PART 1 GENERAL

1.1 DESCRIPTION

.1 This specification describes a high performance variable frequency drive (VFD) used to control the speed of a NEMA design B induction motor.

.2 Load filters shall be supplied with all drives.

.3 A building automation system serial communication module and EMCS communication card shall be supplied with all drives.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedure

.2 Section 01 35 50 – Waste Management and Disposal.

1.3 REFERENCES

.1 Referenced Standards:

- .1 Institute of Electrical and Electronic Engineers (IEEE)
  - .1 Standard 519 Guide for Harmonic Content and Control..
- .2 Underwriters laboratories (ULC)
  - .1 UL508C Power Conversion Equipment
- .3 National Electrical Manufacturer’s Association (NEMA)
  - .1 ICS 7.0, AC Adjustable Speed Drivers
- .4 International ElectroTechnical Commission (IEC)
  - .1 IEC 61800 Adjustable Speed Electrical Power Drive Systems
- .5 International Standards Organization (ISO)
  - .1 ISO-9001 Quality Management Systems

1.4 SUBMITTALS

.1 Submittals shall include the following information:

- .1 Outline dimensions, conduit entry locations and weight.
- .2 Customer connection and power wiring diagrams.
- .3 Complete technical product description include a complete list of options provided.
- .4 Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).
  - .1 The VFD manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%.

Input line filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFD's shall include a minimum of 5% impedance reactors, no exceptions**.**

.5 In accordance with Section 01 33 00.

1.5 QUALITY ASSURANCE

.1 The VFD manufacturing facility shall be ISO 9001 certified. The VFD shall be UL listed, Canadian UL listed, CSA listed, IEEE listed, and NEMA listed.

.2 All printed circuited boards shall be completely tested and burned-in before being assembled into the completed VFD. The VFD shall then be subjected to a preliminary functional test, burn-in, and computerized final test. The burn-in shall be at 40°C, at full rated load, or cycled load. Drive input power shall be continuously cycled for maximum stress and thermal variation. Conformal coating of boards shall be included for each drive.

.3 The drive shall be designed to provide 250 000 hours mean time before failure (MTBF) when the specified preventative maintenance is performed.

.4 VFD manufacturer shall have an analysis laboratory to evaluate the failure of any component. The failure analysis lab shall allow the manufacturer to perform complete electrical testing, x-ray components, and decap or delaminate components and analyze failures within the component.

PART 2 PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES

.1 The VFD package as specified herein shall be enclosed in a NEMA Type 1 or optional NEMA 12 enclosure, completely assembled and tested by the manufacturer in an ISO9001 facility. The VFD tolerated voltage window shall allow the VFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.

.1 Environmental operating conditions: 0 to 40°C continuous duty. VFD's that can operate at 40° C intermittently (during a 24 hour period) are not acceptable and must be oversized. Altitude 0 to 1000m above sea level, less than 95% humidity, non-condensing.

.2 Enclosure shall be type NEMA 1 and shall be UL listed as a plenum rated VFD. VFD's without these ratings are not acceptable.

.2 All VFD's shall have the following standard features:

.1 All VFD's shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFD's.

.2 The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference when

switching between "Hand" and "Auto" modes. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting.

.3 There shall be a built-in time clock in the VFD keypad. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays.

.4 The VFD's shall utilize pre-programmed application macros specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time.

.5 The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).

.6 The VFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.

.7 The VFD shall have an integral 5% impedance reactor to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFD's with only one DC reactor shall add AC line reactors.

.8 The VFD shall include a coordinated AC transient protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.

.9 The VFD shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay outputs shall include programmable time delays that will allow for drive acceleration from zero speed without signaling a false underload condition.

.10 If the input reference (4-20mA or 2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communication bus.

.3 All VFD's to have the following adjustments:

.1 Two (2) PID Setpoint controllers shall be standard in the drive. Two (2) programmable analog inputs shall accept current or voltage signals.

.2 Two (2) programmable analog outputs (0-20ma or 4-20 ma). The outputs may be programmed to output proportional to frequency, motor speed, output voltage, output current, motor torque, motor power (kW), DC bus voltage, active reference, and other data.

.3 Six (6) programmable digital inputs. There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad,

input contact closure, time-clock control, or serial communications) the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD digital input and allows VFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close. The keypad shall display "start enable 1 (or 2) missing". The safety status shall also be transmitted over the serial communications bus. All digital inputs shall be programmable to initiate upon an application or removal of 24VDC.

.4 Three (3) programmable digital Form-C relay outputs. The relays shall include programmable on and off delay times and adjustable hysteresis. Default settings shall be for run, not faulted (fail safe), and run permissive. The relays shall be rated for maximum switching current 6 amps at 30 VDC and 250 VAC and 0.4 A at 120 VDC; Maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS. Outputs shall be true form C type contacts; open collector outputs are not acceptable.

