



Re-use Water Pump Station

MKEC Submittal Review

Switchgear & VFDs – Specification Section 26-0000 - Submittal No. 1

The following items are Reviewed as Noted:

1. Panel PSH – Provide (5) – 15A circuit breakers, and no 150A circuit breakers.
2. Panel PSH – Verify top entry for service entry. Service to be run underground.
3. SPR-P001, SPR-P002, SPR-P003 400A disconnect switches – Provide auxiliary contacts for run indication.

The VFD shop drawings shall be Revised and Resubmitted:

4. See specifications for VFDs on the following pages. Provide verification of all items highlighted in yellow. Provide items highlighted in green.

8. VARIABLE FREQUENCY DRIVES - 6 PULSE WITH THE FOLLOWING UNLESS OTHERWISE SPECIFIED ON THE DRAWINGS:

8.1. THE VFD SHALL BE ENCLOSED IN A UL LISTED TYPE 1 ENCLOSURE. THE TOLERATED VOLTAGE WINDOW SHALL ALLOW THE VFD TO OPERATE FROM A LINE OF +30% NOMINAL, AND -35% NOMINAL VOLTAGE AS A MINIMUM.

8.1.1. ENVIRONMENTAL OPERATING CONDITIONS: 0 TO 40C **CONTINUOUS DUTY**. VFD'S THAT CAN OPERATE AT 40 C INTERMITTENTLY (DURING A 24 HOUR PERIOD) ARE NOT ACCEPTABLE AND MUST BE OVERSIZED. ALTITUDE 0 TO 3300 FEET ABOVE SEA LEVEL, LESS THAN 95% HUMIDITY, NON-CONDENSING.

8.2. ALL VFD'S SHALL HAVE THE FOLLOWING STANDARD FEATURES:

8.2.1. ALL VFD'S SHALL HAVE THE SAME CUSTOMER INTERFACE, INCLUDING DIGITAL DISPLAY, AND KEYPAD. THE KEYPAD SHALL BE REMOVABLE, CAPABLE OF REMOTE MOUNTING AND ALLOW FOR UPLOADING AND DOWNLOADING OF PARAMETER SETTINGS AS AN AID FOR START-UP OF MULTIPLE VFD'S.

8.2.2. 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. THERE SHALL BE FAULT RESET AND "HELP" BUTTONS ON THE KEYPAD. THE HELP BUTTON SHALL INCLUDE "ON-LINE" ASSISTANCE FOR PROGRAMMING AND TROUBLESHOOTING.

8.2.3. THERE SHALL BE A BUILT-IN TIME CLOCK IN THE VFD KEYPAD. THE CLOCK SHALL BE USED TO DATE AND TIME STAMP FAULTS AND RECORD OPERATING PARAMETERS AT THE TIME OF FAULT. THE CLOCK SHALL ALSO BE PROGRAMMABLE TO CONTROL START/STOP FUNCTIONS, CONSTANT SPEEDS, PID PARAMETER SETS AND OUTPUT RELAYS.

8.2.4. UTILIZE PRE-PROGRAMMED APPLICATION MACROS SPECIFICALLY DESIGNED TO FACILITATE START-UP. THE APPLICATION MACROS SHALL PROVIDE ONE COMMAND TO REPROGRAM ALL PARAMETERS AND CUSTOMER INTERFACES FOR A PARTICULAR APPLICATION TO REDUCE PROGRAMMING TIME.

8.2.5. CAPABLE OF STARTING INTO A COASTING LOAD (FORWARD OR REVERSE) UP TO FULL SPEED AND ACCELERATE OR DECELERATE TO SETPOINT WITHOUT SAFETY TRIPPING OR COMPONENT DAMAGE (FLYING START).

8.2.6. THE VFD SHALL HAVE THE ABILITY TO AUTOMATICALLY RESTART AFTER AN OVER-CURRENT, OVER-VOLTAGE, UNDER-VOLTAGE, OR LOSS OF INPUT SIGNAL PROTECTIVE TRIP. THE NUMBER OF RESTART ATTEMPTS, TRIAL TIME, AND TIME BETWEEN ATTEMPTS SHALL BE PROGRAMMABLE.

