SECTION 26 2923 –VARIABLE SPEED DRIVES

Maintain Section format, including the UH master spec designation and version date in bold in the center columns of the header and footer. Complete the header and footer with Project information.

Edit and finalize this Section, where prompted by Editor's notes, to suit Project specific requirements. Make selections for the Project at text identified in bold.

This Section uses the term "Engineer." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

Delete hidden text after this Section has been edited for the Project.

PART 1 - GENERAL

1.1   RELATED DOCUMENTS

   A.   Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

   B.   Contractor's attention is specifically directed, but not limited, to the following documents for additional requirements:

      1.   The current version of the *Uniform General Conditions for Construction Contracts*, State of Texas, available on the web site of the Texas Facilities Commission.

      2.   The University of Houston's Supplemental General Conditions and Special Conditions for Construction.

1.2   DESCRIPTION OF WORK

   A.   Work Included: The extent of variable speed drive (VSD) work is as scheduled, shown on the Drawings, as indicated by the requirements of this Section, and as specified elsewhere in these Specifications.

   B.   Types: The types of variable speed drives required for the project include, but are not limited to variable frequency motor speed controllers.

1.3   STANDARDS

   A.   Products shall be designed, manufactured, tested, and installed in compliance with the following standards, as applicable:

      1. NEMA ICS 2   Industrial Control Devices, Controllers and Assemblies.
      2. NEMA KS 1   Enclosed Switches
      3. NEMA ICS7   Adjustable Speed Drives.
      4. NEMA ICS61800-2. Adjustable Speed Electrical Power Drive Systems
      5. UL-508C.   Standard for Power Conversion Equipment

      6.   IEEE 519   Recommended Practice and Requirements for Harmonic Control in Electric Power Systems

B.   Each VSD shall comply with the applicable requirements of the latest standards of ANSI and IEEE-519 such as, but not limited to, 5 percent voltage distortion and line notching category. Computations or computer simulations shall be provided with the submittals to confirm compliance. The VSD manufacturer shall supply all necessary items to comply with IEEE 519.

C.   VSD design and construction shall comply with all applicable provisions of the National Electric Code.

1.4   QUALITY ASSURANCE

A.   Manufacturers: Provide products complying with these specifications and produced by one of the following:

      1.   ABB ACH Series
      2.   Toshiba.
      3.   Yaskawa.

B.   Products supplied under this section must be of domestic (USA) origin and manufacture.

C.   UL Standards: VSDs shall conform to all applicable UL Standards and shall be UL-listed.

1.5   SUBMITTALS

A.   Shop drawing submittals shall include, but not be limited to, the following:

      1.   Cut sheets of individual VSDs with construction, dimensions, weights, ratings, voltage, poles, options, and all associated accessories clearly indicated.

      2.   Wiring diagrams for the drive power, bypass, and control sections.

      3.   A detailed description of drive operation and adjustable parameters.

      4.   A detailed description of factory testing.

      5.   Additional information as required in Section 23 0516 "Common Motor Requirements for HVAC Equipment."

1.6   PRODUCT DELIVERY, STORAGE AND HANDLING

A.   Store VSDs in a clean, dry space. Maintain factory-wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B.   Handle VSDs carefully to avoid damage to material components, enclosure and finish.

PART 2 - PRODUCTS

2.1   VARIABLE SPEED DRIVES

A.   VSD package as specified herein and defined on the drive schedule shall be enclosed in a UL Type enclosure, completely assembled and tested by the manufacturer to ISO9001 standards.

B.   VSD shall provide full rated output from a line of + 10 percent to – 15 percent of nominal voltage. The drive shall continue to operate without faulting from a line of + 25 percent to – 35 percent of nominal voltage.

      1.   VSD shall be capable of continuous full load operation under the following environmental operating conditions:

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     a. Ambient temperature -15 to 40° C (5 to 104° F).

     b. Altitude 0 to 1000 m (0 to 3,300 feet) above sea level.

     c. Humidity 5 to 95 percent, non-condensing.

