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VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 GENERAL

1.01 COORDINATION

A. Variable frequency dives, not integral with mechanical equipment, shall be provided under Division 26, unless noted otherwise on the drawings. Installation and final connections shall be made under Division 26.

1.02 SUBMITTALS

A. Product data:

1. Data on every variable frequency drive to be used on project.
    a) Compliance with specified construction and safety features.
    b) Options and accessories.
    c) Harmonic filters and ratings.

B. Project record documents:

1. Include shop drawings and descriptive catalog data for starters and drives, including the following as a minimum:
    a) Manufacturer's descriptive catalog data.
    b) Short circuit ratings.
    c) Wiring diagrams and schematic ladder diagrams.
    d) Nameplate data and legends.
    e) Altitude or high ambient temperature correction calculations.

C. Operation and maintenance data:

1. Include documentation of inspections and tests performed, including logs, curves, and certificates.
2. Documentation shall note replacement of equipment or components that failed during testing.

PART 2 PRODUCTS

2.01 APPROVED MANUFACTURERS

A. Variable frequency drives:

1. ABB
2. Yaskawa
3. Dan Foss
4. Square D / Schneider Electric

2.02 VARIABLE FREQUENCY DRIVES (VFD)

A. VFDs shall convert constant frequency three phase AC line voltage to variable frequency, variable voltage AC output suitable for control of standard NEMA design B induction motor.

B. Ratings:

1. Minimum VFD efficiency: 97% at 100% speed and 100% torque.
2. Rated input power: [460] [208] volts ± 10%, 3 phase, 60 Hz ± 5%.
3. Rated output power: 0 to [460] [208] volts (± 1%), 3 phase, 0 to 60 Hz (field adjustable to 90 Hz or 120 Hz).

4. Output frequency stabilizer: ±0.25% of maximum frequency.
5. Ambient temperature range: 0 to 40°C.
6. Elevation: De-rate for elevation of 5400 feet.
7. Power unit rating basis: 100% rated current continuous.
8. Displacement power factor: Minimum 98% over entire speed range.
9. Overload capacity: 110% for one minute at 40°C.
10. Speed range: 10:1.

C. Construction:
1. Full-wave bridge converter to convert incoming fixed voltage/frequency to controlled DC voltage.
2. DC bus filter and chopper circuit to maintain minimum displacement power factor of 0.98 over entire speed range.
3. Inverter section to change controlled DC voltage to six-step adjustable voltage/frequency output, generated by power transistors controlled by six identical base driver circuits. VFD shall not induce excessive power losses in motor. Worst case RMS motor line current measured at rated speed, torque, voltage shall not exceed 1.05 times rated RMS motor current for pure sine-wave operation.
4. UL listed, factory wired and mounted in NEMA 1 wall mounted enclosures requiring front access only.
   a) Door of each power unit shall include power on light, VFD fault light, VFD run light, stop pushbutton, start pushbutton, fault reset pushbutton, hand-off-auto selector switch, manual speed control potentiometer.

D. Basic features:
1. Control:
   a) With H-O-A switch in hand, driver shall be controlled by manual speed potentiometer on drive door.
   b) With H-O-A switch in automatic, drive shall be started and stopped and speed controlled by external control signals provided by others. Speed control switch shall be verified with temperature control installer.
   c) With H-O-A switch in offsetting, run circuit shall be open and VFD shall not operate.
2. Field adjustments:
   a) Inverse-time overcurrent trip: 50% to 110%.
   b) Minimum speed: 0% to 100%.
   c) Maximum speed: 0% to 100%.
   d) Volts/Hertz: 3.7 to 8.6 V/Hz.
   e) Independent acceleration/deceleration rates: 0.5 to 120 seconds. Regenerative or dynamic braking shall not be required for deceleration.
   f) Voltage boost: 0 to 20 volts.
   g) Maximum frequency: 60, 90, 120 Hz.
3. Protective features and circuits:
   a) Input line fuses.
   b) Input line noise suppression with line reactor, metal oxide varistor (MOVs), and snubber circuits.
   c) Instantaneous overcurrent and inverse time overcurrent protection.
   d) Individual transistor overcurrent protection.
   e) Input under voltage (-15%) trip.

f) Three cycle power ride-through capability.

g) Missing phase or blown fuse protection.

h) Chopper circuit overcurrent protection.

i) Chopper power supply failure.

j) Thermal overload trip.

k) Pre-charge failure.

l) Ground fault protection on start-up.

m) Output line-to-line short circuit protection.

