CITY OF FORT WAYNE MASTER UPDATED: 3/25/15

SECTION 26 29 23

LOW-VOLTAGE VARIABLE FREQUENCY DRIVES

NTS: Use this section when multiple drives, for multiple systems, are specified. On smaller, single-system projects, it may be appropriate to include the drives in the driven equipment specification section(s).

1. GENERAL
	1. DESCRIPTION
		1. Scope:
			1. Contractor shall provide all labor, materials, equipment, services, and incidentals as shown, specified, and required to furnish and install low-voltage variable frequency drives, complete and operational.
			2. Variable frequency drives required under this Section are low-voltage, voltage source inverter, pulse width modulated. Variable frequency drives shall be customized.

NTS: Insert at No. 1 specification references to driven equipment and/or existing equipment. Add paragraphs as required.

* + - 1. Low-voltage variable frequency drives included in this Section are associated with the following equipment:
				1. (--1--).
		1. Related Sections:

NTS: List below only sections covering products, construction, and equipment specifically identified in this section and specified in another section and directly referenced in this specification. Do not list administrative and procedural division 01 sections.

Insert at No. 1 the section number and title of the associated driven equipment; provide additional section numbers and titles to suit the project. When references to driven equipment are listed below, they must also be listed at an appropriate location in the text of the section; for example at paragraph “1.1.A.3”, above.

* + - 1. Section 26 05 29, Hangers and Supports for Electrical Systems.
			2. Section 26 05 53, Identification for Electrical Systems.
			3. (--1--)
	1. REFERENCES

NTS: Retain applicable standards and add others as required.

* + 1. Standards referenced in this Section are:

NTS: Delete paragraph “1”, below, when harmonic restrictions do not apply. When harmonic restrictions are necessary, edit this section to clearly state the restrictions and reference IEEE 519 in the text of this section accordingly.

* + - 1. IEEE 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
			2. ISO 9000, Quality Management Systems, Fundamentals and Vocabulary.
			3. ISO 9001, Quality Management Systems, Requirements.
			4. ISO 9002, Quality Systems, Model for Quality Assurance in Production, Installation and Servicing.
			5. NEMA ICS 2, Controllers, Contactors and Overload Relays Rated 600 Volts.
			6. NEMA ICS 7, Industrial Control and Systems Adjustable Speed Drives.
			7. NEMA MG 1, Motor and Generators.
			8. UL 489, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.
			9. UL 508, Industrial Control Equipment.
			10. Certifications and approvals shall include for Low Voltage Variable Frequency Drives:
				1. c-UL-us – Listed to UL508C and CAN/CSA-C22.2 for Power Conversion Equipment
				2. C-Tick – AS/NZS, 1997 Group 1, Class A
				3. CE – Marked for all applicable European Directives:

EMC Directive (2004/108/EC), Standards EN 61800-3, EN 50081-1, EN 50082 2

Low Voltage Directive (73/23/EEC), Standards EN 50178, EN 60204

* + - * 1. The VFD shall also be designed to meet the appropriate portions of the following specifications:

NFPA 70 – US National Electrical Code

NEMA ICS 3.1 – Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems

IEC 146 – International Electrical Code

* + - * 1. The VFD shall be listed to UL508C for mounting in plenums and compartments handling conditioned air.
				2. The VFD shall meet the seismic requirements of the 2003 International Building Code as specified by AC156.
				3. National Electrical Manufacturers Association - NEMA 250 - Enclosures for Electrical Equipment.
				4. International Electrical Code - IEC 146.
	1. QUALITY ASSURANCE
		1. Qualifications:

NTS: Edit or delete paragraph “1”, below, when Project requirements prohibit an experience requirement.

