Jones & Henry
ENGINEERS, LTD.

City Of Carmel
West Ground Storage Tank Booster Pump Station

ADDENDUM 6

November 27, 2024

Planholders on the City of Carmel Ground Storage Tank Booster Pump Station project are hereby notified of the following amendments to the Contract Documents. This Addendum is hereby made a part of the Contract Documents.

SPECIFICATIONS

The attached Specification 26 10 00 – Variable Frequency Motor Controllers shall be added to the Contract Documents.

PART 1 GENERAL

1.01 WORK INCLUDED

A. Provide variable frequency drive controllers as herein specified for the following:
   1. Water booster pumps

B. HP rating of controller shall be as scheduled for the pump and fan served.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Grounding and Bonding: 26 05 26

B. Identification of Electrical Systems: 26 05 53

C. Overcurrent Protective Device Coordination Study: 26 05 73

D. Performance Testing: 26 08 01

E. Low Voltage Controllers: 26 29 00

1.03 QUALIFICATIONS

A. Variable frequency drives and options shall be UL listed as a complete assembly. Variable frequency drives that require the customer to supply external fuses for the variable frequency drives to be UL listed are not acceptable. Variable frequency drives with red label UL stickers, requiring additional branch circuit protection are not acceptable. The base variable frequency drive shall be UL listed for 100 KAIC without the need for input fuses.

B. CE Mark - The variable frequency drives shall conform to the European Union Electro Magnetic Compatibility directive, a requirement for CE marking. The variable frequency drive shall meet product standard EN 61800-3 for the First Environment restricted level.

1.04 SUBMITTALS

A. Submit shop drawings for variable frequency speed controller(s) including wiring diagrams in accordance with Specification Section 23 05 01, General Provisions.

B. 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 including a complete list of options provided.
   4. Compliance to IEEE519 - harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).
      a. The variable frequency drive manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input filters shall be sized and provided as required by the variable frequency drive manufacturer to ensure compliance with IEEE standard 519. All variable frequency drives shall include a minimum of 5% impedance reactors, no exceptions.

1.05 CODE AND STANDARDS

Drive(s) shall be built to applicable NEMA standards and be suitable for use as a component to meet NEC requirements. Drive is to be listed by Underwriters Laboratories (UL), CSA and IEC-146 approved.

1.06 QUALITY ASSURANCE

A. All material shall be inspected and/or tested for conformance to quality assurance specifications. All chips (CMOS,TTL, LINEAR, etc.) shall be functionally tested.

B. All subassemblies shall be inspected and/or tested for conformance to vendors engineering and quality assurance specifications.

C. The completed drive shall be functionally tested with a motor before shipment to assure proper operation per specifications. The variable frequency drives must be tested at 40° C for a minimum 30 minutes. All results of the load test for each variable frequency drives must be available to the Owner.

1.07 START-UP SERVICE

A. The supplier of the AC drive described herein shall have a factory trained service representative within 4 hours of the job site. The factory representative shall be trained in the maintenance and troubleshooting of the equipment as specified herein and qualified as the Warranty Representative for the manufacturer.

B. Submit hourly rate charge with bid for service calls requested after the warranty period. Rate shall be effective for two (2) years.

1.08 TRAINING

The AC drive manufacturer shall provide an on-site training program for maintenance personnel. This program shall provide operating and instruction manuals, 4 total hours of on-site training in equipment operation, and troubleshooting of the AC drive.

In addition, the variable frequency drives manufacturer shall have available a comprehensive, HVAC Drive Computer Based Training (CBT) product. The CBT product shall include detailed, interactive sections covering variable frequency drives unpacking, proper mechanical and electrical installation, and programming. The CBT product shall allow the user to provide just-in-time training to new personnel or refresher training for maintenance and repair personnel on the user's site.