C. VSD shall utilize an Advanced Control Panel (keypad) user interface.

  1. The control panel shall include the followings controls:

     a. Four navigation keys (Up, Down, Left, Right) and two soft keys to simplify operation and programming.

     b. Hand-Off-Auto selections and manual speed control without having to navigate to a parameter.

     c. Fault Reset and Help keys. The Help key shall include assistance for programming and troubleshooting.

  2. The control panel shall display the following items; output frequency, output current, reference signal, drive name, time, and operating mode (Hand vs Auto, Run vs Stop). Bi-color (red/green) status LED shall be included. Drive (equipment) name shall be customizable.

  3. There shall be a built-in time clock in the control panel. The clock shall have a battery backup with 10 years minimum life span. Daylight savings time shall be selectable.

  4. I/O Summary display with a single screen shall indicate and provide:

     a. The status/values of all analog inputs, analog outputs, digital inputs, and relay outputs. Drives that require access to internal or live components to measure these values, are not acceptable.

     b. The programmed function of all analog inputs, analog outputs, digital inputs, and relay outputs.

     c. The ability to force individual digital I/O high or low and individual analog I/O to desired value, for increased personal protection during drive commissioning and troubleshooting. Drives that require access to internal or live components to perform these functions, are not acceptable.

  5. The control panel shall be removable, capable of remote mounting.

  6. The LCD screen shall be backlit with the ability to adjust the screen brightness and contrast, with inverted contrast mode.

  7. Primary settings for the VSD shall provide quick set-up of all parameters and customer interfaces to reduce programming time.

  8. VSD shall be able to operate with the control panel removed.

D. VSD shall have the following hardware features/characteristics:

  1. Two (2) programmable analog inputs shall accept current or voltage signals. Current or Voltage selection configured via control panel.

  2. Two (2) programmable analog outputs. At least one of the analog outputs shall be adjustable for current or voltage signal, configured via control panel.

  3. Six (6) programmable digital inputs. All digital inputs shall be programmable to support both active high and active low logic, and shall include adjustable on/off time delays. The digital input shall be capable of accepting both 24 VDC and 24 VAC.

4.   Three (3) programmable Form-C relay outputs. The relay outputs shall include programmable on/off time delays. The relays shall be rated for a continuous current rating of 2 Amps. Maximum switching voltage of 250 VAC / 30 VDC.

5.   Drive terminal blocks shall be color coded for easy identification of function.

6.   An auxiliary power supply rated at 24 VDC, 250 mA shall be included.

7.   The VSD shall have internal impedance equivalent to 5 percent to reduce the harmonics to the power line. Refer to Section 26 0573 "Power Systems Studies" for harmonic study information. Harmonic migration shall comply with IEEE 519.

8.   The overload rating of the drive shall be 110 percent of its normal duty current rating for 1 minute every 10 minutes, 130 percent overload for 2 seconds every minute.

9.   The input current rating of the drive shall not be greater than the output current rating.

10.   Earth (ground) fault detection shall function in both modulating (running) and non-modulating modes.

11.   Coordinated AC transient surge protection system consisting of 4 MOVs (phase-to-phase and phase-to-ground), a capacitor clamp, and internal chokes. The MOVs shall comply with UL 1449 latest Edition.

12.   VSD shall include a robust DC bus to provide short term power-loss ride through. The DC bus Joule to drive kVA ratio shall be 4.5 J/kVA or higher. An inertia-based ride through function should help maintain the DC bus voltage during power loss events.

E.   VSD shall have the following software features:

1.   A Fault Logger that stores the last 16 faults in non-volatile memory.

   a.   The most recent 5 faults save at least 9 data points, including but not limited to: Time/date, frequency, DC bus voltage, motor current, DI status, temperature, and status words.

   b.   The date and time of each fault and fault reset attempt shall be stored in the Fault Logger.