* + - 1. Manufacturer:
				1. Low-voltage variable frequency drive manufacturer shall have not less than five years of experience designing and regularly manufacturing and servicing substantially similar equipment to that required, and upon ENGINEER’s request shall submit documentation of not less than five installations in satisfactory operation for not less than five years each.
				2. Manufacturer shall be certified under ISO 9000, ISO 9001, or ISO 9002 for materials and equipment specified.
				3. For all required factory tests, low-voltage variable frequency drive manufacturer shall use a factory test facility that has calibrated its testing apparatus in the previous twelve months, and is staffed by qualified, experienced technicians.
				4. The VFD and all associated optional equipment shall be UL listed or recognized.
				5. The VFD shall contain a UL label attached on the inside of the enclosure cabinet.
			2. Suppliers:
				1. All inspection and testing procedures shall be developed and controlled under the guidelines of the supplier’s quality system and must be registered to ISO 9001 and regularly reviewed and audited by a third party registrar.
				2. The VFD shall be factory pre-wired, assembled and tested as a complete package.
		1. Component Supply and Compatibility:
			1. Drives specified under this Section employ a low switching frequency or pattern to minimize instantaneous rate of voltage change over time (dv/dt), and the adverse effects of potential bearing currents. Where alternate manufacturers are proposed, obtain manufacturer recommendations regarding bearing currents and provide equipment required at no additional cost to Owner.
			2. Each low-voltage variable frequency drive shall be fully compatible with associated driven equipment and motors. Variable frequency drives shall be matched to specific load requirements for each system. Operation of variable frequency drive shall not overstress motor insulation.
			3. Similar components of drives associated with each system shall be products of a single manufacturer.
	1. SUBMITTALS
		1. Submit the following:
			1. Shop Drawings:
				1. Dimensional information and construction details of enclosures. Enclosure details shall consist of exterior and interior front door with nameplate legends, interior door front and rear views, and terminal block layout.
				2. Three‑line power and control schematic diagrams.
				3. Wiring diagrams showing the interconnection of conductors to all devices with terminal assignments for remote devices.
				4. Functional description of system operation.
				5. VFD heat dissipation at full load, including heat rejection/cooling system.
			2. Product Data:
				1. Manufacturer’s technical specifications.
				2. Manufacturer’s catalog cuts and product literature.
			3. Testing Plans:
				1. Not less than thirty days prior to source quality control testing, submit descriptions of proposed shop testing methods, procedures, apparatus, and limitations.
				2. Not less than thirty days prior to field quality control testing, submit descriptions of proposed field testing methods, procedures, and apparatus.
			4. Certificates:
				1. Certification letters from low-voltage variable frequency drive manufacturer and motor manufacturer that the approved driven equipment has been reviewed and that variable frequency drive units and motors are compatible, and shall be provided in accordance with the Contract Documents and requirements of the driven equipment.
			5. Source Quality Control Submittals:
				1. Within five days of completing source quality control tests and inspections, submit test results with indication of whether all criteria of the Contract Documents for the specified equipment were met.
			6. Field Quality Control Submittals:
				1. Within five days of completing field quality control tests and inspections, submit test results with indication of whether all criteria of the Contract Documents for the specified equipment were met.
			7. Manufacturer Reports:
				1. Within five days of each visit to the Site by manufacturer’s representative, submit written report of reason for visit, problems encountered, solutions implemented, and remaining work.
			8. Qualifications Statements:
				1. Manufacturer, when requested by ENGINEER.
			9. Operation and Maintenance Data:
				1. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, list of recommended spare parts, and spare parts ordering information.
				2. Manuals shall include record drawings of control schematics, including point-to-point wiring diagrams.
				3. Include a listing of all programmable drive parameters and their settings at Substantial Completion. Submit parameters as both printed pages in the operations and maintenance manual and in electronic format on compact disc that can be directly uploaded to the drive in event of drive replacement or repair.
				4. Comply with Section 01 78 23, Operations and Maintenance Data.
	2. DELIVERY, STORAGE, AND HANDLING
		1. Packing, Shipping, Handling, and Unloading:
			1. Packing:
				1. Inspect prior to packing to ensure that assemblies and components are complete and undamaged.
				2. Protect mating connections.
				3. Cover all openings into enclosures with-vapor inhibiting, water-repellent material.
				4. Indoor containers shall be bolted to skids.
			2. Upon delivery, check materials and equipment for evidence of water that may have entered equipment during transit.
			3. Handling:
				1. Lift, roll or jack low-voltage variable frequency drive equipment into locations shown.
				2. Variable frequency drives shall be equipped for handling required for installation. Handle equipment in accordance with manufacturer’s requirements.
		2. Storage and Protection:
			1. Store low-voltage variable frequency drive equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.
	3. WARRANTY
		1. The manufacturer shall provide their standard parts warranty for twelve (12) months from the date of being energized.
		2. This warranty applies to variable frequency drive systems.
1. PRODUCTS
	1. VFD Cable
		1. All 480 VAC variable frequency drives shall be installed using a VFD cable, specifically designed for connection between a VFD and motor.
		2. Cable shall be provided by VFD manufacturer and rated for specific application.

NTS: PowerFlex 755 is the preferred variable frequency drive. PowerFlex 755 has a built in Ethernet/IP port and has five I/O slots.