1.09 DOCUMENTATION

A. An instruction manual for programming and hardware shall be provided with the drive.

B. The variable frequency drives keypad shall utilize pre-programmed application macro's specifically designed to facilitate startup. The Application Macros shall provide one command to reprogram all parameter and customer interfaces for a particular application to reduce programming time. The variable frequency drives shall have two user macros to allow the end-user to create and save custom settings.

PART 2 PRODUCTS

2.01 VARIABLE FREQUENCY SPEED CONTROLLER

A. General

1. Load
   a. The nominal drive rating shall be based on a NEMA Design B, four pole, AC induction motor. Final drive selection shall be determined by motor type and full load motor current.
   b. Unless otherwise noted, the NEMA Design B AC induction motor to be used shall be heavy duty for a constant torque load over a frequency range of 0 to 60 Hz, reaching the rated motor nameplate horsepower requirements (HP) at 60 Hz.
2. Motor Operation: the adjustable frequency drive shall be capable of generating a controlled adjustable frequency/adjustable voltage output at suitable power levels to operate the scheduled motor.
3. Construction
   a. The drive shall be designed to provide for ease of maintenance and shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without requiring removing the variable frequency drives from the wall or removal of circuit boards. The variable frequency drives cooling fans shall operate only when required. To extend the fan and bearing operating life, the variable frequency drives shall cycle the cooling fans on and off as required.
   b. The drive shall consist of the following major components.
      (1) Input rectifier section to supply fixed DC bus voltage.
      (2) The variable frequency drives 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.

      EMI/RFI filters. All variable frequency drives shall include EMI/RFI filters. The onboard filters shall allow the variable frequency drives assemble to be CE marked and the variable frequency drives shall meet product standard EN 61800-3 for the First Environment restricted level. No exceptions.
      (3) Smoothing reactor for the DC bus
      (4) DC bus capacitors
      (5) Sine weighted PWM generating inverter section.
      (6) Separate terminal blocks for control and power wiring.

B. Drive Environment

1. Ambient:

a. The drive shall be suitable for use in normal indoor non-hazardous industrial environments subject to the following conditions.
(1) For enclosed units, an ambient temperature range of 20 to 122°F (-14°- to 50°C).
(2) For open units, an ambient temperature of 20 to 122°F (14° to 50°C).
(3) A humidity range from 5 to 95%, non condensing.
(4) An altitude range up to 3,300 feet without derating the drive's output power capability.
(5) Drive vibration of no more than 1.0 G with the drive in its normal mounting position.
b. To ensure adequate heat dissipation the drive unit may include fan assisted cooling such that it will not degrade the enclosure rating.

2. Enclosure
a. The variable frequency drives package as specified herein shall be enclosed in a UL listed Type 1 or UL Type 12 enclosure, exceeding NEMA enclosure design criteria, completely assembled and tested by an accredited independent agency ensuring the UL Type 1 or Type 12 design specific criteria. NEMA 1 or NEMA 12 enclosures are not acceptable.
b. Enclosure shall be UL listed as a plenum rated variable frequency drives. Variable frequency drives without these ratings are not acceptable.
c. The drive shall have power terminal blocks physically separate from control signal terminal blocks.
d. The drive shall be modularly constructed. Printed circuit boards shall have plug-in connections and be easily removed from the drive. Power components shall be readily accessible and have "fast-on" or screw terminal connections for easy removal.

C. Electrical Design Characteristics

1. Listings: all units shall be U.L. listed, C.S.A. Approved, IEC 146 Approved
2. Input Power
a. Variations of up to $\pm$ 10% of line voltage and $\pm$ 2 Hz of line frequency shall be permitted without the drive shutting down on a fault.
b. Power line interruptions of up to 0.5 second shall be permitted without the drive shutting down on a fault.
c. The variable frequency drives system voltage window shall allow the system to operate from a line of +30% -35% nominal voltage as a minimum. The system shall incorporate circuitry that will allow the drive contactor to remain “sealed in” over this voltage tolerance at a minimum. Systems using Simple control transformers with narrower voltage tolerances are not acceptable.
d. The drive shall present displacement power factor of 0.95 or better to AC line at any speed or load.

e. The drive control efficiency at rated load and frequency shall be 98% or better.
f. The drive shall not be sensitive to notching on the incoming line.
g. The drive shall not require an input isolation transformer.
h. The variable frequency drives shall have an internal 5% impedance reactors 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. Variable frequency drives with only one DC reactor shall add AC line reactors.
i. The input current rating of the variable frequency drives shall be no more than 3% greater than the output current rating. Variable frequency drives with higher input current ratings require the upstream wiring, protection devices and source transformers to be oversized per NEC430-2.

