type check valves, “SWING-FLEX” as manufactured by Val Matic Valve and Manufacturing Corporation.

1. Suitable for working pressures up to 150 psig at 180°F.
2. Full body type, with one moving part, the resiliently hinged disc.
3. Bolted dome shaped access cover allowing replacement of resiliently hinged disk without removing valve from line.
4. Certified for potable water service and lead free, per NSF/ANSI-61 and NSF-61 Annex G.
5. Exterior and interior of the valve coated with an NSF/ANSI 61 approved fusion bonded epoxy coating.
6. American Water Works Association Standard ANSI/AWWA C508 compliant.
7. Flanged in accordance with ANSI B16.1, Class 125.
8. Valve body equal to nominal pipe diameter at all points through the valve. The 4 in. valve shall be capable of passing a minimum 3 in. sphere.
9. Hinged disk: One-piece construction, molded with integral o-ring type sealing surface, with alloy steel and nylon reinforcement in the flexible hinge area. Provide disc material compatible with domestic water service, unaffected by chloramines. Flex portion of disc shall be warranted for twenty-five years. The valve disc design shall have been cycle tested 1,000,000 times in accordance with ANSI/AWWA C508 and show no signs of wear, cracking, or distortion to the valve disc or seat and shall remain drip tight at all pressures.
10. Disk seating surface on a 45 degree angle to minimize disc travel. 35 degree maximum disc stroke and memory disc return action to provide a cracking pressure of 0.25 psig.
11. Valve body and cover shall be constructed of ASTM A536 ductile iron.
12. Hydrostatically tested and seat tested to demonstrate zero leakage.
13. Locate check valves between the pump discharge and the pump downstream isolation valve.

SPEC EDITOR: HYDRO-PNEUMATIC TANKS ARE RECOMMENDED FOR BOTH CONSTANT AND VARIABLE SPEED APPLICATIONS TO ALLOW NO-FLOW PUMP SHUT DOWN AND TO IMPROVE PRESSURE CONTROL. THE SPECIFICATION BELOW IS FOR LARGER STYLE TANKS WITH TANK VOLUMES OF APROX.50 GALLONS AND LARGER. SMALLER TANKS ARE TYPICALLY NOT AVAILABLE WITH THE REPLACEABLE BLADDER SPECIFIED BELOW. DESIGNER MUST PROVIDE TANK DIMENSIONS, VOLUME, ACCEPTANCE VOLUME, PRESSURE/TEMPERATURE RATING, AND PRECHARGE PRESSURE (PROJECT SPECIFIC, FIELD SET) ON THE DRAWINGS. FOR VERY LARGE TANKS IT IS RECOMMENDED THAT THE DESIGNER SPECIFY A “FULL ACCEPTANCE VOLUME” TANK (WHERE ACCEPTANCE VOLUME EQUALS TANK VOLUME), WHICH AVOIDS BLADDER DAMAGE IF THE AIR CHARGE IS LOST. IF TANK IS TO BE MOUNTED ON THE PUMP SKID, INDICATE SUCH ON THE DRAWING.

2.5 HYDRO PNEUMATIC TANKS

A. Acceptable Manufacturers:

1. Amtrol
2. Armstrong
3. Wessels

B. ASME rated, precharged, vertical style bladder tank with bottom system (water) connection.

1. NSF/ANSI-61 and NSF-61 Annex G listed for drinking water use.
2. Replaceable (non-EPDM) butyl bladder, minimum 0.10 inch thick.
3. Large flanged bladder service openings to allow bladder to be replaced without tipping tank on its side.
4. Steel shell with red oxide exterior primer. FDA approved liner of polypropylene or epoxy.
5. Rated for system pressure and temperature, but not less than 125 PSIG at 200F.
6. Provide the following additional features: Tire valve style charging connection to permit on-site charging. Bronze or malleable iron water connection. Auxiliary gauge/pressure switch connection. Lift ring(s). Steel floor support skirt.

SPEC EDITOR: SELECT EITHER CONSTANT VOLUME OR VARIABLE VOLUME PUMP CONTROL BY DELETING ONE OF THE TWO BELOW ARTICLES.

