

Part 1 General

1.1 SCOPE

- .1 **Division 26** Contractor shall supply, install, wire and connect, and program all VFD controllers and indicated on the Drawings.

1.2 STANDARD MOTOR

- .1 All VFDs supplied under this Contract shall meet or exceed the following Specifications.
- .2 Provide a complete inventory (as specified) of spare cooling fans, and fuses, for each VFD supplied.
- .3 The adjustable frequency controller shall be designed to operate standard squirrel cage induction motor with a 1.15 S.F. or definite purpose motors meeting National Electric Manufacturers Association (NEMA) MG1 Part 31.
- .4 Harmonic loading will not exceed a motor service factor of 1.0.
- .5 Products shall comply with Institute of Electrical and Electrical Engineers (IEEE) Standard 519.
- .6 VFD unit shall be Underwriters Laboratories (UL) listed and Canadian Standards Association (CSA) certified.
- .7 VFD unit shall comply with applicable requirements of the latest standards of CSA, American National Standards Institute (ANSI), IEEE and the Canadian Electrical Code.

1.3 TESTS

- .1 Factory testing
 - .1 VFD units are to be factory tested prior to shipment. Provide confirmation from factory of actual tests completed and results.
 - .2 Provide certified copies of production test results required by CSA and Electrical and Electronic Manufacturer's Association of Canada (EEMAC), prior to acceptance of the equipment.
- .2 Field testing
 - .1 The VFD supplier shall provide on-site start-up, fine-tuning, commissioning support, operator training and instruction.
 - .2 The VFD supplier shall provide site functionality test reports indicating loading/current levels during testing as well as control point proving results.
 - .3 The VFD supplier shall ensure shaft to ground voltages do not exceed 1.5 V at any speed or load requirement.

- .4 Allow for all costs and labour for as many trips as necessary to complete requirements.
- .5 It is the intent of this specification to provide a VFD installation that does not adversely affect the electrical system. Included in the Contract Documents is information on the electrical system including:
 - .1 Single line drawing.
 - .2 Additional information on electrical system layout and load profile.
 - .3 The VFD supplier can use this information to evaluate the predicted effect of the VFD installation on the electrical system and advise the Contract Administrator of these effects. For the purposes of analysis, the point of common coupling (PCC) will be taken as the secondary of the main distribution transformers.
- .3 Provide certified copies of all production test results required by CSA and NEMA.

1.4 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit Shop Drawings in accordance with **Section E3**.
- .2 Indicate:
 - .1 Mounting method and dimensions.
 - .2 Starter size and type.
 - .3 Layout of identified internal and front panel components.
 - .4 Enclosure types.
 - .5 Wiring diagram for each type of starter.
 - .6 Interconnection diagrams.

1.5 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for motor starters for incorporation into manual specified in **Section E4**.
- .2 Include operation and maintenance data for each type and style of VFD.
- .3 Provide parameter settings for each VFD.

1.6 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with **Section E4**.
- .2 Provide listed spare parts for each different size and type of starter:
 - .1 Three (3) contacts, stationary.

- .2 Three (3) contacts, movable.
- .3 One (1) contacts, auxiliary.
- .4 One (1) control transformers.
- .5 One (1) operating coil.
- .6 Two (2) fuses.
- .7 10% indicating lamp bulbs used.

PART 2 PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES

- .1 Variable Frequency Drives as supplied by one of the following acceptable manufacturers:
 - .1 Asea Brown Boveri Ltd. (ABB) - ACS 800 series.
 - .2 Eaton – SV9000
 - .3 Allen Bradley – PowerFlex700
 - .4 Schneider Electric – Altivar 61
- .2 Variable speed controller shall be electronic adjustable frequency and voltage output unit.
- .3 The VFD shall employ a minimum 6-pulse pulse width modulated (PWM) inverter system utilizing Insulated Gate Bipolar Transistors (IGBT) power switching devices and come complete with line reactors or DC link filters.
- .4 The drive shall be rated for continuous duty while operating a NEMA design induction motor of the sizes and operating voltages as indicated on the drawings. Drive output shall be sized for a 1.0 motor service factor. The VFD shall have a current rating at least 10% in excess of the motor full load amp rating. Overload service factors of 110% for thirty minutes and 135% for one minute must be provided to ensure adequate safety margins. VFD selection shall be based on load current at constant torque ratings. Do not size VFD's based on variable torque maximums.
- .5 Input voltage shall be as indicated on motor schedules and drawings (line voltage variation $\pm 10\%$) Based on 347/600 volt systems (Not 575V). Line frequency variation $\pm 5\%$. Output voltage shall vary with motor speed to nominal motor voltage. Speed stability shall be $\pm 1\%$. Drive shall match torque characteristic of load.
- .6 Input frequency setting signal will be selective between 4-20 mA or 0-10v DC. Output speed monitoring signal shall be selective between 4-20 mA or 0-10 v DC.
- .7 Enclosure:

