BoosterpaQ Hydro MPC-F Guide Specification

Part I – GENERAL

1.1 WORK INCLUDED

A. Variable Speed Packaged Pumping System

1.2 REFERENCE STANDARDS

The work in this section is subject to the requirements of applicable portions of the following standards:

A. Hydraulic Institute
B. ANSI – American National Standards Institute
C. ASTM – American Society for Testing and Materials
D. IEEE – Institute of Electrical and Electronics Engineers
E. NEMA – National Electrical Manufacturers Association
F. NEC – National Electrical Code
G. ISO – International Standards Organization
H. UL – Underwriters Laboratories, Inc.

Part 2 – PRODUCTS

2.1 VARIABLE SPEED PACKAGED PUMPING SYSTEM

A. Furnish and install a pre-fabricated and tested variable speed packaged pumping system to maintain constant water delivery pressure.

B. The packaged pump system shall be a standard product of a single pump manufacturer. The entire pump system including pumps and pump logic controller, shall be designed and built by the same manufacturer.

C. The complete packaged water booster pump system shall be certified and listed by UL (Category QCZJ – Packaged Pumping Systems) for conformance to U.S. and Canadian Standards.

2.2 PUMPS

A. All pumps shall be ANSI/NSF 61 approved for drinking water.

B. The pumps shall be of the in-line vertical multi-stage design.

C. The head-capacity curve shall have a steady rise in head from maximum to minimum flow within the preferred operating region. The shut-off head shall be a minimum of 20% higher than the head at the best efficiency point.

D. Small Vertical In-Line Multi-Stage Pumps (Nominal flow from 3 to 125 gallons per minute) shall have the following features:

1. The pump impellers shall be secured directly to the pump shaft by means of a splined shaft arrangement.

2. The suction/discharge base shall have ANSI Class 250 flange or internal pipe thread (NPT) connections as determined by the pump station manufacturer.

3. Pump Construction.

a. Suction/discharge base, pump head, motor stool: Cast iron (Class 30)
b. Impellers, diffuser chambers, outer sleeve: 304 Stainless Steel
c. Shaft 316 or 431 Stainless Steel
d. Impeller wear rings: 304 Stainless Steel
e. Shaft journals and chamber bearings: Silicon Carbide
f. O-rings: EPDM

Shaft couplings for motor flange sizes 184TC and smaller shall be made of cast iron or sintered steel. Shaft couplings for motor flange sizes larger than 184TC shall be made of ductile iron (ASTM 60-40-18).

Optional materials for the suction/discharge base and pump head shall be cast 316 stainless steel (ASTM CF-8M) resulting in all wetted parts of stainless steel.

4. The shaft seal shall be a balanced o-ring cartridge type with the following features:

a. Collar, Drivers, Spring: 316 Stainless Steel
b. Shaft Sleeve, Gland Plate: 316 Stainless Steel
c. Stationary Ring: Silicon Carbide
d. Rotating Ring: Silicon Carbide
e. O-rings: EPDM

The Silicon Carbide shall be imbedded with graphite.

5. Shaft seal replacement shall be possible without removal of any pump components other than the coupling guard, shaft coupling and motor. The entire cartridge shaft seal shall be removable as a one piece component. Pumps with motors equal to or larger than 15 hp (fifteen horsepower) shall have adequate space within the motor stool so that shaft seal replacement is possible without motor removal.

E. Large In-line Vertical Multi-Stage Pumps (Nominal flows from 130 to 500 gallons per minute) shall have the following features:

1. The pump impellers shall be secured directly to the smooth pump shaft by means of a split cone and nut design.

2. The suction/discharge base shall have ANSI Class 125 or Class 250 flange connections in a slip ring (rotating flange) design as indicated in the drawings or pump schedule.

3. Pump Construction.

a. Suction/discharge base, pump head Ductile Iron (ASTM 65-45-12)
b. Shaft couplings, flange rings: Ductile Iron (ASTM 65-45-12)
b. Shaft 431 Stainless Steel
c. Motor Stool Cast Iron (ASTM Class 30)
d. Impellers, diffuser chambers, outer sleeve: 304 Stainless Steel
e. Impeller wear rings: 304 Stainless Steel
f. Intermediate Bearing Journals: Tungsten Carbide
g. Intermediate Chamber Bearings: Leadless Tin Bronze
h. Chamber Bushings: Graphite Filled PTFE
I. O-rings: EPDM

4. The shaft seal shall be a single balanced metal bellows cartridge with the following construction:

a. Bellows: 904L Stainless Steel
b. Shaft Sleeve, Gland Plate, Drive Collar: 316 Stainless Steel
c. Stationary Ring: Carbon
d. Rotating Ring: Tungsten Carbide

e. O-rings: EPDM

5. Shaft seal replacement shall be possible without removal of any pump components other than the coupling guard, motor couplings, motor and seal cover. The entire cartridge shaft seal shall be removable as a one piece component. Pumps with motors equal to or larger than 15 hp (fifteen horsepower) shall have adequate space within the motor stool so that shaft seal replacement is possible without motor removal.