2.6 STARTER AND CONTROLS - CONSTANT VOLUME PUMP PACKAGES

A. Provide UL listed and labeled controller/starter assembly specifically designed for constant speed domestic water pumping applications.

B. Pump staging shall be user-selectable based on kilowatts (kW), current (amps), or pressure (PSI).

1. kW shall be true power derived from a transducer. Amps shall be RMS obtained from the kW transducer. kW and amps shall be controller calibrated with calibration held in non-volatile memory. PSI shall be derived from a pressure transducer with a 4-20 mA analog output.

C. The controller shall operate the pump(s) to provide the following sequence of operation:

1. Pump(s) shall be staged based on DESIGNER SELECT ONE: kilowatts/current/pressure.
2. In the "AUTO" mode, the lead pump shall start upon initiation of the system either by activation of the "START" button or by digital input from the Owner’s Building Automation System (BAS).
3. The lead pump shall operate at the point on its curve where system demand is satisfied. If the lead pump is unable to satisfy demand, lag pumps shall be sequentially started as required to meet system demand.
4. As demand decreases, the lag pumps shall be de-staged to minimize energy consumption.
5. The system shall continue to operate, subject to the controller safety features and alarms, or a low/zero flow condition.

a. The controller shall detect low/zero flow conditions. When the (user adjustable) low/zero flow condition limit is reached, the controller shall shut off the pump(s) and allow system demand to be provided by the hydro-pneumatic tank. The controller shall automatically restart the pumps as hydro pneumatic tank storage is depleted (user adjustable), to maintain the required system pressure/flow.

6. In the event of a failure due to motor overload, the next pump in sequence shall be started.
7. In the event of any safety/alarm condition, controller shall activate a common alarm contact hardwired back to the Owner's BAS system.
8. The controller shall equalize pump run-times.
9. In "MANUAL" mode, it shall be possible to manually turn individual pumps on and off. When a pump is started manually, controller safety and alarm features shall continue to operate including pump cut-out.

D. The controller shall provide the following safety features and alarms:

1. Low suction pressure alarm and cut out(automatic reset)
2. High suction pressure alarm and cut out(automatic reset) (suction pressure is sufficient to satisfy building demand)
3. Low system pressure alarm
4. High system pressure alarm and cut out (manual reset)
5. Pump failure alarm
6. High temperature alarm and cut out (automatic reset)
7. Motor overload failure alarm (manual reset)

E. The control enclosure shall conform to NEMA 1 and shall include motor starters, overloads, control power transformer and a digital microprocessor based controller with a NEMA 4 rated operator interface. Provide a single point electrical power connection that provides power to all controls.

F. Controller shall be capable of operation in ambient conditions of 32°F to 140°F and a humidity range of 5% to 95%, non-condensing.

G. The controller will include the following features:

1. Liquid crystal display user interface.
2. Pump status indication.
3. Alarms shall be displayed in plain English on the display.
4. Fault information accessed by interrogating the controller through its HELP and log keys.
5. Minimum one level of software password security provided for protection of field modifiable data.
6. Data logging to provide historical information of key events with date and time stamps. Log information shall include alarms, pump run timers, system on-off times and pump cycle counters. The data log shall display the minimum, maximum and average values of temperature, pressure and flow. It shall also display kilowatt-hours.
7. Capable of operating in automatic, manual or off-line diagnostic modes.
8. A common alarm contact for hardwiring back to Owner's BAS system, which will activate when any alarm condition occurs.

H. The controller shall be microcomputer based and hold its software in non-volatile memory. On-line field modified data entries, such as stage point, or method of staging, shall be stored in flash memory with capability to prevent accidental loss of data due to power loss, voltage surge or spike. In the event of a complete power outage, all field and factory settings shall remain stored and shall automatically be restored when power is restored.

I. The controller shall be powered by 115V/1ph/60Hz AC power from a control power transformer provided within the control enclosure. The control panel shall be equipped with a regulated 24VDC power supply to power analog input signals. The controller shall be capable of receiving up to four 4-20 mA analog input signals and RTD signals.

