Hydro Multi-E Pump System (Integrated VFD/PM Motor) 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, built, and tested 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.

D. The complete packaged pumping system shall be NSF61 / NSF372 Listed for drinking water and low lead requirements.

E. The packaged pump system shall be ASHRAE 90.1 – 2010 compliant without the need of a remote mounted sensor. The control logic used to simulate a remote mounted sensor shall be proportional pressure control with squared or linear adaptation. An actual flow rate or calculated flow rate shall be used to adjust setpoint pressure in proportional pressure control.

2.2 PUMPS

A. All pumps shall be ANSI NSF 61 / NSF372 Listed for drinking water and low lead requirements.

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 80-55-06)
b. Shaft couplings, flange rings:	Ductile Iron (ASTM 80-55-06)
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:	Silicon 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 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, 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 INTEGRATED VARIABLE FREQUENCY DRIVE MOTORS

A. Each motor on pump system shall have ability to control all motors and pumps on system.

B. Two motors on system shall be fitted with discharge sensors for 100% control redundancy.

C. Each motor shall be of the Integrated Variable Frequency Drive design consisting of a permanent magnet synchronous motor (ECM) and a Variable Frequency Drive (VFD) built and tested as one unit by the same manufacturer.

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

E. 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 current suitable for centrifugal pump control and to eliminate the need for motor de-rating.

F. The VFD shall automatically reduce the switching frequency and/or the output voltage and frequency to the motor during periods of sustained ambient temperatures that are higher than the normal operating range. The switching frequency shall be reduced before motor speed is reduced.

G. An integral RFI filter shall be standard in the VFD.

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

I. The VFD shall have internal solid-state overload protection designed to trip within the range of 105-110% of rated current.

J. The integrated VFD motor shall include protection against input transients, phase imbalance, loss of AC line phase, over-voltage, under-voltage, VFD over-temperature, and motor over-temperature. Three-phase integrated VFD motors shall be capable of providing full output voltage and frequency with a voltage imbalance of up to 10%.

K. The integrated VFD motors on system shall have, as a minimum, the following input/output capabilities:

L. Two digital inputs
M. Two digital outputs that can be configured to be digital inputs for total of four digital inputs
N. Two analog inputs (configurable for 4-20 mA, 0-20 mA, 0-10 V)
O. Fieldbus communication port (RS485)

P. The motor shall be Totally Enclosed Fan Cooled (TEFC) with a standard NEMA C-Face, Class F insulation with a temperature rise no higher than Class B.

Q. The cooling design of the motor and VFD shall be such that a Class B motor temperature rise is not exceeded at full rated load and speed at a minimum switching frequency of 9.0 kHz.

R. The overall efficiency of the VFD and motor must exceed NEMA Premium Efficiency for motor only.

S. Motor drive end bearings shall be adequately sized so that the minimum L10 bearing life is 20,000 hours at the minimum allowable continuous flow rate for the pump at full rated speed.

2.4 CONTROL INTERFACE AND CONTROL FUNCTIONALITY

A. Control interface shall be graphical control pad interface installed in motors capable of system control. A minimum of two motors on system shall be capable of system control. The control interface shall provide easy viewing of system status parameters and control of field programming parameters.

B. The controller user interface shall have display with a minimum screen size of 2-1/2" x 2-1/2". The display shall have a back light with contrast adjustment. Password protection of system settings is possible.

C. The control interface 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 (%)

D. The system control shall have as a minimum the following hardware inputs and outputs:

- Two analog inputs (4-20mA or 0-10VDC)
- Two digital inputs
- Two digital outputs capable of being to digital inputs for total of four digital inputs
- Fieldbus communication port (RS485)

E. System programming (field adjustable) shall include as a minimum the following:

- Water shortage protection (analog or digital)
- Sensor Settings (Suction, Discharge, Differential Pressure analog supply/range)
- PI Controller (Proportional gain and Integral time) settings
- Low suction pressure/level shutdown (via analog or digital signal)
- Flow meter settings (if used, analog signal)

F. The system controller shall be able to display specific energy when flow measurement input is available.

G. The system controller shall be able to accept an alternate set-point and change to via a digital input.

H. The system controller shall be able to accept via digital input readings from pulse flow meter and display accumulated flow, flow rate, and specific energy.

I. The system controller shall be able to control off subtraction of two pressure or temperature sensors for differential pressure or differential temperature control.

J. The system controller shall be able to have pump curve data entered into it and use pump curve data to enable proportional pressure control functionality and display system estimated flow rate calculation.

