SECTION 23 05 13 - MOTORS

PART 1 - GENERAL

1.1 SYSTEM DESIGN REQUIREMENTS

A. Provide mechanical/electrical coordination schedule on the drawings and coordination section in the specifications to clarify power and control wiring.

B. Altitude Deration: Motors shall operate within nameplate horsepower at 5000 feet elevation. Do not operate on service factor.

C. Energy Efficiency: Select and specify energy efficient motors with nominal efficiency equal to or greater than that stated in NEMA MG 1, 1.41.3, for motor type and rating. Motors specifically manufactured for a particular piece of equipment with a lower efficiency shall be brought to the attention of the Project Manager.

D. On variable frequency drives (VFD) applications Provide motors rated for inverter-duty with attached steel nameplate indicating “Inverter-Duty Motor”

E. Use VFDs to drive motors 1- horsepower or larger on variable flow systems

F. Starters: Starters shall be specified in Division 26 . Consult with Electrical Engineer and ensure starters are scheduled and provided.

G. Motor drive sheaves shall be a minimum of one size smaller than the driven pulleys. No variable pitched sheaves allowed.

H. Motor Control Centers:
1. Where a large group of starters can be centrally located, it will be beneficial to have these assembled in a motor control center (MCC) and specified in Division 26.
2. Where starters are specified in a MCC in Division 26, close coordination is required with the Electrical Engineer to make sure starters match specific motor requirements for part winding start, auto transformer type starting, wye/star-delta closed transition type or where two speed motors have been specified.
3. Provide adequate space in design for installation of field panels to contain relays and point cards for remote start-stop and status indication.

I. Manual Control:
1. Specify maintained-contact push buttons with pilot lights for single-speed or multi-speed operation.

J. Automatic Control:
1. Specify magnetic starters for motors 1/2 horsepower and larger and for smaller motors with interlock or automatic operation.
2. Specify auxiliary contacts if needed. Provide space for future.
3. Specify “Hand-Off-Automatic” switches in starter cover with externally operated manual reset.
4. Specify trip-free thermal overload relays for each phase. Size for 125 percent of rated load.

1.2 WARRANTY

A. Provide option for an extended warranty package on variable frequency drive package including motor matched to drive.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Motors
      a. Baldor
      b. Magneteck
      c. Toshiba
   2. Variable Frequency Drives: Purchase VFD and motor from one distributor. Drive manufacturers shall submit a list of acceptable motors for use with the proposed drive.
      a. Toshiba
      b. Siemens
      c. ABB
      d. Yaskawa
   3. Shaft Grounding Kits:
      a. Preferred: Helwig Carbon BPK
      b. Other options: SGS

2.2 MATERIALS, GENERAL

A. Motor Frames and Mounts: Equip motor frames with two axis adjustments, namely slotted frame ends for adjusting in shaft direction and two adjusting screws for belt tensioning.
   1. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.
   2. Motors shall be capable of starting the driven equipment while operating at 90 percent rated terminal voltage.
   3. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
   4. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design “B”, except “C” where required for high starting torque.
   5. Provide inverter-duty motors specifically designed for variable speed operation with premium efficiency at part load conditions a constructed with Class F insulation for equipment specified to operate with variable frequency drives.
   6. Phases and Current characteristics: Unless indicated otherwise, provide squirrel-cage induction poly-phase motors for 3/4 hp and larger, and provide capacitor-start single-phase motors for 1/2 hp and smaller, except 1/6 hp and smaller may be split-phase type.
   7. Provide motors for operation at 5000 foot elevation or higher.
   8. Motors smaller than 1 hp to be single-phase. Motors larger than 1 hp to be 3-phase.
   9. Motors 1 HP and larger shall be inverter-duty, with nominal efficiency equal to or greater than that stated in NEMA Standard MG1, 1.41.3.
   10. Match motor electrically to the drive (a package unit).
   11. Motors for pulse-width modulating (PWM) drives will have both motor bearings isolated.
   12. Motors, 5hp and larger, must be driven by PWM.
   13. Bearings:
      a. Ball or roller bearings with inner and outer seals on sizes up to 1.5”. Ball or roller bearings with inner and outer shields on sizes greater than 1.5” shaft dia.
      b. Regreasable except permanently sealed where motor is normally inaccessible for regular maintenance.
      c. Sleeve type for light-duty, fractional horsepower equipment.