2.3 VARIABLE FREQUENCY DRIVE

A. The VFD shall be of the PWM (Pulse Width Modulation) design using current IGBT (Insulated Gate Bipolar Transistor) technology.

B. The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of motor. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump control and to eliminate the need for motor de-rating.

C. The VFD shall have a minimum of two skip frequency bands which can be field adjustable.

D. The VFD shall have internal solid-state overload protection designed to trip within the range of 125-150% of rated current.

E. The VFD shall include protection against input transients, phase imbalance, loss of AC line phase, over-voltage, under-voltage, VFD over-temperature, and motor over-temperature (when PTC thermistors are used).

F. The VFD shall have DC link reactors on both the positive and negative rails of the DC bus to minimize power line harmonics. VFDs without DC link reactors shall provide a minimum 3% impedance line reactor.

G. Protect VFD from sustained low voltage. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output with an input voltage as low as 180 V AC for 208/230 volt units, and 342 V AC for 460 volt units.

H. To prevent breakdown of the motor winding insulation, the VFD shall be designed to comply with IEC Part 34-17. Otherwise, the VFD manufacturer must ensure that inverter rated motors are supplied.

I. VFD shall catch a rotating motor operating forward or reverse up to full speed.

J. The VFD shall have, as a minimum, the following input/output capabilities:

1. Speed Reference Signal: 0-10 VDC, 4-20mA
2. Digital remote on/off
3. Fault Signal Relay (NC or NO)

2.4 FIXED SPEED MOTORS

A. Fixed Speed Motors are to be provided with the following basic features:

1. Designed for continuous duty operation, NEMA design B with a 1.15 service factor.

2. Totally Enclosed Fan Cooled or Open Drip Proof with Class F insulation.

3. Nameplate shall have, as a minimum, all information as described in NEMA Standard MG 1-20.40.1.

4. Motors shall have a NEMA C-Flange for vertical mounting.

5. Drive end bearings shall be adequately sized so that the minimum L10 bearing life is 17,500 hours at the minimum allowable continuous flow rate for the pump.

2.5 PUMP SYSTEM CONTROLLER

A. The pump system controller shall be a standard product developed and supported by the pump manufacturer.

B. The controller shall be microprocessor based capable of having software changes and updates via personal computer (notebook). The controller user interface shall have a VGA display with a minimum screen size of 3-1/2” x 4-5/8” for easy viewing of system status parameters and for field programming. The display shall have a back light with contrast adjustment. Password protection of system settings shall be standard.

C. The controller shall provide internal galvanic isolation to all digital and analog inputs as well as all fieldbus connections.

D. The controller shall display the following as status readings from a single display on the controller (this display shall be the default):

- Current value of the control parameter, (typically discharge pressure)
- Most recent existing alarm (if any)
- System status with current operating mode
- Status of each pump with current operating mode and rotational speed as a percentage (%)

E. The controller shall have as a minimum the following hardware inputs and outputs:

- Three analog inputs (4-20mA or 0-10VDC)
- Three digital inputs
- Two digital outputs
- Ethernet connection
- Field Service connection to PC for advanced programming and data logging

F. Pump system programming (field adjustable) shall include as a minimum the following:

- Water shortage protection (analog or digital)
- Transducer Settings (Suction and Discharge Analog supply/range)
- PI Controller (Proportional gain and Integral time) settings
- High system pressure indication and shut-down
- Low system pressure indication and shut-down
- Low suction pressure/level shutdown (via digital contact)
- Low suction pressure/level warning (via analog signal)
- Low suction pressure/level shutdown (via analog signal)
- Flow meter settings (if used, analog signal)

G. With additional input/output modules, the system controller shall be able to accept up to seven closed loop programmable set-points and seven open loop programmable set-points.