K. The pump system control shall have water shortage protection. A pressure switch (3 psi cutoff / 5 psi reset) **or** pressure transducer factory installed on inlet manifold is used for dry run protection. System restart after shut-down shall be manual or automatic (user selectable).

L. 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).

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

N. The system control shall have ability to activate soft pressure build-up mode when power is cycled and pressure is below predetermined pressure setting.

O. The system control shall be able to monitor minimum two analog signals and active a limit exceed alarm based on a low limit or high limit setting.

P. The controller shall be capable of displaying instantaneous power consumption (Watts or kilowatts) and cumulative energy consumption (kilowatt-hours).

Q. The system control shall have the ability to communicate common field-bus protocols, (BACnet, Modbus, Profibus, and LON), via optional communication expansion card installed inside motor.

2.5 SEQUENCE OF OPERATION

A. Two pumps on system shall be capable of primary pump system control. The control shall operate equal capacity variable speed pumps to maintain a constant discharge pressure (system set-point). The primary pump system controller shall receive an analog signal [4-20mA] from the factory installed pressure transducer on the discharge manifold, indicating the actual system pressure. As flow demand increases the pump speed shall be increased to maintain the system set-point pressure. When the operating pump(s) reach 100% of full speed and cannot maintain pressure, an additional pump will be started and will increase speed until the system set-point is achieved. When the system pressure is equal to the system set-point all pumps in operation shall reach equal operating speeds. As flow demand decreases the pump speed shall be reduced while system set-point pressure is maintained. When all pumps in operation are running at low speed the pump system controller shall switch off pumps when fewer pumps are able to maintain system demand.

B. The primary pump 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.

C. If a no flow shut-down is required (periods of zero demand) a bladder type diaphragm tank shall be installed. The tank shall be piped to the discharge manifold or system piping downstream of the pump system. When only one pump is running and zero flow is detected by the primary pump system controller, the pump shall be switched off. When the system pressure drops to the start pressure, (flow begins after shut-down), the pump system shall be switched on and pump sequencing shall begin again, increasing speed to maintain the system set-point pressure. Zero flow conditions shall be detected by the primary pump system controller/factory installed pressure transmitter without the use of additional flow switches, motor current sensing devices or temperature measuring devices.

D. All pumps in the system shall alternate automatically based on, first on first off and fault.

2.6 LOW FLOW STOP FUNCTION (Constant Pressure Applications)

The system control 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 and shall not be used.

<u>Standard Low Flow Stop and Energy Saving Mode</u>
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, adjustable) 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, adjustable). The pump shall remain off until the discharge pressure reaches the start pressure (system set-point minus 50% of programmed on/off band, adjustable). Upon low flow shut-down a pump shall be restarted in one of the following two ways:

A. Low Flow Restart: If the low flow condition still exists, 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 pump system controller determines a low flow condition no longer exists the pump shall start and the speed shall be increased until the system pressure reaches the system set-point.

2.7 SYSTEM CONSTRUCTION

A. Suction and discharge manifold construction shall be in way that ensures minimal pressure drops, minimize potential for corrosion, and prevents bacteria growth at intersection of piping into the manifold. Manifold construction that includes sharp edge transitions or interconnecting piping protruding into manifold is not acceptable. Manifold construction shall be such that water stagnation can not exist in manifold during operation to prevent bacteria growth inside manifold.

B. The suction and discharge manifolds material shall be 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

C. 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.

D. 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 check 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.

E. For systems that require a diaphragm tank, a connection of no smaller than ¾" shall be provided on the discharge manifold.

F. 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 either a factory installed pressure transducer or pressure switch mounted 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.

G. 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 its maximum span without requiring recalibration.

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

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

J. 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 its own base (floor mounted with plinth)

2.8 TESTING

A. The tester used for testing the pump system shall be constructed and calibrated according to the requirements of hydraulic test standard ISO 9906.

B. The entire pump station shall as a minimum be factory tested for functionality and documented results of functionality test supplied with pump station.

Functionality testing shall include the following parameters:

1. Complete System Hydrostatic Test – 1.5 times the nameplate maximum pressure
2. No-Flow Detection Shutoff Test
3. Water Shortage Test
4. Two-Point Setpoint Performance Test.

C. Water used for testing shall be treated with three different filtration systems to ensure only clean water is used for testing pump station.
1. 25 micron mechanical filter – removes solid parts from water
2. Activated carbon filter – keeps water clear and eliminates odor
3. Ultraviolet light system – kills all bacteria growth

D. Optional performance testing shall include: (Select one)
1. 10-Point Verified Performance Test
2. Witnessed Verified Performance Test
3. Remote Witnessed Verified Performance Test

2.8 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.