J. All external sensors/transmitters and switches shall be powered by the controller through its integral 24VDC power supply. Over voltage and short circuit protection shall be on-board. All analog circuits shall be protected from up to 575V with a fast-acting fuse and sacrificial input resistors. All digital outputs shall be externally isolated. The incoming power and I/O circuitry shall reject electromagnetic (EMI) and radio frequency interference.

2.7 VARIABLE FREQUENCY DRIVE (VFD) AND CONTROLS- VARIABLE VOLUME PUMP PACKAGES

A. Provide UL listed and labeled variable speed drive(s) and controller assembly specifically designed for variable speed domestic water pumping applications. The controller shall provide multi-pump parallel operation control, duty-standby pump selection, automatic alternation and automatic transfer to the standby pump upon pump/VFD failure.

B. Unless noted otherwise, provide a separate variable frequency drive for each pump.

C. The controller shall operate the pump(s) to provide the following sequence of operation:

1. When the controller mode is in REMOTE, the pumping system shall start and operate automatically upon the closure of Owner’s BAS contact.
2. When the controller mode is in LOCAL, the pumping system shall start immediately and operate automatically.
3. It shall be possible to manually turn individual pumps on and off. When a pump is started manually, controller safety and alarm features shall continue to operate including pump cut-out.

SPEC EDITOR: INDICATE QUALITY AND LOCATION OF REMOTE PRESSURE SENSORS ON THE DRAWINGS. PRESSURE SENSORS LOCATED AT THE PUMP SKID DEFEAT THE PRIMARY ADVANTAGE OF VFD PUMPING SYSTEMS AND ARE NOT RECOMMENDED.

4. The controller shall control pump speed based on remote mounted pressure transmitter(s), quantity as indicated on drawings.

5. The pump logic controller shall compare each remote pressure transmitter signal (“process variable”)to the user adjustable set point. It shall be possible to set an individual setpoint for each process variable location.
6. When the process variable set points at all locations are satisfied the pump speed shall remain constant at the optimum energy consumption level.
7. The controller shall continuously scan and compare each process variable to its individual set point and control to the least satisfied zone.
8. If the set point cannot be satisfied by the designated lead pump, the controller shall initiate a timed sequence of events to stage on a lag pump.
9. The lag pump shall accelerate resulting in the lead pump(s) decelerating until they equalize in speed.
10. Further changes in process variable shall cause the pumps to change speed together.
11. As the worst case zone deviates from set point, the controller shall send the appropriate analog signal to the VFD to speed up or slow down the pump(s).
12. When the set point can be safely satisfied with fewer pumps, the controller shall initiate a timed pump de-stage sequence and continue variable speed operation.
13. The controller shall provide end-of-pump-curve point protection.
14. In the event of any safety/alarm condition, controller shall activate a common alarm contact hardwired back to the Owner’s BAS system.
15. The system shall continue to operate, subject to the controller safety features and alarms, or a low/zero flow condition.
    a. The controller shall detect low/zero flow conditions. When the (user adjustable) low/zero flow condition limit is reached, the controller shall shut off the pump(s) and allow system demand to be provided by the hydro pneumatic tank. The controller shall automatically restart the pumps as hydro pneumatic tank storage is depleted (user adjustable), to maintain the required system pressure/flow.
16. In the event of a VFD fault, the controller shall automatically initiate a timed sequence of events to start the redundant pump/VFD set in the variable speed mode.
17. In the event of the failure of a sensor/transmitter, its process variable signal shall be removed from the controllers scan/compare program and a plain English alarm message shall be displayed.
18. In the event of failure to receive a pressure variable signal, a user selectable number of the VFDs shall maintain a user adjustable speed; reset shall be automatic upon correction of the sensor failure.
19. The controller shall equalize pump run-times.