B. Drives:
   1. Rated capacity of V-Belt drives shall not be less than 150 percent of motor nameplate horsepower.
   2. Fixed pitch sheaves, including single groove fan sheaves shall be of the bushed type. No fixed pitch sheave shall be smaller than 3” dia.
   3. Variable pitch sheaves are not allowed.

4. Provide OSHA approved belt guard with tachometer holes.
5. For equipment serving hazardous or critical systems such as fume hoods, and bio-hazards, provide fans with a minimum of two-groove sheaves and fan belts.

C. Variable Frequency Drives:
1. Drive shall convert constant frequency AC line voltage to a variable frequency, variable voltage AC output suitable for control of variable frequency, NEMA design B induction motor, with full-load amp rating between 10 percent and 110 percent of the drive full load current capability, without requiring modifications to the motor or drive.
2. VFD for motors shall have the following features.
   a. One motor per drive. No sharing of drive by two motors, except for air handler "fan –wall" applications. Provide separate overload for each fan in "fan wall".
   b. Pulse width modulation.
   c. Enclosure type - NEMA 1. Provide bypass power and controls in separate enclosure.
   d. AC line fused disconnect or circuit breaker. Provide door interlock disconnect.
   e. AC line reactors in drive cabinet for protection against line notching and surges without requirement for an input isolation transformer. Minimum impedance of line reactors shall be 2.5 percent. Maximum total harmonic distortion shall not exceed 3 percent per IEEE. Input isolation transformers are not permitted.
   f. Metal oxide varistors on incoming line for transient protection.
   g. Manual speed potentiometer, HAND-OFF-AUTO switch and 4-20 milli-amp signal follower, fully isolated and suitable for grounded or ungrounded input signal.
   h. RS485 communication port and protocol capable of full communication with the Siemens FLN. The drive control should act as an application and allow monitoring and manipulation of points from the Siemens front-end software. VFD parameters to be password protected. VFDs shall stop when there is no longer communication to the BAS system, unless otherwise required.
   i. Current Rating: A minimum continuous current rating of the VFD shall be a continuous ampere rating suitable for operation of a premium efficiency motor, VFD continuous amps shall not be less than the amps specified in NEC Table 430-150 for the specified horsepower motor. Additionally, provide VFD to operate at 125 percent of design motor load. Overcurrent rating shall be 110 percent for one minute minimum.
   j. Instantaneous overcurrent shutdown with indicator lamp when current exceeds 200% of nameplate values.
   k. Inverse characteristic time-overcurrent overload protection for the motor sized in accordance with NEC requirements.
   l. Drive shall be capable of withstanding random application of an output short circuit without damage to drive components or fuses.
   m. Input phase loss and under voltage protection.
   n. Torque/current limit control which will slow the motor without tripping when the motor is subjected to an overload, or slow the acceleration ramp when accelerating a high inertia load.
   o. Automatic restart circuitry to restart motor after a momentary or sustained power failure, phase loss, or non-damaging fault trip. No more than 5 restart attempts should be allowed before lockout. Auto restart feature shall be switch defeatable. For fan applications, the VFD shall be capable of restarting into a spinning load.
   p. Cabinet ground lug in VFD enclosure.
   q. Troubleshooting diagnostic features of diagnostic fault display to show reason for trip. Display shall differentiate between: input under voltage, input phase loss or blown fuse, instantaneous overcurrent, sustained motor overload, heat sink over-temperature, over voltage, etc. Diagnostic test unit may be of the plug-in type, with one test unit provided for several VFDs. If plug-in type unit is provided, provide minimum of one for each building.
   r. LED indicators, for all normal operation functions, including on-off status of all power SCRs or transistors, and bypass LED indication when the drive is in bypass.
   s. Test mode switch to allow operation and setup of control electronics with power circuitry disabled.