- .1 Drive shall be installed in individual CSA 12 enclosure complete with control transformer, solid state timers, isolation relays, Hand-Off-Auto selector switch, and manual speed pot. Filters to be provided for any forced air-cooled enclosures as required by the supplier. VFD(s) shall be suitable for mounting in the HHW Ewaste building and shall be able to operate under these conditions with no special cleaning requirements. VFD cabinets shall be mounted in such a way that there is adequate room for ventilation and no build-up of heat. The minimum clearance in front of VFDs is 1 m.
- .8 Protective devices to be incorporated are:
 - .1 Fast acting electronic circuit board protective devices for protection of electronic components.
 - .2 3% Line reactor.
 - .3 Drive output filter: KLC series dv/dt.
 - .4 Integral electronic motor overload protection adjustable up to 150% of motor rating for sixty (60) seconds.
 - .5 Overcurrent instantaneous trip 250%.
 - .6 Programmable short-circuit protection.
 - .7 Programmable ground fault protection.
 - .8 Overvoltage/overcurrent DC bus monitor/protection.
 - .9 Undervoltage protection.
 - .10 Loss of phase and phase unbalance protection.
 - .11 Inverter over-temperature protection.
 - .12 Capable of running without motor for start-up.
 - .13 Maximum acceptable noise level is 80 dBA at 1 m.
- .9 Operation features:
 - .1 Integral flush mounted display in VFD cover with keypad for programming, monitoring and operating of drive, accessible through password or other acceptable security measure only. Remote keypads, completely duplicating functions of integral keypads, shall also be provided and door mounted.
 - .2 Fault shutdown and indication.
 - .3 Automatic restart following power outage.
 - .4 Ability to disconnect motor load for setup or trouble.

- .5 Manual speed control (potentiometer or keypad).
- .6 Adjustable maximum and minimum speed.
- .7 Acceleration and deceleration time adjustment.
- .8 Controller “stop” interlock from a NC dry contact.
- .9 Drive fault contact.
- .10 Stop/start push buttons on keypad.
- .11 Transient voltage protection.
- .12 Provide three (3) dry “C” type contacts programmable for any combination of the following:
 - .1 Running (output frequency being generated).
 - .2 Fault lockout.
 - .3 Stopped.
 - .4 At speed.
 - .5 Under speed.
 - .6 Forward/Reverse.
 - .7 Low reference.
 - .8 Manual/Auto Mode.
 - .9 Local/Remote Mode.
- .13 Soft start sequence.
- .14 Minimum of three (3) skip frequencies.
- .15 Provide Hand/Off/Auto selector switch. Keypad HOA is not an acceptable replacement.
- .16 Password protection of parameter programming or some method to prevent unauthorized changes.
- .17 Output speed monitoring signal to be selective between 4-20 mA. or 0-10 V.
- .18 Data communication link.
 - .1 Data communication links shall be provided with various components in the electrical distribution system as defined in various Section of this Division and as shown on Drawings. The data communication link shall be Modbus Ethernet.

- .2 Motor control data communication link.
 - .3 Each variable frequency drive shall be provided with Ethernet data communication link capable of communicating with the Plant SCADA System.
- .10 Environmental Capabilities: The drive shall operate without mechanical or electrical damage under any combination of conditions as follows:
- .1 Ambient temperature -0° to 40°C.
 - .2 Humidity 0 to 90% (non condensing).
 - .3 Vibration up to 0.5 g.
 - .4 Altitude 0 to 1250 m.
- .11 Diagnostic and indicating features:
- .1 Power On indication.
 - .2 Percentage speed indicator.
 - .3 Overload indication.
 - .4 Short circuit indication.
 - .5 Ground fault indication.
 - .6 Overvoltage indication.
 - .7 Undervoltage indication.
 - .8 High temperature (controller).
 - .9 AC voltmeter (output).
 - .10 AC ammeter (output).
 - .11 Inverter ready.
 - .12 Inverter fault.
 - .13 External fault.
- .12 Cooling System:
- .1 VFD supplier to provide adequate proven cooling devices for VFD equipment.
 - .2 VFD supplier to ensure any enclosure utilized will not allow a build-up of heat. This can be accomplished by use of fans and / or sufficient guarded, filtered openings.

- .13 Control wiring shall be TEW 105° C rise.
- .14 Terminal blocks in separate control enclosures for remote interface shall be Weidmueller SAK6N or approved equivalent.
- .15 Provide wire markers at both ends of all control wires, Electrovert Type Z or approved equivalent.
- .16 Provide all control wiring and panel devices required for operation as per the mechanical sequence of operation. This will include damper control, “occupied” mode switching, high rate push button start (remotely located) with electronic timer to shut down.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Identify mounting requirements and include all materials and labour, including concrete pads for all floor-mounted equipment.
- .2 Install VFD(s) in locations as indicated on drawings, and connect up all necessary wiring. All VFD(s) are to be mounted in the electrical room. Follow manufacturer’s recommendations for maximum distance between the VFD and the motor. The minimum clearance in front of VFDs is 1 m.
- .3 Connect VFD output to motor using drive rated cable.
- .4 Contractor shall connect all interlocks including (but not limited to) vibration switch, freeze stats, and fire alarms to the VFD. These interlocks will be active in both the Hand (local) and Auto (remote) configurations.
- .5 Contractor shall ensure that all control and stop commands shut down the drive as per manufacture’s recommended procedure (example, ramp to stop, ramp and hold, or coast to stop). Contactors on the line or load side of the drive are not an approved method of control.
- .6 MCC disconnect switch, VFD and motor isolation switch are to be labelled with proper shutdown procedures as follows:

“Caution”

“Ensure VFD is stopped before operating this switch”

“Record all faults before resetting”

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with **Section 26 05 00 - Common Work Results - For Electrical** and Manufacturer's instructions.
- .2 Operate switches, contactors to verify correct functioning.
- .3 Perform starting and stopping sequences of contactors and relays.

- .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.
- .5 Contractor to verify the sequence of operation as defined by mechanical which includes damper operation, fan start/stop and fan speed control.