8.2.7. THE VFD SHALL HAVE AN INTEGRAL 5% IMPEDANCE REACTOR. THE 5% IMPEDANCE MAY BE FROM DUAL (POSITIVE AND NEGATIVE DC BUS) REACTORS, OR 5% AC LINE REACTORS. VFD'S WITH ONLY ONE DC REACTOR SHALL ADD AC LINE REACTORS.

8.2.8. THE VFD 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.

- 8.2.9. THE VFD SHALL BE CAPABLE OF SENSING A LOSS OF LOAD (BROKEN BELT / BROKEN COUPLING) AND SIGNAL THE LOSS OF LOAD CONDITION. THE DRIVE SHALL BE PROGRAMMABLE TO SIGNAL THIS CONDITION VIA A KEYPAD WARNING, RELAY OUTPUT AND/OR OVER THE SERIAL COMMUNICATIONS BUS. RELAY OUTPUTS SHALL INCLUDE PROGRAMMABLE TIME DELAYS THAT WILL ALLOW FOR DRIVE ACCELERATION FROM ZERO SPEED WITHOUT SIGNALING A FALSE UNDERLOAD CONDITION.
- 8.2.10. IF THE INPUT REFERENCE (4-20MA OR 2-10V) IS LOST, THE VFD SHALL GIVE THE USER THE OPTION OF EITHER (1) STOPPING AND DISPLAYING A FAULT, (2) RUNNING AT A PROGRAMMABLE PRESET SPEED, (3) HOLD THE VFD SPEED BASED ON THE LAST GOOD REFERENCE RECEIVED, OR (4) CAUSE A WARNING TO BE ISSUED, AS SELECTED BY THE USER. THE DRIVE SHALL BE PROGRAMMABLE TO SIGNAL THIS CONDITION VIA A KEYPAD WARNING, RELAY OUTPUT AND/OR OVER THE SERIAL COMMUNICATIONS BUS.
- 8.3. ALL VFD'S TO HAVE THE FOLLOWING ADJUSTMENTS:
- 8.3.1. TWO (2) PID SETPOINT CONTROLLERS IN THE DRIVE. TWO (2) PROGRAMMABLE ANALOG INPUTS SHALL ACCEPT CURRENT OR VOLTAGE SIGNALS.
- 8.3.2. TWO (2) PROGRAMMABLE ANALOG OUTPUTS (0-20MA OR 4-20 MA) PROGRAMMABLE TO OUTPUT PROPORTIONAL TO FREQUENCY, MOTOR SPEED, OUTPUT VOLTAGE, OUTPUT CURRENT, MOTOR TORQUE, MOTOR POWER (KW), DC BUS VOLTAGE, ACTIVE REFERENCE, AND OTHER DATA.
- 8.3.3. SIX (6) PROGRAMMABLE DIGITAL INPUTS. THERE SHALL BE A RUN PERMISSIVE CIRCUIT FOR DAMPER OR VALVE CONTROL. AT ANY RUN COMMAND, THE VFD SHALL PROVIDE A DRY CONTACT CLOSURE THAT WILL SIGNAL THE DAMPER TO OPEN. WHEN THE DAMPER IS FULLY OPEN, A NORMALLY OPEN DRY CONTACT SHALL CLOSE. THE CLOSED END-SWITCH IS WIRED TO AN VFD DIGITAL INPUT AND ALLOWS VFD MOTOR OPERATION. TWO SEPARATE SAFETY INTERLOCK INPUTS SHALL BE PROVIDED. WHEN EITHER SAFETY IS OPENED, THE MOTOR SHALL BE COMMANDED TO COAST TO STOP, AND THE DAMPER SHALL BE COMMANDED TO CLOSE. THE KEYPAD SHALL DISPLAY "START ENABLE 1 (OR 2) MISSING". THE SAFETY STATUS SHALL ALSO BE TRANSMITTED OVER THE SERIAL COMMUNICATIONS BUS. ALL DIGITAL INPUTS SHALL BE PROGRAMMABLE TO INITIATE UPON AN APPLICATION OR REMOVAL OF 24VDC.
- 8.3.4. 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, 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.
- 8.3.5. THE VFD SHALL INCLUDE A MOTOR FLUX OPTIMIZATION CIRCUIT THAT WILL AUTOMATICALLY REDUCE APPLIED MOTOR VOLTAGE TO THE MOTOR.