D. The controller shall provide the following safety features and alarms:

1. Low suction pressure alarm and cut out(automatic reset)
2. High suction pressure alarm and cut out(automatic reset). (suction pressure is sufficient to satisfy building demand

3. Low system pressure alarm
4. High system pressure alarm and cut out (manual reset)
5. Pump failure alarm
6. High temperature alarm and cut out (automatic reset)
7. Motor overload failure alarm (manual reset)

E. The control enclosure shall conform to NEMA 1 and shall include a control power transformer and a digital microprocessor based controller with a NEMA 4 rated operator interface. Provide a single point electrical power connection that provides power to all controls.

F. Controller shall be capable of operation in ambient conditions of 32°F to 140°F and a humidity range of 5% to 95%, non-condensing.

G. The controller will include the following additional features:

1. Liquid crystal display user interface.
2. Pump status indication.
3. Alarms shall be displayed in plain English on the display.
4. Fault information accessed by interrogating the controller through its HELP and log keys.
5. Minimum one level of software password security provided for protection of field modifiable data.
6. Hydraulic stabilization program with proportional-integral-derivative control, providing smooth pump start-up, speed control, and pump stage and de-stage; and shall prevent damaging hydraulic conditions including motor overload, pump flow surges, and hunting. PID values shall be field adjustable.
7. Display readout shall display the following values at minimum:
   a. Pressures at each remote pressure sensor (PSIG)
   b. Skid discharge pressure (PSIG)
   c. Skid total flow (GPM)
8. Data logging to provide historical information of key events with date and time stamps. Log information shall include alarms, pump run timers, system on-off times and pump cycle counters. The data log shall display the minimum, maximum and average values of temperature, pressure and flow. It shall also display kilowatt-hours.
9. Capable of operating in automatic, manual or off-line diagnostic modes.
10. A common alarm contact for hardwiring back to Owner’s BAS system, which will activate when any alarm condition occurs.
11. Shall meet Part 15 of FCC regulations pertaining to class A computing devices.
12. Upon VFD fault(s), the pump controller shall display an alarm condition through a plain English message.
    a. VFD fault indication shall be continuously displayed on the operator interface of the controller until the fault has been corrected and the controller has been manually reset.

13. Analog input resolution from flow meters and pressure sensors shall be 12-bit minimum, and the controller shall scan each analog input a minimum of once every 100 milliseconds. All sensor/transmitter inputs shall be individually wired to the pump logic controller for continuous scan and comparison function. All analog inputs shall be provided with current limit circuitry to provide short circuit protection and safeguard against incorrect wiring of sensors
14. The controller shall be microcomputer based and hold its software in non-volatile memory. On-line field modified data entries, such as stage point, or method of staging, shall be stored in flash memory with capability to prevent accidental loss of data due to power loss, voltage surge or spike. In the event of a complete power outage, all field and factory settings shall remain stored and shall automatically be restored when power is restored.
15. The controller shall be powered by 115V/1ph/60Hz AC power from a control power transformer provided within the control enclosure. The control panel shall be equipped with a regulated 24VDC power supply to power analog input signals. The controller shall be capable of receiving up to four 4-20 mA analog input signals and RTD signals.
16. All external sensors/transmitters and switches shall be powered by the controller through its integral 24VDC power supply. Over voltage and short circuit protection shall be on-board. All analog circuits shall be protected from up to 575V with a fast-acting fuse and sacrificial input resistors. All digital outputs shall be externally isolated. The incoming power and I/O circuitry shall reject electromagnetic (EMI) and radio frequency interference (RFI)

H. Variable Speed Drive

1. Provide variable speed drives per Related Section. The following features described in the Related Section are not required, except as necessary to meet other parts of this specification.
    a. VFD manual across-the-line electrical bypass.
    b. Local-Remote speed control switch
    c. A run permissive circuit, separate from the safety interlock circuit, which prevents motor operation whether in drive or bypass mode. This circuit, via the customer's external contact device, signals the motor may run, provided the safety interlock contact(s) is made.
    d. “Powered run mode” and “powered run request” circuits.
    e. PID controller integral to VFD.
    f. Auxiliary contacts that actuate when the motor is started in any mode.
    g. Indicating lamp for "POWER AVAILABLE" and for "MOTOR ON BYPASS".