.5 The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and audible motor noise.

.6 The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows the highest carrier frequency without derating the VFD or operating at high carrier frequency only at low speeds.

.4 Serial Communications

.1 The VFD shall have an RS-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2 bus, and Siemens Building Technologies FLN, protocols for LonWorks, BACnet, Profibus, Ethernet, and DeviceNet shall be available. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority. Use of non-certified protocols is not allowed.

.2 Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The EMCS shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus – keypad "Hand" or "Auto" selected, bypass selected, the ability to change the PID setpoint, and the ability to force the unit to bypass. The EMCS system shall also be able to monitor if the

motor is running in the VFD mode or bypass mode (if bypass is specified) over serial communications. A minimum of 15 field parameters shall be capable of being monitored.

.3 The VFD shall allow the EMCS to control the drive's digital and analog outputs via the serial interface. This control shall be independent of any VFD function.

.5 EMI / RFI filters. All VFD's shall include EMI/RFI filters. The onboard filters shall allow the VFD assembles to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level.

.6 BYPASS FEATURES – Features to be furnished and mounted by the drive manufacturer. All features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.

.1 A complete factory wired and tested bypass system consisting of an output contactor and bypass contactor. Overload protection shall be provided in both drive and bypass modes.

.2 Door interlocked, padlockable circuit breaker that will disconnect all input power from the drive and all internally mounted options.

.3 Fast acting fuses exclusive to the VFD – fast acting fuses allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection, maintaining bypass capability. Bypass designs, which have no such fuses, or that incorporate fuses common to both the VFD and the bypass will not be accepted. Three contactor bypass schemes are not acceptable.

.4 The drive / bypass shall provide single-phase motor protection in both the VFD and bypass modes.

.5 The following indicating lights (LED type) shall be provided. A test mode or push to test feature shall be provided.

.1 Power-on (Ready)

.2 Run enable (safeties) open

.3 Drive mode select damper opening

.4 Bypass mode selected

.5 Drive running

.6 Bypass running

.7 Drive fault

.8 Bypass fault

.9 Bypass H-O-A mode

.10 Automatic transfer to bypass selected

.11 Safety open

.12 Damper opening

.13 Damper end-switch made

.6 The following relay (form C) outputs from the bypass shall be provided:

.1 System started

.2 System running

.3 Bypass override enabled

.4 Drive fault

.5 Bypass fault (motor overload or underload (broken belt))

.6 Bypass H-O-A position

.7 The digital inputs for the system shall accept 24V or 115VAC (selectable). The bypass shall incorporate internally sourced power supply and not require an external control power source.

.8 Dedicated digital input that will transfer motor from VFD mode to bypass mode upon dry contact closure for fireman's override. Two modes of operation are required.

.1 One mode forces the motor to bypass operation and overrides both the VFD and bypass H-O-A switches and forces the motor to operate across the line (test mode). The system will only respond to the digital inputs and motor protections.

.2 The second fireman's override mode remains as above, but will also defeat the overload and single-phase protection for bypass and ignore all keypad and digital inputs to the system (run until destruction).

.9 The VFD shall include a "run permissive circuit" that will provide a normally open contact whenever a run command is provided (local or remote start command in VFD or bypass mode). The VFD system (VFD or bypass) shall not operate the motor until it receives a dry contact closure from a damper or valve end-switch. When the VFD system safety interlock (fire detector, freezestat, high static pressure switch, etc) opens, the motor shall coast to a stop and the run permissive contact shall open, closing the damper or valve.

.10 Class 20 or 30 (selectable) electronic motor overload protection shall be included.

.11 There shall be an internal switch to select manual or automatic bypass.

.12 There shall be an adjustable current sensing circuit for the bypass to provide loss of load indication (broken belt) when in the bypass mode.

PART 3 PART 3 – EXECUTION

3.1 INSTALLATION

.1 Installation shall be the responsibility of the EMCS contractor. The contractor shall install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

.2 Power wiring shall be completed by the electrical contractor. Three copper conductors and a ground wire are required. Separate the input power wiring from the output power wiring in individual metallic conduit. Do not combine. Provide a separate metallic conduit for control wiring. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

3.2 START-UP

.1 Certified factory start-up shall be provided for each drive by a factory authorized service center in accordance with Section 01 81 00 Commissioning and Section 26 05 00 Common Work Results - Electrical. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.

3.3 PRODUCT SUPPORT

.1 Factory trained application engineering and service personnel that are thoroughly familiar with the VFD products offered shall be locally available at both the specifying and installation locations. A 24/365 technical support line shall be available on a toll-free line.

3.4 WARRANTY

.1 Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time and expenses. There shall be 365/24 support available via a toll free phone number.

END OF SECTION