SECTION 22 11 24
DOMESTIC-WATER PACKAGED BOOSTER PUMPS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. Section Includes:

1. Duplex, variable-speed domestic-water pressure booster pump assembly. Furnish and install a factory packaged and tested, variable-speed domestic water pressure boosting system including pumps, motors, controls, valves, interconnecting piping, wiring and accessories for a complete, NSF 61 and NSF 372 Certified system with UL508A Industrial Control Panel and UL QCZJ 3rd Party Package Label affixed.

1.3 DEFINITIONS

A. VFC: Variable-frequency controller(s).

B. VFD; Variable-frequency drive.

1.4 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. Underwriters Laboratories Listings 508A Industrial Control Panels and QCZJ Packaged Pumping Systems (UL)
2. 2015 Edition of the International Plumbing Code (IPC)
3. 2017 Edition of the National Electric Code, Section 409.110 (NEC)
4. National Electrical Manufacturers Association (NEMA)
5. ANSI/NSF Standard 61-2018 - Drinking Water System Components - Health Effects
6. ANSI/NSF Standard 372-2016 - Lead Free Plumbing Products

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, and dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, furnished specialties, accessories, BAS connectivity and service connections as required.

B. Shop Drawings: For booster pumps. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.
3. Manufacturer's Installation Instruction: Indicate support details, connection requirements, and include start-up instructions for pump system.
4. Field Reports: Submit verification statement, signed by system manufacturer representative, of start-up, adjustment service and acceptance of installation. Indicate summary of field performance test, system pipe flushing and field acceptance tests performed.

1.6 INFORMATIONAL SUBMITTALS

A. Certificates: For booster pumps, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For booster pumps to include in emergency, operation, and maintenance manuals.

1. Operation Data: Include manufacturer’s instructions, start-up data, and troubleshooting check lists for pumps, drivers, and controllers.
2. Maintenance Data: Include manufacturer’s literature, cleaning procedures, replacement parts lists, and repair data for pumps, drivers and controllers, preventive maintenance schedule, preventive maintenance recommendations and procedures. Identify place of purchase, location and contact numbers of service depot and technical support for each product installed.

1.8 QUALITY ASSURANCE

A. All equipment under this section shall be furnished completely assembled and pre-tested at simulated project site conditions in a laboratory, by a single supplier and shall be products that the manufacturer regularly engages in the production of. The supplier shall have sole responsibility for proper functioning of the system and equipment supplied. Copies of simulated factory tests must be available at the request of the Client Agency or engineer.

B. Manufacturer's Qualifications: Company specializing in manufacturing the products specified in this Section with a minimum five years documented experience. The packaged system manufacturer shall have local service available provided by a trained factory authorized representative.

C. Assembly Qualifications: All disconnects, transformers, and control devices shall be installed to provide minimum wire bending clearances per N.E.C. All power wiring shall be a minimum THHN, stranded copper conductor with 90° C. insulation. Conductors shall be numbered and identified at all termination points. All wiring shall be installed in nylon wire ways and laced with nylon tie straps. All disconnects, transformers, controllers, control devices, selector switches, and indicator lights shall be provided with nameplates indicating their respective function and/or identification. A factory wiring schematic shall be provided inside the controller by the manufacturer. The entire assembly shall be wired and tested in accordance with the National Electrical Code (N.E.C. 2017, Section 409.110). All components shall be built to National Electrical Manufacturers Association (NEMA) standards and be Underwriters Laboratory (UL) 508A Industrial Control Panels. The entire package pumping system shall comply with Federal Regulations 29 CFR 1910.399 and certified through UL under category ULQCZJ or other accepted 3rd Party Compliance Laboratory.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. ASME Compliance: Comply with ASME B31.9 for piping.

F. UL Compliance for Packaged Pumping Systems:

1. UL 508, "Industrial Control Equipment."
2. UL 508A, "Industrial Control Panels."
3. UL 778, "Motor-Operated Water Pumps."

G. Certification shall be obtained by the manufacturer indicating that the function and performance characteristics of all products and materials have been determined by testing and ongoing surveillance by an approved third-party certification agency. Assertion of certification shall be in the form of identification in accordance with the requirements of the third-party certification agency and provided with submittal documentation to the engineer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Accept pumps and components on Site in factory packing. Inspect for damage. Comply with manufacturers rigging and installation instructions.