H. The controller shall have advanced water shortage protection. When analog sensors (level or pressure) are used for water shortage protection, there shall be two indication levels. One level is for warning indication only (indication that the water level/pressure is getting lower than expected levels) and the other level is for complete system shut-down (water or level is so low that pump damage can occur). System restart after shut-down shall be manual or automatic (user selectable).

I. The system pressure set-point shall be capable of being automatically adjusted by using an external set-point influence. The set-point influence function enables the user to adjust the control parameter (typically pressure) by measuring an additional parameter. (Example: Lower the system pressure set-point based on a flow measurement to compensate for lower friction losses at lower flow rates).

J. The controller shall be capable of receiving a remote analog set-point (4-20mA or 0-10 VDC) as well as a remote system on/off (digital) signal.

K. The pump system controller shall store up to 24 warning and alarms in memory. The time, date and duration of each alarm shall be recorded. A potential-free relay shall be provided for alarm notification to the building management system. The controller shall display the following alarm conditions:

High System Pressure	Low system pressure
Low suction pressure (warning and/or alarm)	Individual pump failure
VFD trip/failure	Loss of sensor signal (4-20 mA)
Loss of remote set-point signal (4-20mA)	System power loss

L. The pump system controller shall be mounted in a NEMA 4 enclosure (NEMA 3R if cooling fan is required). The entire control panel shall be UL 508 listed as an assembly. The control panel shall include a main disconnect, circuit breakers for each pump and the control circuit and control relays for alarm functions.

<u>Control panel options shall include, but not be limited to:</u>

Pump Run Lights	Pump Alarm Lights
System Fault Light	Audible Alarm (80 db[A])
Surge Arrestor	Control Panel Internal Illumination
Emergency/Normal Operation Switches	Service Disconnect Switches

M. The controller shall be capable of receiving a redundant sensor input to function as a backup to the primary sensor (typically discharge pressure).

N. The controller shall have a pump "Test Run" feature such that pumps are switched on during periods of inactivity (system is switched to the "off" position but with electricity supply still connected). The inoperative pumps shall be switched on for a period of two to three (2-3) seconds every 24 hours, 48 hours or once per week (user selectable).

O. The controller shall be capable of providing instantaneous power consumption (Watts or kilowatts) and cumulative energy consumption (kilowatt-hours) when connected to integrated VFD motors through the field bus.

P. The actual pump performance curves (5^{th} order polynomial) shall be loaded (software) into the pump system controller.

2.6 SEQUENCE OF OPERATION

The system controller shall operate from two to six equal capacity pumps and one Variable Frequency Drive (VFD) to maintain a constant discharge pressure (system set-point). The system controller shall receive an analog signal [4-20mA] from the factory installed pressure transducer on the discharge manifold, indicating the actual system pressure. When a flow demand is detected (drop in system pressure) the VFD controlled pump shall start first. As flow demand increases, the speed of the VFD controlled pump shall be increased to maintain the system set-point pressure. When the VFD controlled pump cannot maintain the system set-point as flow increases (pressure starts to drop below system set-point), an additional pump will be started Direct-On-Line (DOL). The VFD controlled pump shall immediately adjust speed to maintain the system set-point. Additional DOL pumps shall be started as flow demand increases. As flow demand decreases, the pump speed shall be reduced while system set-point pressure is maintained. The system controller shall switch off DOL operated pumps as required with decreasing flow.

The system controller shall be capable of switching pumps on and off to satisfy system demand without the use of flow switches, motor current monitors or temperature measuring devices.

2.7 LOW FLOW STOP FUNCTION

The system controller shall be capable of stopping pumps during periods of low-flow or zero-flow without wasting water or adding unwanted heat to the liquid. Temperature based no flow shut-down methods that have the potential to waste water and add unwanted temperature rise to the pumping fluid are not acceptable.

Standard Low Flow Stop and Energy Saving Mode
If a low or no flow shut-down is required (periods of low or zero demand) a bladder type diaphragm tank shall be installed with a pre-charge pressure of 70% of system set-point. The tank shall be piped to the discharge manifold or system piping downstream of the pump system. When only one pump is in operation the system controller shall be capable of detecting low flow (less than 10% of pump nominal flow) without the use of additional flow sensing devices. When a low flow is detected, the system controller shall increase pump speed until the discharge pressure reaches the stop pressure (system set-point plus 50% of programmed on/off band). The pump shall remain off until the discharge pressure reaches the start pressure (system set-point minus 50% of programmed on/off band). Upon low flow shut-down a pump shall be restarted in one of the following two ways:

a. Low Flow Restart: If the drop in pressure is slow when the start pressure is reached (indicating the flow is still low), the pump shall start and the speed shall again be increased until the stop pressure is reached and the pump shall again be switched off.

b. Normal Flow Restart: If the drop in pressure is fast (indicating the flow is greater than 10% of pump nominal flow) the pump shall start and the speed shall be increased until the system pressure reaches the system set-point.

