

## **Close Coupled Vertical In-Line Pump with CUE Drive Specifications**

### **Part I – GENERAL**

#### **1.1 WORK INCLUDED**

A. Contractor shall furnish and install Grundfos In-line close coupled pump, Grundfos Model VLC complete with pump, motor, mounting plate, and Grundfos CUE drive (variable frequency drive) in accordance with manufacturer's recommendations and plans.

#### **1.2 REFERENCE STANDARDS**

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

- A. HI – 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.
- I. CSA –Canadian Standards Association
- J. OSHA – Occupational Safety & Health Administration
- K. ASME – American Society of Mechanical Engineers
- L. IEC– International Electrotechnical Commission
- M. ETL – Electrical Testing Laboratories
- N. NSF – National Sanitation Foundation

### **Part 2 – PRODUCTS**

#### **2.1 Close Coupled In-Line Pumps with CUE Drive**

- A. Furnish and install close coupled in-line pumps as per plans and pump schedule.
- B. The pump, electric motor, mounting plate, and CUE drive shall be factory assembled at the pump manufacturer's facility. The pump manufacturer shall have complete unit responsibility.

##### **2.1.1 PUMPS**

- A. The pumps shall be close coupled, single stage, in-line design, cast iron bronze fitted construction.
- B. The pumps shall have the following features:
  - 1. All pumps shall be of the back pull-out design so that the rotating element can be removed

from the casing without disconnecting the suction or discharge piping. The casing material shall be close-grained cast iron ASTM A48 - Class 30 with a minimum tensile strength of 30,000 P.S.I. Pumps larger than 12.2" impeller shall have casing material of ductile iron ASTM A536- Class 65 with a minimum tensile strength of 65,000 P.S.I. Volute shall have integrally cast suction and discharge connections, gauge ports at nozzles, and vent and drain ports. Pumps suction and discharge shall be of same size. Pumps with 3" and above suction/discharge sizes shall have double volute casing and shall have suction splitter to reduce pre-rotation and improve efficiency. Casings shall be designed for scheduled working pressure and can withstand hydrostatic test at 150% of the maximum working pressure under which the pump could operate at design speed.

2. Pumps shall be fitted with bronze renewable case wear rings.
3. Suction and discharge flanges shall be drilled to ANSI Class 125# standards and be machined flat face.
4. The motor shaft shall be of cold rolled steel AISI 1024 with bronze sleeves covering the wetted area of the shaft. Motors with 56J frame shall have a motor shaft of stainless steel AISI 416.
5. The pump manufacturer shall recommend the proper mechanical seal based on the pressure, temperature and liquid outlined on the equipment schedule. Mechanical seals, at a minimum, shall have ceramic stationary seats, carbon rotating rings, buna elastomers and stainless steel hardware. Application of a mechanical seal shall be internally flushed type, without requiring external flushing lines. Seals shall be capable of being inspected and easily replaced without removing the piping or volute.
6. Recirculation line of nylon tubing with brass fitting shall be provided to vent the mechanical seal.
7. Impeller shall be of the enclosed francis vane type, single suction design, made of silicon bronze, ASTM B584 C87600, both hydraulically and dynamically balanced to ISO 1940-1:2003 balance grade G6.3 and keyed to the shaft. The impeller shall be trimmed to meet the specific hydraulic requirements.
8. Pump Construction. The standard material of construction for the pump shall be as below. Special material shall be available as option to suit the liquid pumped.
  - Volute: Cast Iron ASTM A48 - Class 30 or Ductile Iron ASTM A536- Class 65
  - Case Wear ring: Tin Bronze ASTM B584-90500
  - Impeller: Silicon Bronze ASTM B584 C87600
  - Shaft: Cold Roll Steel AISI 1024 or Stainless Steel AISI 416
  - Shaft Sleeve: Bronze III932 C89835
  - Mechanical Seals: Carbon – Ceramic with Buna Elastomers and Stainless Steel hardware
  - Recirculation Line: Nylon Tubing with Brass Fittings

- Mounting Plate: Steel Grade 304
- C. Pump rotation shall be clockwise as viewed from the motor end.
- D. Optional Supports: Pump shall be mounted on a heavy duty cast iron support stand or on steel flange supports for floor mounting.
- E. Pump shall be of a maintainable design for ease of maintenance and should use machine fit parts that are easily disassembled.
- F. Each pump shall be painted with one coat of high quality factory approved paint and name-plated before shipment from the factory.
- G. Where noted on schedule the pump shall also be NSF-61 certified.
- H. Pumps shall be manufactured and assembled in an ISO-9001 certified facility.
- I. Mounting plate shall be attached to the foot of the motor with shock isolation pads to absorb vibration. The isolation pads shall provide a gap between the pump and the CUE drive to reduce head transfer to the motor.

### **2.1.2 MOTORS**

- A. Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Pump and motors shall be factory assembled. Motor shall be a footed motor.
- B. Motors shall be suitably sized per ISO5199 and shall meet NEMA specifications and conform to the standards outlined in EISA 2007.

### **2.1.3 VARIABLE FREQUENCY DRIVES (GRUNDFOS CUE)**

- A. The VFD shall convert incoming fixed frequency single-phase or three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC induction motors. The VFD shall be a six-pulse input design, and the input voltage rectifier shall employ a full wave diode bridge; VFD's utilizing controlled SCR rectifiers shall not be acceptable. The output waveform shall closely approximate a sine wave. The VFD shall be of a PWM output design utilizing current IGBT inverter technology and voltage vector control of the output PWM waveform.
- B. The VFD shall include a full-wave diode bridge rectifier and maintain a displacement power factor of near unity regardless of speed and load.
- C. The VFD shall produce an output waveform capable of handling maximum motor cable distances of up to 1,000 ft. (unshielded) without tripping or derating.
- D. The VFD shall utilize an output voltage-vector switching algorithm, or equivalent, in both variable and constant torque modes. VFD's that utilize Sine-Coded PWM or Look-up tables shall not be acceptable.
- E. VFD shall automatically boost power factor at lower speeds.