B. Protect pumps and components from physical damage including effects of weather, water, humidity, construction dust (concrete/drywall/gypsum), and construction debris.

C. Provide temporary inlet and outlet caps, and maintain in place until installation.

1.10 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.11 WARRANTY

A. All components furnished shall be warranted for a period of 5 years from documented date of shipment.

B. Furnish service and maintenance of packaged system for one year from documented date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

A. Statically and dynamically balance rotating parts.

B. Pumps to operate at 3500 rpm maximum unless specified otherwise.

C. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

D. All materials that may come in contact with the potable water delivered shall comply with ANSI/NSF Standard 61 and the “complete system” shall be certified as constructed. Individual component certification is not compliant.

E. Pressure ratings of pumps, pipe, fittings, valves, gauges and all other water carrying appurtenances shall be suitable for the anticipated system pressures in which they are installed. Headers shall be constructed of 304 stainless steel at a minimum.

F. The Contractor shall ascertain for himself the space and access available for the installation of a factory assembled pre-packaged and tested unit. All components of the system shall be compatible and be furnished by a single source manufacturer and all electrical services and interconnecting equipment wiring must be provided for a complete assembly with a single-source, fused power disconnect and water connections.

G. The entire system shall be factory skid mounted on a minimum 304 stainless-steel structural square tube support frame, with in-shear molded rubber vibration isolators in compliance with standards as required in installation instructions published by pump manufacturer. Suction and Discharge Headers must be supported by pump skid frame to prevent piping strain on the pump casing and during system transport. No Exceptions.

H. System must meet ANSI/ASHRAE/IES 90.1, Section 10.4.2, “Energy Standard for Buildings” and have proof of compliance utilizing either remote sensor option or software logic which adjusts set point according to flow rate.

I. For isolation valve sizes 2" and smaller, valves shall be full port bronze ball valves with integral union, compliant ball and stem design. For isolation valve sizes 2.5" and larger, valves shall be epoxy coated ductile iron lever operated lug type butterfly valves with stainless steel disc and stainless steel shaft. Valves must be rated for maximum pressure service for the system and also comply with NSF 61 & 372 Drinking Water requirements.

J. Unions or flanges shall be provided for easy removal of pumps. System headers shall be sized for a velocity not exceeding 10 FPS at full flow and shall be terminated with a groove or flanged joint capable of accepting a groove coupling ANSI flange or groove flange furnished by Contractor.

K. The packaged pumping system shall include all electrical wiring between components and shall be completely flow and pressure tested for actual site conditions at the factory prior to shipment.

L. System shall be arranged such that single point connections are required for piping and electrical power supply. Multiple power connections are un-acceptable.

M. Individual pumps, motors and check valves shall be serviceable with the booster system in operation utilizing isolation valves for each pump.

N. Refer to schedules on Contract Drawings for required pump capacities and electrical characteristics.

2.2 PACKAGED DOMESTIC WATER PRESSURE BOOSTER PUMP ASSEMBLY

A. Provide a complete Packaged Pumping System, including pumps, motors, control equipment, variable frequency drives, valves, fittings and manifolds must be UL Listed. In addition to the UL Listing for the complete system the control panel assembly must be separately listed under UL-508 Industrial Control Equipment.

B. System shall include vertical or horizontal mounted stainless steel, close-coupled, end suction centrifugal pumps with NPT threaded or ANSI flanged connections. Pump features to include stainless steel casing, back pull out design, top centerline discharge and hydraulically balanced stainless steel impeller with ceramic-carbon seal minimum. Pump shall be hydro-formed for maximum efficiency with stainless steel fitted construction and a replaceable shaft sleeve and mechanical seal.

1. Approved Manufacturers: The following manufacturers are acceptable provided their products meet or exceed these Specifications and the Contract drawing schedules.

    a. QuantumFlo, Inc.
    b. Thrush Pump
    c. Canariis Corporation
    d. Or equal as approved by the Professional.

2. Basis of Design: Quantum Flo, Inc - Prodigy Duplex Model #QES-120/3 1.5

C. Motors Motor shall be NEMA Premium Efficiency, Class F Insulated, Inverter duty, close-coupled type with a J, JM or TC type motor. Motors shall be TEFC enclosed and manufactured in accordance with NEMA standards for the voltage, frequency and phasing indicated on the pump schedule or plans.