[OPTIONAL] Low Flow Stop and Energy Saving Mode

The pump system controller shall be capable receiving a digital signal from a flow switch or an analog signal from a flow meter to indicate a low flow condition. A bladder type diaphragm tank shall be installed with a pre-charge pressure of 70% of system set-point. The tank shall be piped to the discharge manifold or system piping downstream of the pump system. When low flow is detected (signal from flow switch or meter), the system controller shall increase pump speed until the discharge pressure reaches the stop pressure (system set-point plus 50% of programmed on/off band). The pump shall remain off until the discharge pressure reaches the start pressure (system set-point minus 50% of programmed on/off band). The pump shall remain in the energy saving on/off mode during low flow indication. When low flow is no longer present (low flow indication ceases), the pump(s) shall resume constant pressure operation.

It shall be possible to change from the standard low flow stop to the optional low flow stop (and vice-versa) via the user interface.

2.8 SYSTEM CONSTRUCTION

A. The suction and discharge manifolds shall be constructed of 316 stainless steel. Manifold connection sizes shall be as follows:

3 inch and smaller:	Male NPT threaded
4 inch through 8 inch:	ANSI Class 150 rotating flanges

10 inch and larger: ANSI Class 150 flanges

B. Pump Isolation valves shall be provided on the suction and discharge of each pump. Isolation valve sizes 2 inch and smaller shall be nickel plated brass full port ball valves. Isolation valve sizes 3 inch and larger shall be a full lug style butterfly valve. The valve disk shall be of stainless steel. The valve seat material shall be EPDM and the body shall be cast iron, coated internally and externally with fusion-bonded epoxy.

B. A spring-loaded non-slam type check valve shall be installed on the discharge of each pump. The valve shall be a wafer style type fitted between two flanges. The head loss through the valve shall not exceed 5 psi at the pump design capacity. Check valves 1-1/2" and smaller shall have a POM composite body and poppet, a stainless steel spring with EPDM or NBR seats. Check valves 2" and larger shall have a body material of stainless steel or epoxy coated iron (fusion bonded) with an EPDM or NBR resilient seat. Spring material shall be stainless steel. Disk shall be of stainless steel or leadless bronze.

C. For systems that require a diaphragm tank, a minimum diaphragm tank connection size of ¾" shall be provided on the discharge manifold.

D. A pressure transducer shall be factory installed on the discharge manifold (or field installed as specified on plans). Systems with positive inlet gauge pressure shall have a factory installed pressure transducer on the suction manifold for water shortage protection. Pressure transducers shall be made of 316 stainless steel. Transducer accuracy shall be +/- 1.0% full scale with hysteresis and repeatability of no greater than 0.1% full scale. The output signal shall be 4-20 mA with a supply voltage range of 9-32 VDC.

E. A bourdon tube pressure gauge, 2.5 inch diameter, shall be placed on the suction and discharge manifolds. The gauge shall be liquid filled and have copper alloy internal parts in a stainless steel case. Gauge accuracy shall be 2/1/2 %. The gauge shall be capable of a pressure of 30% above it's maximum span without requiring recalibration.

F. Systems with a flooded suction inlet or suction lift configuration shall have a factory installed water shortage protection device on the suction manifold.

G. The base frame shall be constructed of corrosion resistant 304 stainless steel. Rubber vibration dampers shall be fitted between each pump and baseframe to minimize vibration.

H. Depending on the system size and configuration, the control panel shall be mounted in one of the following ways:

On a 304 stainless steel fabricated control cabinet stand attached to the system skid
On a 304 stainless steel fabricated skid, separate from the main system skid
On it's own base (floor mounted with plinth)

2.9 TESTING

A. The entire pump station shall be factory performance tested as a complete unit prior to shipment. Job-site programming shall be entered into the controller prior to shipment (details of installation requirements shall be communicated to the pump system manufacturer). A verified performance test report shall be made available from the system manufacturer.

B. The system shall undergo a hydrostatic test of 250 psig for a minimum of 15 minutes prior to shipment.

3.0 WARRANTY

A. The warranty period shall be a non-prorated period of 24 months from date of installation, not to exceed 30 months from date of manufacture.