I. Pressure Transmitters

1. Two wire 24 VDC system providing 4-20mA output signal to pump controller. Waterproof NEMA 4 electrical enclosure with a 0.5" NPT conduit connection. 316 stainless steel wetted parts. Adjustable span. Maximum inaccuracy 0.5% of full span including linearity, hysteresis and repeatability errors. Range 0-50 PSIG. Provide higher range transmitters when required by system design or configuration. Capable of withstanding over pressurization of no less than 300 PSIG. Immune from radio frequency interference.

SPEC EDITOR: THE ARTICLE HEADING BELOW (IN HIDDEN TEXT) IS RESERVED FOR SPECIFYING A FLOW METER IF DESIRED. A FLOW METER IS NOT REQUIRED FOR PUMP CONTROL BUT COULD ASSIST IN TROUBLE SHOOTING. FOR VERY LARGE BOOSTER PUMP INSTALLATIONS A MAGNETIC FLOW METER SHOULD BE CONSIDERED DUE TO DURABILITY, ACCURACY, AND HIGH TURN-DOWN. A MAGNETIC FLOW METER CAN EASILY BE SPECIFIED BY REVISING THIS SECTION TO REFERENCE THE MAGNETIC FLOW METER SPECIFICATION FOUND IN SECTION 230900 – MECHANICAL SYSTEMS CONTROLS.

J. Flow Meter

2.8 FACTORY TESTING

A. Prior to shipment, hydrostatically and electrically test each unit, including all safeties and control functions. Test system with motors connected to starters or VFD output. Operate skid from 0 to 100% of design flow requirement and validate proper pump staging and speed control. Calibrate and test all safety features. Test all inputs, outputs and program execution specific to this application.

B. The Owner’s Representative shall be allowed to witness the factory testing. A report detailing the results of the factory test shall be provided. An officer of the manufacturer’s company shall certify by signature that the report accurately reflects the test results, and that the package meets all performance requirements. The report shall clearly identify any performance requirements that were not achieved.

PART 3 - EXECUTION

SPEC EDITOR: WHEN REMOTE SENSORS ARE USED, COORDINATE DOCUMENTS TO PROVIDE SENSOR LOCATION AND CONDUIT/WIRING FROM SENSOR TO PUMP CONTROLLER. DESIGNER MUST SHOW SENSOR LOCATIONS ON PLANS.

3.1 EXAMINATION AND PREPARATION

A. Rig units off delivery trucks. Comply with Manufacturer's rigging instructions.

B. Store units protected from weather, dirt, water, construction debris, and physical damage. Support stored units at points as required by manufacturer.

C. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting equipment performance, maintenance, and operations. Assure that required NEC electrical clearances will be available at skid mounted components such as VFDs, starters, control panels, and similar electrical equipment. Existing and new piping cannot run over skid control panels or skid VFDs. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install in strict compliance with manufacturer's installation instructions and Related Sections. Maintain manufacturer's recommended clearances for service and maintenance.

B. Install skid and hydro-pneumatic tanks on support structures or concrete bases as indicated. Install skid vibration isolation when indicated or required by Related Section. Set skid base level, using stainless steel shims and metal blocks designed for leveling machinery bases. Anchor base to floor using all mounting holes.

C. Install separate devices furnished by skid manufacturer and not factory installed, including but not limited to pressure transmitters and flow meters. Install such devices in compliance with Related Sections.

D. Connect suction and discharge headers to building piping using flexible piping connectors per Related Section, whether indicated or not. Cap unused ends of skid manifolds.

E. Install flow meters and pressure transmitters when included or required. Final termination of devices (both ends) shall be accomplished by the factory service technician.