D. Motors shall be premium efficiency in accordance with DOE June 2016 requirements. Motors shall have ball bearings and operate at 40° ambient. Each motor shall be equipped with the manufacturer’s nameplate and shall have a sufficient horsepower rating to operate the pump at any point on the pump’s head-capacity curve without overloading the nameplate horsepower rating of the motor. The motor shall have a service factor of 1.15 for variations in voltage and frequency.

E. Pumps and motors larger than 5 H.P. shall be mounted with rubber-in-shear isolators to reduce vibration and stress into the baseplate, machine and system piping as required.

F. Structural Elements: The entire system shall be factory skid mounted on a minimum; 304 stainless-steel structural square tube support frame, with in-shear molded rubber vibration isolators. All skid-mounted components shall be factory finished in high quality enamel paint.

Bare, uncoated steel is unacceptable. Individual pumps and motors may be serviced with the booster system in operation, and all components shall be suitable for the maximum working pressure in the system.

G. Valves: All valves shall be full port bronze ball valves, with S.S. ball and stem design for valve sizes 2 1/2" and smaller, and cast iron, epoxy coated lever operated, grooved end type butterfly valves, with stainless steel disc, and Stainless Steel shaft, for valve sizes 3" and larger. Each pump discharge shall have a wafer style silent non-slam check valve with cast iron body and sized for a maximum loss of 3 PSI at design flow and be suitable for the maximum working pressure of the system. Valves must be rated for maximum pressure service for the system and also comply with NSF 61 Annex G and NSF/ANSI/372 for 0.25% maximum load content requirement.

2.3 VARIABLE FREQUENCY DRIVES

A. System shall feature variable frequency drives of the PWM design suitable for variable torque applications using any standard NEMA Design B squirrel cage induction motor. Variable frequency drives shall be sized for the maximum possible amp draw throughout the programmed sequence of pump operation.

B. Drives shall be pulse width modulated, start into a rotating load, follow signal from logic section of control panel when in auto mode and be provided with the following features:

1. Hand/off/auto switch and manual speed adjustment if auto system is inoperable.
2. Auto Drive Shutdown for electrical fault.
3. Automatic restart after power fails shutdown.
4. Complete service diagnostics with fault history log up to 6 events.

C. Keypad Operator Device including the following:

1. Backlit LCD Display.
2. Power On and Alarm/Fault Displays.

D. Operational data displays include:

1. Drive Speed [HZ]
2. Motor Torque [%]
3. Input Power [kW]
4. Current [A]
5. Elapsed Time [Hours]
6. Motor Voltage [V]

E. No electrical A-T-L (across the line) bypass shall be provided with any drive as the VFD is the only mode of pressure control.

F. Drives shall be controlled via a Master/Slave control arrangement where the controller makes all adjustments via a high-speed interface which provides for greater PID resolution and PID auto-tuning. Exceptions to this requirement must be approved via pre-approval documentation with the engineer proving their energy-efficiency to the standard set forth.

2.4 PRESSURE SENSOR/TRANSMITTER

A. Provide suction and discharge, Type 4X, stainless-steel pressure sensors/transmitters and internal separate pressure switch with integral event-logger, which provides a 4-20 mA signal output, compatible with the system controls, temperature and pressure requirements. Pressure sensor/transmitter shall have zero, span and damping devices. The transmitter shall be installed on the system suction and discharge headers and factory wired to the control circuitry. Sensor shall feature a high contrast LED readable from a 6-foot distance by maintenance personnel. When high-contrast LED transmitters are provided, other gauges or sensors are redundant and un-necessary.

2.5 SEQUENCE OF OPERATION

A. The lead pump shall run only as necessary to maintain system pressure and will be controlled automatically by means of the pressure sensor/transmitter and programmable logic controller (PLC) designed to prevent short cycling and provide sensor-less flow detection. If the lead pump is unable to maintain system pressure the lag pump(s) will be called on as required by the sensor-less flow algorithm and will operate in parallel with the lead pump until no longer necessary and be sequenced off. When one pump can handle the system demand the controls will optimize energy consumption by eliminating the lag pump from sequence. When a low or no-flow condition is reached the system shall revert to the stand-by mode if no flow is present via an intelligent flow detection algorithm, which does not raise the set pressure to charge a tank to detect low flow. These systems DO NOT require a hydro-pneumatic tank installed and thereby does not raise the system pressure set point. (See 2.08) Note: Raising system pressure to charge a tank violates ANSI/ASHRAE/IES Standard 90.1 by raising the pressure in lieu of maintaining constant system pressure.