t. Availability of critical speed avoidance option which could be added to VFD in the field at a future date.
u. UL listed.
v. Rated and sized for 5000 foot elevation operating condition.
w. Automatic soft start feature to start motor at lowest speed and ramp slowly up to required speed on start-up and for any abrupt increases in required speed.
x. Factory test of each unit for a minimum of 2 hours of burning at elevated temperatures of 122-176 degree F prior to shipping.
y. Bypass device (automatic and manual) to allow for total isolation of drive unit for service, while providing for temporary operation of motor. This shall include:
    1) A main disconnect switch in the bypass enclosure with a door interlock handle which provides positive shutdown of all power to both bypass circuitry and VFD. The by-pass shall be in a separate enclosure from the VFD.
    2) VFD output contactor and a constant speed contactor.
    3) Three pole motor overload relay with heaters connected to shut down the motor in both VFD and bypass modes.
    4) Timing relay adjustable 5-30 seconds to prevent rapid switching from bypass to VFD modes.
    5) A control relay and terminal blocks which allows two-wire, start-stop control of motor from a single remote contact in both VFD and bypass (auto) modes.
    6) Control relay and terminal blocks to allow connection of remote interlock shutdown contacts such as freeze stats, smoke detectors, etc. When this interlock loop is opened, operation of the motor shall be disabled in both VFD and bypass modes.
    7) Four position oil-tight selector switch for VFD-OFF-BYPASS (AUTO)-BYPASS (MANUAL). Indicator lights on face of bypass panel with long life neon or transformer type incandescent bulbs to indicate "POWER ON", "MOTOR ON VFD", "MOTOR ON BYPASS CONTROL", "MOTOR OVERLOAD", "INTERLOCK SHUTDOWN".
    8) 120 volt control power transformer with fused secondary and primary.
    9) Bypass mode operation shall be independent of VFD control power.
    10) Output contactor shall be wired to allow a controlled VFD deceleration ramp to stop.
    11) Panel shall be arranged to allow power-off maintenance of VFD while motor is operating on bypass. Bypass circuitry in same compartment as VFD is not permitted.
z. Locate test switches, LED readouts or digital readouts on outside of panel.
aa. Correction for long-lead length as pertains to over voltage problems at the motor will be the responsibility of the installer. Electrical correction will be implemented as required to achieve and maintain safe and smooth motor operation. Leads shall not be longer than 50 ft.
bb. Provide current transformers with adjustable, internal, current sensitive, normally open and normally closed contacts (one each), for Bypass, Drive, and motor contactor conductors (for status).
cc. At least two pre-set speed-control modes in drive circuitry.
dd. Disconnect at motor shall have auxiliary contact so that when disconnect is opened, the control circuitry to the drive will be interrupted.
ee. VFDs shall not be located inside the cabinets of controlled equipment.
ff. VFD shall control interlock with associated damper end switches. Coordinate with sequence of operations.
gg. VFDs to be programmed for speed not less than 18Hz or 30%.

3. Spare Parts: Refer to Section 01 78 46 – Extra Stock Materials.
4. Provide shaft grounding kits for all motors used with VFDs.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Motor Frames and Mounts: Mounts for adjustments of belt tension shall be of the two-pull variety.

B. Variable Frequency Drives: Install floor mounted variable frequency drives on 4-inch high concrete housekeeping pad.

C. Correction for long-lead length at the motor will be the responsibility of the installer. Electrical correction will be implemented as required to achieve and maintain safe and smooth motor operation.

D. Disconnect at the motor shall have auxiliary contact so that when disconnect is opened the control circuitry to the drive will be interrupted. Provided by Division 26.

E. VFD shall have sheet metal splash pans above the drives when hydronic piping is located above the VFD.

3.2 TESTING, CLEANING, AND CERTIFICATION

A. Factory test variable frequency drives under simulated operation. Provide certification of factory test.

B. Testing: Test and start VFD's and bypass under actual conditions by factory trained personnel. Operate VFD's through its full range to determine resonant speeds,.

3.3 COMMISSIONING (DEMONSTRATION)

A. Start-up of variable frequency drive equipment shall be performed by factory authorized representative. Provide checklist certifying equipment startup and operation.

3.4 TRAINING

A. Provide the university's representative 2 hours of training by factory authorized representative for each variable frequency drive installed. Training includes startup, shutdown, emergency operation, maintenance and servicing.

PART 4 - CHANGE LOG

11/4/2021 1. Added Yaskawa to 2.1, A, 2., Updated shaft grounding kits.

END OF SECTION 23 05 13