8.3.6. THE VFD SHALL INCLUDE A CARRIER FREQUENCY CONTROL CIRCUIT THAT REDUCES THE CARRIER FREQUENCY BASED ON ACTUAL VFD TEMPERATURE THAT ALLOWS THE HIGHEST CARRIER FREQUENCY WITHOUT DERATING THE VFD OR OPERATING AT HIGH CARRIER FREQUENCY ONLY AT LOW SPEEDS.

8.4. SERIAL COMMUNICATIONS

8.4.1. EACH VFD SHALL HAVE AN RS-485 PORT AS STANDARD WITH MODBUS, JOHNSON CONTROLS N2 BUS, AND SIEMENS BUILDING TECHNOLOGIES FLN PROTOCOLS. OPTIONAL PROTOCOLS FOR LONWORKS, BACNET, PROFIBUS, ETHERNET, AND DEVICENET SHALL BE AVAILABLE. ALL PROTOCOLS SHALL BE "CERTIFIED" BY THE GOVERNING AUTHORITY.

Verify all required communication protocols with Pedrotti. Provide comm cards as required.

8.4.2. SERIAL COMMUNICATION CAPABILITIES SHALL INCLUDE 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 CONTROL SYSTEM TO MONITOR FEEDBACK SUCH AS PROCESS VARIABLE FEEDBACK, OUTPUT SPEED / FREQUENCY, CURRENT, % TORQUE, POWER, KILOWATT HOUR, OPERATING HOURS, AND DRIVE TEMPERATURE. THE CONTROL SYSTEM SHALL ALSO BE CAPABLE OF MONITORING THE VFD 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 COMMUNICATIONS BUS. REMOTE VFD FAULT RESET SHALL BE POSSIBLE. THE FOLLOWING ADDITIONAL STATUS INDICATIONS AND SETTINGS SHALL BE TRANSMITTED OVER THE SERIAL COMMUNICATIONS BUS - KEYPAD "HAND" OR "AUTO" SELECTED, BYPASS SELECTED, THE ABILITY TO CHANGE THE PID SETPOINT, AND THE ABILITY TO FORCE THE UNIT TO BYPASS. THE CONTROL SYSTEM SHALL ALSO BE ABLE TO MONITOR IF THE MOTOR IS RUNNING IN THE VFD MODE OR BYPASS MODE OVER SERIAL COMMUNICATIONS. A MINIMUM OF 15 FIELD PARAMETERS SHALL BE CAPABLE OF BEING MONITORED.

8.5. EMI / RFI FILTERS. ALL VFD'S SHALL INCLUDE EMI/RFI FILTERS

8.6. BYPASS FEATURES - FEATURES TO BE FURNISHED AND MOUNTED BY THE DRIVE MANUFACTURER.

8.6.1. A COMPLETE FACTORY WIRED AND TESTED BYPASS SYSTEM CONSISTING OF AN OUTPUT CONTACTOR AND BYPASS CONTACTOR. OVERLOAD PROTECTION AND SHALL BE PROVIDED IN BOTH MODES.

8.6.2. DOOR INTERLOCKED, PADLOCKABLE CIRCUIT BREAKER THAT WILL DISCONNECT ALL INPUT POWER FROM THE DRIVE AND ALL INTERNALLY MOUNTED OPTIONS.