B. An empty pipe condition is to be determined by an algorithm allowing for a slow ramp to set point to prevent system pressure shocks. The “pipe-fill” algorithm will also prevent VFD “wind-up” and pressure spikes associated with this condition.

C. The system shall employ software to detect pipe break and stop system, initiate an alarm and log the event. In the event of a sensor failure, the system shall run one pump in a semi-automatic mode allowing the building to maintain a minimum pressure until the sensor can be repaired or replaced.

D. An auto-tuning PID algorithm shall continuously monitor system pressure and maintain steady-state system pressure as demand load changes rapidly and pump moves horizontally on its plumbing-performance curve. The PID algorithms shall incorporate intelligent algorithms to start the pumps at the point of creating pressure saving energy and reducing time to set pressure upon pump call.

2.6 CONTROL PANEL

A. Logic Section - Provide, mount and wire on the skid a programmable logic controller in a NEMA 3R, splash-proof, forced-air ventilated enclosure to fully contain all VFD’s and interface the signal from the pressure sensor to the VFD's and provide a stabilized response to speed up or slow down or add pumps to meet system requirements. The controller shall provide set point adjustment, timer adjustment, PID functions (as required) and both system and controller self-diagnostics via touch screen display. The HMI Screen shall feature an LED backlight, analog resistive, IP65/NEMA 4X, 2 GB eMMC Flash memory, rated 0-55 Degrees C with alarm logging and real-time, internal clock, Intel® Atom™ E620T 333 MHz clock speed. The touch screen display/human machine interface shall include a 7” TFT WVGA, 16.7 million color, 800x480

Pixels, resistive analog display with RS232/485 ports, Optional Ethernet (OPC-UA) and USB Ports for Upload/Download of system trend data.

B. All user interface set points shall be easily accessible via a password protected display screen. The password shall be of the “rolling” type to prevent un-authorized access to factory settings. Normal system operation shall be auto-tuned to eliminate pressure hunting. Controller shall feature an (optional) USB Download connection which allows user to download trending analysis without the need for a formal BAS connection. All system data and settings shall be accessible from the display without the need to access the high-voltage controller internals. The software shall include clear alarm indications and user troubleshooting wizards to ascertain and correct all system alarms and conditions.

C. Power Section – The internally touch-safe, high voltage controller with HMI shall be factory wired and mounted on a structural square-tube frame, stainless steel system skid. The panel shall be furnished with single-point power connection, fused main disconnect switch with a single door mounted and interlocked handle, each VFD shall be protected by a fused branch compact circuit protector. Multiple power source connections are un-acceptable. A 24-volt DC power supply shall be provided for logic, sensors and fan circuitry where necessary. Controller shall feature the following minimum additional components:

1. UL 1449 Type I Surge Arrestor with active over-voltage control via MOV’s (metal oxide varistors). Passive surge or lightning arrestors are not acceptable.
2. Low suction pressure shutdown circuit with auto reset and alarm logging.
3. High system pressure shutdown circuit with auto reset and alarm logging.
4. System key-logger which records all keypad entries stored in non-volatile memory. (downloadable)
5. Audible alarm with silence push button and alarm log recognition of reset.
6. Auto-alternate all pumps automatically on each stand-by cycle.
7. 24 hour pump exerciser function which runs exercises pumps to maintain seal lubrication when the pump has not been started in the previous 24 hours.
8. Auxiliary relay contacts for all alarm conditions or discreet data monitoring capability.
9. Audible and visual indication of low storage tank level, with silence push button. (when optional suction break-tank is used)
10. Elapsed time meters, system pressure, KW and other critical values, portable to system SCADA via discrete communication.
11. Pipe Break Alarm with auto-shut down and time/date alarm logging of event.
12. Table chart indicating system pressure and system KW with optional direct to USB Flash download for the most recent 1-week events, time and date stamped.
13. The system shall not require external flow meters or KW monitoring. The system will not implement speed, thermal or time delay means to detect and shut down pumps on a no demand condition as this wastes energy and provides for unnecessary run times.
14. System must feature ANSI/ASHRAE/IES Energy Standard 90.1 compliance via either a remote mounted pressure sensor or internal system logic which detects low flow and automatically adjusts set point according to piping losses at the condition with auto reset.
15. As per current NEC 2017, Section 409.110, control panel MUST have a listed minimum SCCR value, equal to or greater than the available fault current of the feeder circuit. A coordination study must be completed and furnished by the electrical designer or contractor to verify available fault current against the connected equipment.
16. hydro-pneumatic tank not required with sensor-less flow detection.