1. Install flow meters per flow meter manufacturer's recommendations and with the recommended up and downstream straight lengths of pipe. Install piping as required to provide these straight lengths. When manufacturer does not indicate the required up and downstream requirements, provide a minimum of 5 pipe diameters upstream and downstream of straight pipe. Provide wiring in conduit between the flow meter and the skid controller.
2. Install pressure transmitters at locations specified on the drawings.
    a. Install pressure transmitters in locations easily accessible for calibration and replacement.
    b. Install ball type isolation valve to isolate the pressure transmitter.
    c. Provide a pressure gauge at the same location as each pressure transmitter, to validate pressure transmitter reading.
    d. Provide wiring in conduit between the pressure transmitter and the skid controller.
3. Install wiring in conformance with Related Section (Mechanical Systems Controls), utilizing approved contractors listed in that section.

F. Install hydro pneumatic tanks as indicated on the drawings.

1. Install to maintain manufactures specified clearance above tanks, minimum 18 inches.
2. Connect to system piping. Provide separate isolation valve and drain valve with hose bib for each hydro-pneumatic tank.
3. Install pressure gauge (or switch when indicated) on hydro-pneumatic tank auxiliary air connection.
4. Isolate each tank from the system, drain the tank, then charge to specified precharge pressure. If precharge pressure is not indicated, obtain from project engineer. Factory precharge is not to be considered the correct precharge pressure. Commissioner shall witness the setting of precharge pressure.

G. Complete all manufacturer’s pre-start checks.

H. Prior to placing system into operation, sanitize skid piping, hydro-pneumatic tanks, and any building piping not previously sanitized. Assure sanitizing solution enters each hydro-pneumatic tank. Provide temporary piping and bypasses as required to accomplish sanitization.

I. Insulate skid piping and hydro-pneumatic tanks; materials and installation per Related Section.

3.3 TEMPORARY SERVICE

A. Start units for temporary use only with the express written permission of the Project Manager and in compliance with all requirements of the Contract Documents.

B. Prior to placement into temporary service perform manufacturer's pre-start protocols.

C. Utilize factory trained service technician to perform start-up as described under the Field Quality Control article. Commission prior to putting into temporary service to the extent required by the Commissioning Authority. Re-perform factory service technician start-up and all commissioning activities prior to Owner acceptance, even if previously completed to ready for temporary service.

D. Perform all required routine maintenance procedures during temporary service. Continuously maintain a log of such procedures. Store log at unit during temporary use period and include log as part of the final O & M manual.

3.4 FIELD QUALITY CONTROL

A. Provide a factory trained service technician to perform start-up services. The service technician shall perform the following:

1. Verify correct installation and organize, instruct and assist the mechanical contractor's personnel in start-up procedures
2. Terminate all control wiring connections associated with the skid.
3. Perform manufacturer’s pre-start checks.
4. Set all safety devices.
5. Start skid controller and VFDs. Set all controller and VFD parameters. Tune the controller.

6. Commission the pump package, including demonstrating all safeties, proper pump staging, de-staging, and speed control, zero-flow shutdown, restart after power failure, and all other skid features.
    a. Optimize the setpoint of each pressure transmitter control variable to the minimum pressure (with reasonable safety factor) required for the plumbing fixtures actually installed. Obtain preliminary setpoints in advance from project engineer. Adjust setpoints under the direction of the Commissioning Authority.
    b. On constant volume pump packages, adjust pump pressure regulating valves to provide adequate pressure at the most remote plumbing fixture (with reasonable safety factor). Set controller to specified staging method (kW/amps/pressure); reset to another staging method and adjust controller parameters as required to provide proper performance.
7. Provide a written service report prepared on site and submitted at the time of each service visit (with copies immediately provided to the Owner and Commissioner). Report shall indicate services provided and list all controller settings, PID settings, and set points.
8. Train Owner personnel. Training and start up services are separate functions and training shall not be combined with startup services.

3.5 COMMISSIONING

A. Perform commissioning activities per Related Sections.

3.6 TRAINING

A. Provide a qualified service technician from the Manufacturer's staff to provide training.

B. Train Owner's maintenance personnel on equipment operation, start-up and shutdown, trouble-shooting, servicing and preventative maintenance procedures. Review the data contained in the Operating and Maintenance Manuals with Owner's personnel.

    1. Provide 2 hours training minimum.

END OF SECTION 221123