2.   An Event Logger that stores the last 16 warnings or events that occurred, in non-volatile memory.

   a.   Events shall include: Warning messages, checksum mismatch, run permissive open, start interlock open, and automatic reset of a fault.

   b.   The date and time of each event's start and completion points shall be stored in the Event Logger.

3.   Programmable loss-of-load (broken belt / coupling) indication. Indication shall be selectable as a control panel warning, relay output, or over network communications. This function to include a programmable time delay to eliminate false loss-of-load indications.

4.   External fault circuit – Three separate external fault inputs shall be provided. This circuit shall have the same features and functionality as the start interlock circuit, except it shall require a manual reset before the drive is allowed to operate the motor.

5.   The ability to automatically restart after an over-current, over-voltage, under-voltage, external fault, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable. Each of these faults may have automatic restart individually disabled via a parameter selection.

6.   Three (3) programmable critical frequency lockout ranges to prevent the drive from operating the load continuously at an unstable speed/load.

7.   Seven (7) programmable preset frequencies/speeds.

8. Two independently adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps.

9. VSD shall include a fireman's override mode. Upon receipt of a contact closure from the Fire Alarm Life Safety system, VSD shall operate in a dedicated Override mode distinct and separate from the drive's Normal operation mode. The following features will be available in the drive override function:

   a. The Override mode shall be secured by password to prevent changes once programmed.

   b. The drive shall ignore external inputs and commands not defined as part of the override function.

   c. Override operation mode shall be selectable between: single frequency, multiple fixed frequencies, follow an analog input signal, or come to a forced stop.

   d. The drive shall be configurable to receive from 1 to 3 discrete digital input signals and operate at up to three discrete speeds.

F. Network Communications

   1. The drive shall have Ethernet with TCPIP and RS-485 ports with removable terminal blocks. The onboard protocols shall be BACnet and Modbus.

G. Disconnect – A Disconnect switch shall be provided when indicated on the drive schedule. The disconnect shall be door interlocked and padlockable. Drive input fusing shall be included on all packaged units that include a disconnecting means. All disconnect configurations shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.

H. Bypass – Bypass drive packages shall be provided when indicated on the drive schedule. All drive/bypass configurations shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.

   1. The drive and bypass package shall be a complete factory wired and tested bypass system consisting of a padlockable disconnect device, drive output contactor, bypass contactor, and drive input fuses.

   2. The drive and bypass package shall have a UL listed short circuit current rating of 100 kA, for 240 VAC and 480 VAC systems, and this rating shall be indicated on the rating label.

   3. The bypass control shall be powered by a three-phase switch mode power supply with a voltage tolerance of + 30 percent, - 35 percent.

   4. Bypass package shall utilize a dedicated LCD bypass control panel (keypad) user interface. The bypass control panel must be a separate display from the drive control panel.

      a. The bypass shall include a two-line, 20-character LCD display. The display shall allow the user to access parameters and view:

         1) Bypass input voltage, current (Amps) and power (kW)
         2) Bypass faults, warnings, and fault logs

      b. The bypass control panel shall include the following controls:

         1) Four navigation keys (Up, Down, Enter, Escape)
         2) Bypass Hand-Off-Auto, Drive mode / Bypass mode selectors, Bypass fault reset

      c. The following indicating lights (LED type) or control panel display indications shall be provided.

         1) Drive mode selected, Bypass mode selected

        2)   Drive running, Bypass running

        3)   Drive fault, Bypass fault

    d.   Safety interlock and run permissive status shall be displayed using predetermined application specific nomenclature, such as: Damper end switch, smoke alarm, vibration trip, and overpressure.

  5.   The bypasses shall have the following hardware features/characteristics:

    a.   Six (6) digital inputs and five (5) Form-C relay outputs. The digital inputs shall be capable of accepting both 24 VDC and 24 VAC. The bypass control board shall include an auxiliary power supply rated 24 VDC, 250 mA.

    b.   The bypass shall be able to detect a single-phase input power condition while running in bypass, disengage the motor, and provide a single-phase input power indication.

    c.   The bypass shall be designed for stand-alone operation and be completely functional in both Hand and Automatic modes, even if the drive and/or drive's control board has failed. Network communications shall remain functional.