- F. The VFD shall be able to provide its full rated output current continuously at 110% of rated current for 60 seconds.
- G. An empty pipe fill mode shall be available to fill an empty pipe in a short period of time, and then revert to the PID controller for stable operation (available through PC Tool).
- H. Switching of the input power to the VFD shall be possible without interlocks or damage to the VFD at a minimum interval of 2 minutes.
- I. Switching of power on the output side between the VFD and the motor shall be possible with no limitation or damage to the VFD and shall require no additional interlocks.
- J. The VFD shall have temperature controlled cooling fans for quiet operation, minimized internal losses, and greatly increased fan life.
- K. VFD shall provide full torque to the motor given input voltage fluctuations of up to +10% to -15% of the rated input voltage.
- L. The VFD shall provide internal DC link reactors to minimize power line harmonics and to provide near unity power factor. VFD's without a DC link reactor shall provide a 5% impedance line side reactor.

M. VFD to be provided with the following protective features:

1. VFD shall have input surge protection utilizing MOV's, spark gaps, and Zener diodes to withstand surges of 2.3 times line voltage for 1.3 msec.
2. VFD shall include circuitry to detect phase imbalance and phase loss on the input side of the VFD.
3. VFD shall include current sensors on all three-output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.
4. VFD shall auto-derate the output voltage and frequency to the motor in the presence of sustained ambient temperatures higher than the normal operating range, so as not to trip on an inverter temperature fault. The use of this feature shall be user-selectable and a warning will be exported during the event. Function shall reduce switching frequency before reducing motor speed.
5. VFD shall auto-derate the output frequency by limiting the output current before allowing the VFD to trip on overload. Speed can be reduced, but not stopped.
6. The VFD shall have the option of an integral RFI filter. VFD enclosures shall be made of metal to minimize RFI and provide immunity.

N. VFD to be provided with the following interface features:

1. VFD shall provide an alphanumeric backlit display keypad, which may be remotely mounted using standard 9-pin cable. VFD may be operated with keypad

disconnected or removed entirely. Keypad may be disconnected during normal operation without the need to stop the motor or disconnect power to the VFD.

2. VFD shall display all faults in plain text; VFD's, which can display only fault codes, are not acceptable.
3. All VFD's shall be of the same series, and shall utilize a common control card and LCP (keypad/display unit) throughout the rating range. The control cards and keypads shall be interchangeable through the entire range of drives used on the project.
4. VFD keypad shall be capable of storing drive parameter values in non-volatile RAM uploaded to it from the VFD, and shall be capable of downloading stored values to the VFD to facilitate programming of multiple drives in similar applications, or as a means of backing up the programmed parameters.
5. A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.
6. A start guide menu with factory preset typical parameters shall be provided on the VFD to facilitate commissioning.
7. VFD shall provide full galvanic isolation with suitable potential separation from the power sources (control, signal, and power circuitry within the drive) to ensure compliance with PELV requirements and to protect PLC's and other connected equipment from power surges and spikes.
8. All inputs and outputs shall be optically isolated. Isolation boards between the VFD and external control devices shall not be required.
9. There shall be three programmable digital inputs for interfacing with the systems external control and safety interlock circuitry. An additional digital input is preprogrammed for start/stop.
10. The VFD shall have two analog signal inputs. One dedicated for sensor input and one for external set point input.
11. One programmable analog output shall be provided for indication of a drive status.
12. The VFD shall provide two user programmable relays with selectable functions. Two form 'C' 230VAC/2A rated dry contact relay outputs shall be provided.
13. The VFD shall store in memory the last 5 faults with time stamp and recorded data.
14. The VFD shall be equipped with a standard RS-485 serial communications port for communication to the multi-pump controller. The bus communication protocol for the VFD shall be the same as the controller protocol.

O. VFD service conditions:

1. Ambient temperature operating range, -10 to 45°C (14 to 113°F).
2. 0 to 95% relative humidity, non-condensing.
3. Elevation to 1000 meters (3,300 feet) without derating.
4. VFD's shall be rated for line voltage of 525 to 690VAC, 380 to 480VAC, or 200 to 240VAC; with +10% to -15% variations. Line frequency variation of  $\pm 2\%$  shall be acceptable.

**2.1.4 PRESSURE TRANSDUCER**

- A. Pressure transducer will be manufactured by Grundfos.
- B. A pressure transducer (optional) shall be factory installed on the pump discharge side with copper tubing. The pressure transducer shall be installed on the motor by the manufacturer and electrical connection shall be finalized in the factory.
- C. Pressure transducers shall be made of 316 Stainless Steel.
- D. 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 0-10 VDC.

**2.2 INSTALLATION**

The pump shall be installed per manufacturer's recommendations and according to the standards of the Hydraulics Institute.

**2.3 TESTING**

Where noted on schedule, pumping equipment may require one or more of the following:

Certified Performance test

Hydro static test

NPSH Test

Any other factory test as noted in the pump Schedule

The testing shall be in accordance with Hydraulic Institute level B or the latest HI standard as noted in the pump schedule.

**2.4 WARRANTY**

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. Warranty shall cover against defective material and/or faulty workmanship.

**END OF SECTION**