* 1. POWERFLEX 755 VFD
		1. MANUFACTURERS
			1. Allen-Bradley – PowerFlex 755 VFD (No substitutions)
		2. VARIABLE FREQUENCY DRIVE UNIT
			1. Features
				1. Certifications

Listed to UL508C and CAN/CSA-C22.2 No. 14-05

* + - 1. Hardware
				1. Utilize diode bridge or SCR bridge on the input rectifier.
				2. Utilize DC bus inductor on all six-pulse VFDs only.
				3. Utilize switching logic power supply operating from the DC bus.
				4. Incorporate phase to phase and phase to ground MOV protection on the AC input line.
				5. Utilize gold plated plug-in connections on printed circuit boards.
				6. Microprocessor based inverter logic shall be isolated from power circuits.
				7. Utilize latest generation IGBT inverter section.
				8. Inverter section shall not require commutation capacitors.
				9. Embedded Ethernet port for direct network cable connections.
				10. Battery receptacle for Lithium battery power to the Real Time Clock.
				11. Additional DPI port for handheld and remote HIM options.
				12. Dedicated Digital Input for hardware enable.
				13. Conformal coated printed circuit boards.
				14. Optional onboard 24V DC Auxiliary Control Power Supply.
			2. Control Logic
				1. Ability to operate with motor disconnected.
				2. Provide a controlled shut down, when properly protected, with no component failure in the event of an output phase to phase or phase to ground short circuit. Provide annunciation of the fault condition.
				3. Provide multiple programmable stop modes including Ramp, Coast, DC-Brake, Ramp-to-Hold, Fast Braking, and Current Limit Stop.
				4. Provide multiple acceleration and deceleration rates.
				5. Adjustable output frequency up to 650Hz.
			3. DeviceLogix Control
				1. Ability to control outputs and manage status information locally within the VFD.
				2. Ability to function stand-alone or complimentary to supervisory control.
				3. Ability to speed reaction time by processing in the VFD.
				4. Ability to provide scaling, selector switches, or other data manipulations not already built into the VFD.
				5. Ability to read inputs/write outputs and exclusively control the VFD.
				6. Ability to provide an option for decision making if communication is lost with main controller.
				7. Ability to control other VFDs via a peer-to-peer EtherNet/IP network.
				8. Ability to write programs off-line.
			4. Motor Control Modes
				1. Selectable Sensorless Vector, Flux Vector, V/Hz, Interior Permanent Magnet Motor, Surface Mount Permanent Magnet Motor, and Adjustable Voltage Control modes selectable through programming.

Frame 8 to 10 drives requires encoder to operate a surface permanent magnet motor.