3. Output Power
a. The drive shall produce a (sine weighted PWM) three phase output for the load.
b. The drive output frequency shall be adjustable from 0 to 60 Hz
c. The drive shall produce a reduced volts-per-hertz (V/Hz) ratio in the 60 Hz range and below.
d. The drive shall supply a constant voltage output when operating above 60 Hz.
e. The volts-per-hertz output of the drive shall not be affected or require readjustment when other drive adjustments (such as maximum speed) are changed.
f. Selectable constant V/Hz ratio or configurable V/Hz ratio. The drive shall have selectable pre-programmed V/Hz ratios and the capability of programming a custom V/Hz pattern.
g. When the subject to the range of ambient conditions stated in Paragraph B, the drive shall be capable of maintaining 100% of rated output current continuously. The variable frequency drives shall include a carrier frequency control circuit that reduces the carrier frequency based on actual variable frequency drives temperature that allows higher carrier frequency without derating the variable frequency drives or operating at high carrier frequency only at low speeds.
h. When subject to the range of ambient conditions stated in Paragraph B, the drive shall be capable of delivering 110% of rated output current for up to one minute.
i. The drive shall be capable of restoring motor operation after 0.5 second line loss without shutting down of a fault.
j. The drive shall be capable of operating output open circuited with no fault or damage.

D. Control Circuitry
1. Control Features
a. All variable frequency drives shall have the same customer interface, including digital displays, 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 startup of multiple variable frequency drives.
b. 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.

c. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting.

d. There shall be a built-in time clock in the variable frequency drives keypad. The clock shall have a battery back up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the variable frequency drives shall automatically revert to hours of operation since initial power up. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays. The variable frequency drives shall have a digital input that allows an override to the time clock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings.

e. The variable frequency drives shall utilize pre-programmed application macro's specifically designed to facilitate startup. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The variable frequency drives shall have two user macros to allow the end-user to create and save custom settings.

f. The variable frequency drives shall have user programmable underload and overload curve functions to allow user defined indications of broken belt or mechanical failure causing motor overload.

g. The variable frequency drives shall include multiple "two zone" PID algorithms that allows the variable frequency drives to maintain PID control from two separate feedback signals (4-20mA, 0-10V, serial communication). This allows the drive to respond to the worst case of the two feedback signals. The two zone control PID can control motor speed based on a minimum, maximum, or average of the two feedback signals. All of the variable frequency drives PID controllers shall include the ability for "two zone" control.

h. The speed potentiometer may be remotely located up to 100 feet (30 meters) from the drive.

E. All variable frequency drives to have the following adjustments:

1. Three (3) programmable critical frequency lockout ranges to prevent the variable frequency drives from operating the load continuously at an unstable speed.

2. Two (2) PID setpoint controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the variable frequency drives, using the microprocessor in the variable frequency drives for the closed loop control. The variable frequency drives shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter. The PID setpoint shall be adjustable from the variable frequency drives keypad, analog inputs, or over the communication bus. There shall be two parameter sets for the first PID that allow the sets to be switched via a digital input, serial communications or from the keypad for night setback, summer/winter setpoints, etc.

3. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain setpoint of an independent process (i.e. valves, dampers, etc.). All setpoints, process variables, etc. to be accessible from the serial communication network. The setpoints shall be set in Engineering units and not require a percentage of the transducer input.
4. Two (2) programmable analog inputs shall accept current or voltage signals.
5. Two (2) programmable analog outputs (0-20ma or 4-20ma). 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.
6. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices. All digital inputs shall be programmable to initiate upon an application or removal of 24 VDC.
7. 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 8 amps at 24 VDC and 0.4 A at 250 VAC; 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.
8. Run permissive circuit - 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 variable frequency drives shall provide a dry contact closure that will signal the damper to open (variable frequency drives motor does not operate). When the damper is fully open, a normally open dry contacts (end-switch) shall close. The closed end-switch is wired to a variable frequency drives digital input and allows variable frequency drives motor operation.
9. The variable frequency drives control shall include a programmable time delay for variable frequency drives start and a keypad indication that this dime delay is in process. This will allow VAV terminal units to be driven open before the motor operates. The time delay shall be field programmable from 0 - 120 seconds. Start delay shall be active regardless of the start command source (keypad, input contact closure, time-clock control, or serial communications). Seven (7) programmable preset speeds. Two independently adjustable accel and decel ramps with 1 - 1800 seconds adjustable time ramps.
10. The variable frequency drives shall include a carrier frequency control circuit that reduces the carrier frequency based on actual variable frequency drives temperature that allows higher carrier frequency without derating the variable frequency drives or operating at high carrier frequency only at low speeds.
11. The variable frequency drives shall include password protection against parameter changes.
12. The keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). The keypad shall utilize the following assistants:
    a. Startup assistants
    b. Parameter assistants
    c. Maintenance assistant
    d. Troubleshooting assistant
    e. Drive optimizer assistant

F. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):

1. Output Frequency
2. Motor Speed (RPM, %, or Engineering units)
3. Motor Current
4. Calculated Motor Torque
5. Calculated Motor Power (kW)
6. DC Bus Voltage
7. Output Voltage

G. Serial Communications

1. The variable frequency drives shall have an RS-485 port as standard. The standard protocols shall be Modbus, BACnet, Johnson Controls N2 bus, and Siemens Building Technologies FLN. Optional protocols for LonWorks, Profibus, Ethernet, and DeviceNet shall be available. Each individual drive shall have the protocol in the base variable frequency drives. 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. The BACnet connection shall be an RS485, MSTP interface operating at 9.6, 19.2, 38.4 or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:
   a. Data Sharing - Read Property - B
   b. Data Sharing - Writer Property - B
   c. Device Management - Dynamic Device Binding (Who-Is, I-Am)
   d. Device Management - Dynamic Object Binding (Who-Has; I-Have)
   e. Device Management - Communication Control - B
3. If additional hardware is required to obtain the BACnet interface, the variable frequency drives manufacturer shall supply one BACnet getaway per drive. Multiple VFD’s sharing one gateway shall not be acceptable.
4. 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 DDC shall also be capable of monitoring the variable frequency drives 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 communication bus. Remote variable frequency drives fault reset shall be possible.

H. Fault and Protection Circuits
   1. Motor Overload Protection
      a. The drive shall provide motor overload protection when a single motor is connected to the drive.
      b. The overload protection shall be adjustable from 50 to 115% of the drive full load current rating.
      c. The overload shall provide the protection required by the NEC for motor overload protection and shall be tested in accordance with U.L.Standard 1991.
   2. Phase Protection
      a. The drive shall have protection against (and indicate), a phase-to-phase short in the output load, or a short circuit in a phase of the output module.
      b. Each output phase shall be monitored. If a short circuit condition occurs, a circuit shall turn off the entire output section experiencing the shorted condition.
      c. The drive shall shut down and annunciate the fault and display in plain English and time and date stamp each of the last 10 Faults. Codes are not acceptable.