4. Arrange VFD to provide automatic restart after trip condition from overcurrent, overvoltage, undervoltage, overtemperature. Drive shall shut down and require manual reset and restart if automatic reset/restart function is not successful within maximum five attempts.

5. VFD shall have ability to start into motor that is spinning in forward direction and resume normal operation upon auto-restart of drive.

6. VFD shall incorporate energy saver circuit which shall improve motor efficiency at reduced speeds.

E. Diagnostic features and fault handling:

1. The following conditions shall cause safe drive shutdown:

a) Loss of input power.

b) Under voltage.

c) Sustained gradual overload.

d) Instantaneous severe overload.

e) Power transistor over temperature.

f) Blown fuse.

g) Logic power supply failure.

2. VFD shall have internal digital display indicating following trip condition as aid in troubleshooting. Faults:

a) Excess start time.

b) Power supply or low line.

c) Blown fuse or missing phase.

d) Ground fault.

e) Instantaneous overcurrent.

f) Inverse time overcurrent.

g) Over temperature.

h) Provide SPDT contacts for external trip indication.

F. Metering, features and enclosure:

1. Special features shall be factory mounted and wired within VFD enclosures unless otherwise specified.

2. The AC drive power converter shall be enclosed in a Type 1, Type 12K, or Type 3R enclosure with a circuit breaker disconnect, industrial rated operator controls, user terminal strip connections and bypass controls (if required).

3. Input circuit breaker: Panel mounted and interlocked with enclosure door, with through-the-door handle to provide positive disconnect of incoming AC power, rated for minimum 14,000 AIC.

4. Door mounted meters:

a) Ammeter (0% - 100%).

b) Speed/frequency meter (0% - 100% speed/Hz).

c) Voltmeter (0-600 VAC).

d) KW Meter (0-110%)..

e) 5-digit elapsed time meter

5. Constant speed bypass: Transfer from VFD to line shall be by manual selector switch.

a) Bypass circuitry: Enclosed in separate NEMA 1 cabinet, bolted to bottom of VFD enclosure, with main disconnect switch or circuit breaker interlocked with bypass compartment door (in addition to VFD compartment disconnect)

6. Bypass cabinet shall include VFD output contactor, full-voltage starting contactor (both contactors electrically interlocked), thermal overload relay to provide motor protection and control power transformer. Mount bypass selector switch, motor fault light, power light, motor on VFD light, motor on-line light on cabinet door.

7. Provide speed profile whereby individual field adjustment settings for start, stop, entry, exit, slope, minimum and maximum speed points can be set to respond to input speed signal.

8. Mount input line reactor within VFD enclosure to limit total harmonic distortion (THD) on input lines to 3% per IEEE-519.

9. Include critical speed avoidance circuit for selection of critical speed with rejection band centered on that speed. Drive shall ignore any speed signals requiring drive operation within rejection band.

G. Integrated Building Automation System (IBAS): Coordinate controls standards with the DPS and the DPS Controls Application Engineer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFDs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Examine VFD before installation. Reject VFDs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 26 05 29 "Hangers and Supports for Electrical Systems."

B. Roof-Mounting Controllers: Install VFD on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.

1. Curbs and roof penetrations are specified in Section 07 72 00 "Roof Accessories."

2. Structural-steel channels are specified in Section 26 05 29 "Hangers and Supports for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in each fusible-switch VFD.

E. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.

F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

G. Comply with NECA 1.

3.03 IDENTIFICATION

A. Identify VFDs, components, and control wiring. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each VFD with engraved nameplate.

3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFDs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFD units.

3.04 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.05 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

3.06 COMMISSIONING

A. Together with driven load, test VFD and demonstrate proper operation of all functions and diagnostics.

3.07 OWNER INSTRUCTION

A. Provide instruction (4 hours) to Owner's maintenance representatives on operation and trouble shooting of VFDs.

END OF SECTION 26 29 23