2.7 CAPACITIES AND CHARACTERISTICS:

A. Minimum Pressure Rating: 150 psig.

B. Booster-Pump Capacity: 91 gpm.

C. Minimum Inlet Pressure: 44 psig.

D. Maximum Inlet Pressure: 59 psig.

E. Discharge Pressure: 70 psig.

F. Each of Two Pumps:

1. Capacity: 45.5 gpm.
2. Total Dynamic Head: 62.79 feet.
3. Speed: 3450 rpm.
4. Electrical Characteristics:

a. Motor Horsepower: 1.5 HP.
b. Volts: 208.
c. Phases: Three.
d. Hertz: 60.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for booster pumps to verify actual locations of piping connections before booster-pump installation.

3.2 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Install the system level and in accordance with manufacturer’s published recommendations.

D. Locate equipment with allowance for manufacturer's recommended clearances around unit.

E. Set entire unit on 4" high reinforced concrete equipment pad. Provide vibration isolators and bolt skid to pad. Structurally connect equipment pad to building slab to prevent movement.

F. Pipe discharge from all relief valves, drains and individual pump thermal purge protection solenoid valves, indirectly to floor drain having adequate capacity to accept discharge.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect domestic-water piping to booster pumps. Install suction and discharge pipe equal to or greater than size of system suction and discharge headers.

1. Install shutoff valves on piping connections to booster-pump suction and discharge headers. Install ball or butterfly same size as suction and discharge headers. Comply with requirements for general-duty valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
2. Install union or flanged connections on suction and discharge headers at connection to domestic-water piping. Comply with requirements for unions and flanges specified in Section 221116 "Domestic Water Piping."
3. Install valved bypass, same size as and between piping, at connections to booster-pump suction and discharge piping. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."
4. Install flexible connectors, same size as piping, on piping connections to booster-pump suction and discharge headers. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."
5. Install piping adjacent to booster pumps to allow service and maintenance.

3.4 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Perform visual and mechanical inspection.
2. Leak Test: After installation, charge booster pump and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start booster pumps to confirm proper motor rotation and booster-pump operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Pumps and controls will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 FACTORY TESTING

A. The booster system shall be completely performance tested under project site simulated conditions and shall undergo a complete electric and hydraulic test from 0 to 100% design flow at the factory. The test shall be performed at the estimated site pressure conditions and pre-set to these conditions prior to shipment. Proof of simulated factory testing shall be provided to the engineer/Client Agency. All control devices including transmitters and all safety features shall be

factory calibrated and tested. Hydrostatic and/or electrical-only testing is NOT ACCEPTABLE as a compliant factory flow test.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

B. Start-up:

1. Initial factory start-up, and Client Agency training shall be performed by a qualified factory trained technician. A factory certified start-up report must be provided to the Client Agency, dated and signed by the factory technician.

C. Parts: A complete listing of all components in the manufacture of the equipment shall be provide in the O&M including individual factory part numbers for each component in the packaged equipment.

D. Start-Up Service: The service of a factory-trained representative shall be made available on the jobsite for start-up and instructing operating personnel.

E. On-Site Factory Warranty: The booster system shall be warranted in writing against defects in materials or workmanship under normal use and service for a period of one year after date of original operation but not more than 18 months from date of shipment from the Company's factory when installed and used in accordance with good standard practice.

1. Factory Test: The booster system shall be hydrostatically tested and shall undergo a complete electric and hydraulic test from 0 to 100% design flow at the factory. All control devices including remote transmitters and all safety features shall be factory calibrated and tested. The Client Agency’s representative may witness the test

3.8 ADJUSTING

A. Adjust booster pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust pressure set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting booster pump to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Client Agency's maintenance personnel to adjust, operate, and maintain booster pumps

END OF SECTION