   3. Ground Fault Detection: should an output phase short to earth ground occur, the drive shall have circuits to guard against excessive currents. This condition shall be monitored and annunciated on the digital display panel.
   4. Drive Protection: The drive protection functions shall monitor and annunciate the following conditions as a minimum:
      a. Overcurrent protection
      b. Short circuit protection
      c. DC bus undervoltage protection
      d. DC Bus overvoltage protection
      e. Overtemperature protection
      f. Power semiconductor protection
      g. Ground fault protection
   5. Drive Diagnostic

I. Disconnect

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

J. Fieldbus adapters: protocols such as LonWorks, DeviceNet, Ethernet IP (DeviceNet over Ethernet & ModBus TCP), and Profibus shall be furnished.

K. Bypass Controller
   1. A complete factory wired and tested bypass system consisting of an output contactor and bypass contactor per section 2.01L. Overload protection and shall be provided in both drive and bypass modes. Motor overload protection shall be provided in both drive and bypass modes.
   2. Drive Isolation Fuses - fast acting fuses, exclusive to the variable frequency drives, shall be provided to allow the variable frequency drives to disconnect from the line prior to clearing upstream branch circuit protection.

3. The system (VFD and Bypass) tolerated voltage window shall allow the system to operate from a line of +30%, -35% nominal voltage as a minimum. The system shall incorporate circuitry that will allow the drive or bypass contractor to remain “sealed in” over this voltage tolerances at a minimum.
4. The Bypass shall be based on a microprocessor controlled system allowing for advanced control and operational items listed below.
5. No contactor chatter - the bypass shall maintain positive contactor control through the voltage tolerance window of nominal voltage +30% , 035%. The drive and bypass contactors shall be standard, off-the-shelf, 115V coil contactors.
6. Motor protection from single phase power conditions - The Bypass system must be able to detect a single phase input power condition while running in bypass, disengage the motor in a controlled fashion and give a single phase input power indication.
7. The Bypass system shall be designed for standalone operation and shall be completely functional in both Hand and Automatic modes even if the variable frequency drives has been removed from the system for repair/replacement.
8. Door interlock, padlocked circuit breaker or disconnect that disconnects all input power from the drive from the drive and all internally mounted options.
9. Serial communications - the bypass shall be capable of being monitored and/or controlled via serial communications. On-board communications protocols shall include ModBus; Johnson Controls N2; Siemens Building Technologies FLN (P1): and BACnet. Protocols such as LonWorks, DeviceNet, Ethernet IP (DeviceNet over Ethernet & ModBus TCP), and Profibus shall be available.
10. Serial communication capabilities shall include, but not limited to; bypass run-stop control; the ability to force the unit to bypass; and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostics warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible. The following status indications and setting shall be transmitted over the serial communications bus - keypad “Hand” or “Auto” selected, and bypass selected. The DDC system shall be able to monitor if the motor is running in the variable frequency drives mode or bypass mode over serial communications. A minimum of 40 field parameters shall be capable of being monitored in the bypass mode.
11. The bypass communications shall allow control of the bypass’ digital outputs via the serial interface. This control shall be independent of any bypass function or operating state. The bypass’ digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. All of the bypass’ digital inputs shall be capable of being monitored by the DDC system.