* + - * 1. The drive shall be supplied with a Start-up and Auto-tune mode.
				2. The V/Hz mode shall be programmable for fan curve or full custom patterns.
				3. Capable of Open Loop V/Hz.
			1. Current Limit
				1. Programmable current limit from 20 to 160% of rated output current.
				2. Current limit shall be active for all drive states: accelerating, constant speed and decelerating.
				3. The drive shall employ PI regulation with an adjustable gain for smooth transition in and out of current limit.
			2. Acceleration / Deceleration
				1. Accel/Decel settings shall provide separate adjustments to allow either setting to be adjusted from 0 to 3600 seconds.
				2. A second set of remotely selectable accel/decel settings shall be accessible through digital inputs.
			3. Speed Profiles
				1. Programming capability shall allow the user to produce speed profiles with linear acceleration/deceleration or "S Curve" profiles that provide changing accel/decel rates.
				2. S Curve profiles shall be adjustable.
			4. Adjustments
				1. A digital interface can be used for all set-up, operation and adjustment settings.
				2. All adjustments shall be stored in nonvolatile memory.
				3. No potentiometer adjustments shall be required.
				4. Nonvolatile memory for factory default values shall be provided.
				5. Software must be available for trending and diagnostics, as well as online and offline programming functionality.
			5. Process PID Control
				1. The drive shall incorporate an internal process PI regulator with proportional and integral gain adjustments as well as error inversion and output clamping functions.
				2. The feedback shall be configurable for normal or square root functions. If the feedback indicates that the process is moving away from the set-point, the regulator shall adjust the drive output until the feedback equals the reference.
				3. Process control shall be capable of being enabled or disabled with a hardwire input. Transitioning in and out of process control shall be capable of being tuned for faster response by preloading the integrator.
				4. Protection shall be provided for a loss of feedback or reference signal.
			6. Skip Frequencies
				1. Three adjustable set points that lock out continuous operation at frequencies which may produce mechanical resonance shall be provided.
				2. The set points shall have a bandwidth adjustable from Maximum Reverse Speed to Maximum Forward Speed.
			7. Fault Reset / Run
				1. The drive shall provide up to nine automatic fault reset and restarts following a fault condition before locking out and requiring manual restart.
				2. The automatic mode shall not be applicable to a ground fault, shorted output faults and other internal microprocessor faults.
				3. The time between restarts shall be adjustable from 0.5 seconds to 30 seconds.
			8. Run on Power Up
				1. A user programmable restart function shall be provided to allow restart of the equipment after restoration of power after long duration power outages. Restart time dependent on presence of incoming signal.
			9. Fault Memory
				1. The last 32 fault codes shall be stored and time stamped in a fault buffer.
				2. Information about the drive’s condition at the time of the last fault such as operating frequency, output current, dc bus voltage and twenty-seven other status conditions shall be stored.
				3. A power-up marker shall be provided at each power-up time to aid in analyzing fault data.
				4. The last 32 alarm codes shall be stored and time stamped for additional troubleshooting reference.
			10. Overload Protection
				1. The drive shall provide internal class 10 adjustable overload protection.
				2. Overload protection shall be speed sensitive and adjustable.
				3. A viewable parameter shall store the overload usage.
			11. Auto Economizer
				1. An auto economizer feature shall be available to automatically reduce the output voltage when the drive is operating in an idle mode (drive output current less than programmed motor FLA). The voltage shall be reduced to minimize flux current in a lightly loaded motor thus reducing kW usage.
				2. When the load increases, the drive shall automatically return to normal operation.
			12. Terminal Blocks for PowerFlex 755
				1. For frames 1 to 7 a separate terminal blocks shall be provided for power wiring.
				2. For frames 8-10 power wiring is landed on robust L-brackets behind the drive unit. This wiring remains in-place if the drive unit is removed.
				3. Terminal blocks shall be provided for control wiring on all frames
				4. I/O terminal blocks shall be removable with wiring in place.
			13. Flying Start
				1. The drive shall be capable of determining the speed and direction of a spinning motor and adjust its output to "pick-up" the motor at the rotating speed. This feature is disabled by default.
			14. Inputs and Outputs for PowerFlex 755
				1. The Input / Output option modules shall consist of both analog and digital I/O.
				2. No jumpers or switches shall be required to configure digital inputs and outputs.
				3. All digital input and output functions shall be fully programmable.
				4. The control terminal blocks shall be rated for 115V AC.
				5. Inputs shall be optically isolated from the drive control logic.
				6. The control interface card shall provide input terminals for access to fixed drive functions that include start, stop, external fault, speed, and enable.
				7. The VFD shall be capable of supporting up to 10 analog inputs, 10 analog outputs, 31 digital inputs, 10 relay outputs, 10 transistor outputs, and 5 positive temperature coefficient (PTC) inputs.
				8. The Input / Output option modules shall have the following features:

Analog Inputs:

Quantity one (1) or two (2) differentially isolated, ±10V (bi-polar), 88k ohm input impedance, 11 bit plus sign.

Analog inputs shall be user programmable for a variety of uses including frequency command and process loop input. Analog inputs shall be user programmable for function scaling (including invert), offset, signal loss detect and square root.

Analog Outputs:

Quantity one (1) or two (2) ±10V (bi-polar) / 11 bit & sign, 2 k minimum load, 4-20 mA, 11 bit plus sign, 400  maximum load.

The analog output shall be user programmable to be proportional to one of fourteen process parameters including output frequency, output current, encoder feedback, output power.

Programming shall be available to select either absolute or signed values of these parameters.

Digital Inputs:

Quantity three (3) or six (6) digital inputs rated 24V DC/115V AC.

All inputs shall be individually programmable for multiple functions including: Start, Run, Stop, Auxiliary Fault, Speed Select, Jog and Process PI functions.

A single safety input (ATEX) shall be a configurable option for a thermostat or PTC temperature sensor.

Digital Outputs:

At a minimum one (1) relay output (N.O. or N.C.).

For 240V AC or 24V DC, N.O. contact output ratings shall be 2 amp max., general purpose (inductive)/resistive. N.C. contact output ratings shall be 2 amp max., resistive only.

Relays shall be programmable to multiple conditions including: Fault, Alarm, At Speed, Drive Ready and PI Excess Error.

Timers shall be available for each output to control the amount of time, after the occurring event, that the output relay actually changes state.

 Transistor outputs are available in quantities varying from zero (0) to two (2).

For 24V DC, transistor output rating shall be 1 amp max, Resistive.