  6.   All bypasses shall have the following software features:

    a.   Programmable loss-of-load (broken belt / coupling) indication shall be functional in drive and bypass mode.

    b.   The bypass shall include a selection for either manual or automatic transfer to bypass. The automatic transfer mode shall allow the user to select the specific drive fault types that result in an automatic transfer to bypass. The automatic transfer mode shall not allow a transfer to bypass on motor related faults.

    c.   Selectable Class 20 electronic motor overload protection shall be included in both drive and bypass mode.

    d.   The drive and bypass shall be designed to operate as an integrated system when in Override mode.

  7.   Network communications – the bypass shall include BACnet and Modbus.

PART 3 - EXECUTION

3.1   INSTALLATION OF VARIABLE SPEED DRIVES

  A.   General: Install variable speed drives where shown, in accordance with the manufacturer's written instructions, the applicable requirements of the NEC and the NECA's "Standard of Installation", and recognized industry practices to ensure that products serve the intended function.

  B.   Supports: Provide all variable speed drives with galvanized angle or other suitable supports where mounting on wall or other rigid surface is impractical. Drives shall not be supported by conduit alone. Where drives are mounted on equipment served, the drive shall not inhibit removal of any service panels or interfere with any required access areas. All drives shall be installed plumb and aligned in the plane of the wall in/on which they are installed.

  C.   Coordination: The Division 23 Contractor shall coordinate variable speed drive selection and installation including, but not limited to, the following:

    1. Coordinate power wiring to variable speed drives and served motors with the Division 26 Contractor.

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    2. Coordinate selection of variable speed drives and served motors to insure compatibility.

    3. Coordinate variable speed drive control interface with controls and sequence of operation specified in.

3.2   START-UP/TESTING

A.   Pre-energization Check: The Division 26 Contractor shall check variable speed drive power wiring for continuity of circuits and for short circuits.

B.   Start-up Services: A representative of the variable speed drive manufacturer shall provide start-up services for each drive including, but not limited to, the following:

    1. Check out of drive control and power wiring.

    2. Start-up drive and demonstrate proper manual, automatic, and bypass operation.

    3. Adjust variable speed drive overload protection and other adjustable parameters to suit project requirements.

C.   Motor/Controller Coordination Documentation: Provide motor/controller coordination documents including, but not limited to, the following information in the operation and maintenance manuals.

    1. Motor size in Horsepower.

    2. Motor full load Amps.

    3. Motor efficiency.

    4. Motor service factor.

    5. Size and manufacturer's catalog number of variable speed drives.

    6. Setting of variable speed drive overload protection and other adjustable parameters.

D.   Motor Rotation: Verify that motor rotation is correct as connected. Where rotation must be changed, the Division 26 Contractor shall reconnect phase conductors to motor leads at motor junction box.

3.3   TRAINING

A.   General: A representative of the variable speed drive manufacturers shall provide for and present to the Owner, at no cost, a training and troubleshooting course at the owner's location. This course shall be comprised of 2 days of classroom instruction for 4 hours per day complete with visual aids, documentation, circuit diagrams and hands-on training. This course is not to be construed as a sales meeting, but rather as a school to familiarize the owner with the care, troubleshooting, and servicing of the variable speed drives. The manufacturer's representative shall provide a list of recommended spare parts.

3.4   IDENTIFICATION

A.   Refer to Section 26 0553 "Identification for Electrical Systems" for VSD nameplate identification requirements.

B.   Each variable speed drive shall have an internal wiring diagram on the inside of the drive cover and shall be labeled inside the cover to indicate the type, ampacity and horsepower rating of the unit.

    END OF SECTION 26 2923