12. The variable frequency drive and bypass shall include a “run permissive circuit” that will provide a normally open contact whenever a run command is provided (local, serial, communications, or remote start command in variable frequency drive or bypass mode) if all safeties are meet. The variable frequency drive system (variable frequency drive or bypass) shall not operate the motor until it receives a dry contact closure from a damper or valve end-switch. When the variable frequency drive 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. This feature will also operate in a Fireman’s override/smoke control mode.
13. The microprocessor based bypass control shall allow for indication and protection from welded contactors or open contactors. This failed contactor operation shall be indicated on the Bypass LCD display as well as over the serial communications protocol. This shall provide a failsafe dry contact, which may be used in conjunction with an upstream shunt-trip circuit breaker to remove power from the system and protect the motor from inadvertent power.
14. The microprocessor based bypass control shall include a programmable time delay for bypass start and keypad indication that this time delay is in process. This will allow VAV terminal units to be driven open before the motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 - 120 seconds.
15. There shall be keyed adjustment to select manual or automatic transfer bypass. The user shall be able to select via keypad programming which drive faults will result in an automatic transfer to the bypass mode. For example, the user may select whether the system shall automatically transfer from drive to bypass mode on the following drive fault conditions:
    a. Over current
    b. Over voltage
    c. Under voltage
    d. Loss of analog input
16. There shall be an adjustable current sensing circuit for the bypass to provide loss of load indication (broken belt) when in the bypass mode. The broken belt indication shall be programmable to be a system (drive or bypass) indication. The broken belt indication shall be programmable to cause a warning or a fault and/or system shutdown. The broken belt indication shall be indicated on the keypad display as well as be transmitted over the building automation protocol and/or a relay output contact closure.
17. The following operators shall be provided:
    a. Bypass Hand-off-Auto
    b. Drive mode selector
    c. Bypass mode selector
    d. Bypass fault reset
    e. Bypass LCD display, 2 lines, for programming and status/fault/warning indications.

18. The following indicating lights (LED type) or keypad display indications shall be provided. A test mode or push to test feature shall be provided.
    a. Power-On (Ready)
    b. Run enable
    c. Drive mode selected
    d. Bypass mode selected
    e. Drive running
    f. Bypass running
    g. Drive fault
    h. Bypass fault
    i. Bypass H-O-A mode
    j. Automatic transfer to bypass selected
    k. Safety open
    l. Damper opening
    m. Damper end switch made
19. The bypass controller shall have six digital inputs, and five programmable relay outputs. This I/O allows for a total System (VFD and Bypass) of 24 I/O expandable to 27 points.
20. The on-board relay (form C) outputs from the bypass shall programmable for any of the following indications. (Choose any five from the list below.)
    a. System started
    b. System running
    c. Bypass override enabled
    d. Drive fault
    e. Bypass fault
    f. Bypass H-O-A position
    g. Bypass underload (broken belt)
    h. Overload
    i. Bypass selected
    j. Bypass run
    k. System started (damper opening)
    l. Bypass alarm
    m. Over temperature
    o. System underload (broken belt)
21. The digital inputs for the system shall accept 24V. The bypass shall incorporate internally sourced power supply and not require an external control power source. The bypass power board shall supply 250 ma of 24 VDC for use by the control contractor.
22. Customer Interlock Terminal Strip - provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in Hand, Auto, or Bypass modes (these may or may not be functional in Override Mode). The remote start/stop contact shall operate in variable frequency drives and bypass modes. The terminal strip shall allow for independent connection of up to four (4) unique safety inputs.
23. The user shall be able to select the text to be displayed on the keypad when the safety opens. Example text display indications include “Firestat” “Freezstat”, “Over pressure” and “Low Pressure”. The user shall also be able to determine which of the four (4) safety contacts is open over the serial communications connection.

24. The bypass shall include a dedicated digital input that will transfer motor from variable frequency drives mode to bypass mode upon dry contact closure for Fireman's Override. Two modes of operation are required.
    a. In the Smoke Control (FSCP Automatic) mode, the motor shall be powered by AC line power through the bypass contactor. The source of the Smoke Control command is a non programmable dedicated digital input and is unaffected by external stop commands. The variable frequency drives keypad and the bypass keypad shall not accept user commands when the system is in Smoke Control mode. While in Smoke Control, the system only acknowledges high priority safeties, the FSCP Manual run command, and the FSCP Off command.
    b. The second override mode remains as above, but allows the user to define which external safeties are disregarded or acknowledged.
25. Class 10, 20 or 30 (selectable) electronic motor overload protection shall be included.

M. Acceptable Manufacturers

1. ABB ACH Series
2. Toshiba
3. Reliance VTAC Series
4. Cutler Hammer

PART 3 EXECUTION

3.01 VARIABLE FREQUENCY SPEED CONTROLLER INSTALLATION

Drives shall be mounted where shown on the drawings.

END OF SECTION