SECTION 262923 – VARIABLE FREQUENCY DRIVES

1.0 The A/E shall evaluate the specific application of each variable frequency drive and provide life cycle costing to prove its economic viability.

2.0 VFDs shall be furnished under Division 23 and installed by Division 26.

3.0 The A/E shall consider the following issues when employing VFDs:

A. When main and standby driven equipment is to be controlled by variable frequency drives, separate drives shall be provided for each redundant piece of equipment. Manual bypass starters for VFDs are generally not required but should be considered on a case by case basis where life safety or risk of extensive losses or downtime are an issue. Where bypass starters are used, the method of system control when one or more motors are running on the constant speed bypass must be determined.

B. Equipment motors shall be matched to the drive so that stable operation and avoidance of overheating at low speeds can be realized.

C. The operational conditions (starting, running, overload) required by the application shall be defined. For example, typical overload requirements may be: variable torque = 115 percent overload for 1 min, constant torque = 150 percent overload for 1 min. VFDs shall employ torque regulation which shall override the speed command and lower frequency while maintaining Volts per Hertz control whenever load level surpasses the preset or maximum capability limit.

D. To eliminate the need for dv/dt output filters, motor nameplate rated for inverter duty in accordance with NEMA MG1, Part 31 shall be specified and provided.

E. The method in which control commands for the VFDs will be interfaced to the BAS shall be determined, i.e.:

Manual Speed Control (i.e., no BAS interface)

Speed feedback signal to BAS - Isolated analog current/voltage loop, 4-20 mA/0-10V – Loop power from VFD

Speed control signal from BAS - Isolated analog current/voltage loop, 4-20 mA/0-10V – loop power from BAS

Dry contact inputs (as/if required for):

Start/Stop
Forward/Reverse
Speed limit preset
External trip
External trip reset
Remote jog
Fire alarm/smoke control override

Isolated Dry contact outputs:

Common trouble alarm
Two (2) additional programmable output relays

Communications to BAS (normally BACNet – to be coordinated with BAS)

Where dry contact inputs are used, the VFD control circuitry shall provide the source of contact wetting voltage. Where dry contact inputs to the BAS are used, the BAS shall be the source of contact wetting voltage

F. VFD software shall include provisions for 1 internal configurable PID control loop, with inputs for:

Remote set point adjust - Isolated analog current/voltage loop, 4-20 mA/0-10V Process feedback input (pressure, temperature, flow, etc.) - Isolated analog current/voltage loop, 4-20 mA/0-10V

G. Upon interruption and restoration of incoming power supply, the VFD unit shall automatically restart and re-accelerate a spinning load when return-to-normal conditions occur.

H. To limit harmonic feedback into building electrical systems, VFD's rated 10 HP or less shall be provided with a 5% line reactor. VFD's rated more than 10 HP shall be Yaskawa Matrix drives complying with IEEE 519 harmonic distortion requirements at lineside input power terminals (lugs) shall be provided. Refer to item P below.

I. The speed range that is required and whether the load will be operated beyond base speed range and/or above 60 HZ shall be defined. Provide "critical/resonant" frequency avoidance protection.

J. It shall be determined if all parts of the rotating load are suitable for the range of vibration excitation frequencies. Perform a torsional analysis for all large and/or high inertia loads.

K. Design Professional shall verify that the motor is sized to provide the necessary load torque while operating at reduced speed. The torque capability of the motor may be restricted at low speeds. The motor torque capability shall be compared with the load requirement across the entire operating speed range. A supplemental motor driven cooling fan (blower motor) may be required for constant torque loads and shall be provided when load requires full torque at zero speed.

L. Design Professional shall ensure that the VFD specified for any given application is rated to supply the full load current or service factor current (whichever is greater) of the motor. Therefore, the VFD should be sized and rated based on current not horsepower.

M. How the VFD operates under fault conditions shall be defined; for example, the drive and system response to a mechanical overload, an electrical short circuit in the motor circuit, or a ground fault in the load system shall be understood and defined.

N. The motor protection provided by the VFD equipment and any additional protection required for comprehensive system protection, e.g., overload, overspeed, reverse rotation, short circuit, phase loss, transient voltage surge protection, etc. shall be defined.

O. The manufacturer shall be required to submit information for system operations and maintenance and provide, warranty, training, and operation and maintenance manuals as part of record documentation.

P. For VFD's with nameplate rating of 10 HP or less, the following manufacturers and models are approved for use:

Yaskawa (formerly Magnetek) (Z1000 Series).
Toshiba (Q9 and QX7)
Rockwell/Allen Bradley (PowerFlex Architecture Class)
ABB Industrial Systems (ACH 550).

For VFD's with nameplate rating exceeding 10 HP, the following manufacturers and models are approved for use:

Yaskawa Matrix Drive
ABB ACH580 Ultra Low Harmonic (ULH) VFD.

Q. The following motor requirements shall be addressed for all VFD applications:

1. Motors rated for inverter duty applications in accordance with NEMA MG1 Part 31 with 1600V insulation shall be specified and provided for all VFD applications.
2. Insulated bearings along with shaft grounding rings and brushes should be specified in order to prevent occurrence of damaging circulating currents in motor shafts and bearings.
3. In addition to being nameplate rated for inverter duty, motors shall be rated for across the line operation with 1.15 service factor. Therefore, motors shall have a dual nameplate rating.
4. In accordance with NEMA MG1 requirements, motors are not permitted to operate at loads above the base nameplate rating, regardless of any service factor ratings.
5. Motors should be specified with adequate turn-down to operate loads at the lowest required speed (example 10:1 turndown for operation of a 4-pole motor at 6Hz or 180RPM).
6. Motors used in dry indoor locations shall be open drip-proof and motors exposed to dirt indoors, in wet locations, or outdoors shall be TEFC.

4.0 The heat rejection from the VFD controller and how the losses are removed from the equipment enclosure shall be defined. Ventilation fans should be considered in units over 50 HP.

5.0 The total input power factor (PF) (i.e., real and apparent power) shall be defined. Drives should operate with an input displacement power factor that is at or near unity.

6.0 The VFD enclosure shall be suitable for the application and shall be minimum NEMA 1 for indoor dry locations, NEMA 12 for indoor locations with possible exposure to dirt, and NEMA 4X for wet or outdoor locations.

7.0 Where bypass is required, a barriered bypass controller shall be provided. The system shall be capable of operation at full motor output without damage to the system.

8.0 VFD's shall include the following features:

A. Integral disconnecting means and OCPD (thermal-magnetic circuit breaker with pad locking, door mounted handle).

B. Hand-off-auto selector switch.

C. Manual speed potentiometer.

D. Status lights, door mounted LED indicator displaying the following conditions (power on, auto,

and fault). Drives with bypass starters shall have bypass status light.

E. Graphical display terminal interface, LCD type with keypad to control, adjust, and configure the drive.

F. Network communications card.

9.0 MULTIPLE VFD's

A. When more than one VFD is required for a piece of equipment, the VFD's shall be of same manufacturer and model. Example: an air handler with supply and return fans shall have same manufacturer and model VFD for both supply and return fan motors.