8.6.3. FAST ACTING FUSES EXCLUSIVE TO THE VFD - FAST ACTING FUSES ALLOW THE VFD TO DISCONNECT FROM THE LINE PRIOR TO CLEARING UPSTREAM BRANCH CIRCUIT PROTECTION, MAINTAINING BYPASS CAPABILITY. BYPASS DESIGNS, WHICH HAVE NO SUCH FUSES, OR THAT INCORPORATE FUSES COMMON TO BOTH THE VFD AND THE BYPASS WILL NOT BE ACCEPTED.

- 8.6.4. THE DRIVE / BYPASS SHALL PROVIDE SINGLE-PHASE MOTOR PROTECTION IN BOTH MODES.
- 8.6.5. THE FOLLOWING INDICATING LIGHTS (LED TYPE) SHALL BE PROVIDED. A TEST MODE OR PUSH TO TEST FEATURE SHALL BE PROVIDED: POWER-ON (READY), RUN ENABLE (SAFETIES) OPEN, DRIVE MODE SELECT DAMPER OPENING, BYPASS MODE SELECTED, DRIVE RUNNING, BYPASS RUNNING, DRIVE FAULT, BYPASS FAULT, BYPASS H-O-A MODE, AUTOMATIC TRANSFER TO BYPASS SELECTED, SAFETY OPEN, DAMPER OPENING, DAMPER END-SWITCH MADE
- 8.6.6. THE FOLLOWING RELAY (FORM C) OUTPUTS FROM THE BYPASS SHALL BE PROVIDED: SYSTEM STARTED, SYSTEM RUNNING, BYPASS OVERRIDE ENABLED, DRIVE FAULT, BYPASS FAULT (MOTOR OVERLOAD OR UNDERLOAD), BYPASS H-O-A POSITION.
- 8.6.7. THE DIGITAL INPUTS FOR THE SYSTEM SHALL ACCEPT 24V OR 115VAC (SELECTABLE). THE BYPASS SHALL INCORPORATE INTERNALLY SOURCED POWER SUPPLY.
- 8.6.8. DEDICATED DIGITAL INPUT THAT WILL TRANSFER MOTOR FROM VFD MODE TO BYPASS MODE UPON DRY CONTACT CLOSURE FOR FIREMAN'S OVERRIDE. TWO MODES OF OPERATION ARE REQUIRED:
 - 8.6.8.1. ONE MODE FORCES THE MOTOR TO BYPASS OPERATION AND OVERRIDES BOTH THE VFD AND BYPASS H-O-A SWITCHES AND FORCES THE MOTOR TO OPERATE ACROSS THE LINE. THE SYSTEM WILL ONLY RESPOND TO THE DIGITAL INPUTS AND MOTOR PROTECTIONS.
 - 8.6.8.2. THE SECOND FIREMAN'S OVERRIDE MODE REMAINS AS ABOVE, BUT WILL ALSO DEFEAT THE OVERLOAD AND SINGLE-PHASE PROTECTION FOR BYPASS AND IGNORE ALL KEYPAD AND DIGITAL INPUTS TO THE SYSTEM (RUN UNTIL DESTRUCTION).
- 8.6.9. THE VFD SHALL INCLUDE A "RUN PERMISSIVE CIRCUIT" THAT WILL PROVIDE A NORMALLY OPEN CONTACT WHENEVER A RUN COMMAND IS PROVIDED (LOCAL OR REMOTE START COMMAND IN VFD OR BYPASS MODE). THE VFD SYSTEM SHALL NOT OPERATE THE MOTOR UNTIL IT RECEIVES A DRY CONTACT CLOSURE FROM A DAMPER OR VALVE END-SWITCH. WHEN THE VFD 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.
- 8.6.10. CLASS 20 OR 30 (SELECTABLE) ELECTRONIC MOTOR OVERLOAD PROTECTION SHALL BE INCLUDED.
- 8.6.11. THERE SHALL BE AN INTERNAL SWITCH TO SELECT MANUAL OR AUTOMATIC BYPASS.
- 8.6.12. THERE SHALL BE AN ADJUSTABLE CURRENT SENSING CIRCUIT FOR THE BYPASS TO PROVIDE LOSS OF LOAD INDICATION (BROKEN BELT) WHEN IN THE BYPASS MODE.