* + - 1. Reference Signals
				1. The drive shall be capable of using the following input reference signals:

Analog inputs

Preset speeds

Remote potentiometer

Digital MOP

Human Interface Module

Communication modules

* + - 1. Loss of Reference
				1. The drive shall be capable of sensing reference loss conditions.
				2. In the event of loss of the reference signal, the drive shall be user programmable to the following:

Fault the drive and coast to stop.

Issue a minor fault - allows the drive to continue running while some types of faults are present.

Alarm and maintain last reference.

* + - * 1. When using a communications network to control the drive, the communications adapter shall have these configurable responses to network disruptions and controller idle (fault or program) conditions:

Fault

Stop

Zero Data

Hold Last State

Send Fault Configuration

* + - 1. Metering
				1. At a minimum, the following parameters shall be accessible through the Human Interface Module, if installed:

Output Current in Amps

Output Voltage in Volts

Output Power in kW

Elapsed MWh

DC Bus Voltage

Frequency

Heatsink Temperature

Last eight (32) faults

Elapsed Run Time

IGBT Temperature

* + - 1. Faults
				1. At a minimum, the following faults shall be accessible through the Human Interface Module:

Power Loss

Undervoltage

Overvoltage

Motor Overload

Heat Sink Over-temperature

Maximum Retries

Phase to Phase and Phase to Ground Faults

* + - 1. Predictive Diagnostics
				1. At a minimum, the following predictive diagnostic features shall be provided:

Relay Output Life Cycles based on load type and amps.

Hours of Fan Life based on load and ambient temperature.

Motor Bearing life based on expected hours of use.

Motor Lubrication schedule based on hours of use.

Machine Bearing life based on expected hours of use.

* + - 1. Real-Time Clock
				1. Shall be capable of providing time stamped events.
				2. Shall have the ability to be set locally or via a remote controller.
				3. Shall provide the ability to be programmable for month, day, year and local time zones in HH:MM:SS.
		1. VFD PACKAGED SYSTEM
			1. Features
				1. Ratings

Voltage for Power Flex 755

Capable of accepting nominal plant power of 400, 480, 600 or 690V AC at 50Hz or 60Hz.

The supply input voltage tolerance shall be ± 10% of nominal line voltage.

Displacement Power Factor for PowerFlex 755

Six-pulse VFD shall be capable of maintaining a minimum true power factor (Displacement P.F. X Distortion P.F.) of 0.95 or better at rated load and nominal line voltage, over the entire speed range.

Efficiency

A minimum of 96.5% (+/- 1%) at 100% speed and 100% motor load at nominal line voltage.

Control power supplies, control circuits, and cooling fans shall be included in all loss calculations.

Operating ambient temperature range without derating: 0 °C to 40 °C (32 °F to 104 °F)

Operating relative humidity range shall be 5% to 95% non-condensing.

Operating elevation shall be up to 1000 Meters (3,300 ft) without derating.

* + - * 1. Sizing

Systems rated at Normal Duty loads shall provide 110% overload capability for up to one minute and 150% for up to 3 seconds.

Systems rated at Heavy Duty loads shall provide 150% overload capability for up to one minute and 180% for up to 3 seconds.

PowerFlex 755 systems rated at Light Duty loads (Frames 8 to 10) shall provide 110% overload capability for up to one minute with no 3 second overload

* + - * 1. Auto Reset/Run

For faults other than those caused by a loss of power or any other non-critical fault, the drive system shall provide a means to automatically clear the fault and resume operation.

* + - * 1. Ride-Through

The VFD system shall attempt to ride through power dips up to 20% of nominal. The duration of ride-through shall be inversely proportional to load. For outages greater than 20%, the drive shall stop the motor and issue a power loss alarm signal to a process controller, which may be forwarded to an external alarm signaling device.

* + - * 1. Run on Power Up

The VFD system shall provide circuitry to allow for remote restart of equipment after a power outage. Unless indicated in the contact drawings, faults due to power outages shall be remotely resettable. The VFD system shall indicate a loss of power to a process controller, which may be forwarded to an external alarm signaling device. Upon indication of power restoration the process controller will attempt to clear any faults and issue a run command, if desired.

* + - * 1. Communications for PowerFlex 755

VFD shall provide an embedded EtherNet/IP port.

VFD shall be capable of communicating on multiple networks.

VFD shall be capable of supporting the following network options:

DeviceNet

EtherNet/IP

ControlNet Coax

ControlNet Fiber

Interbus

CANopen

Modbus/TCP

Modbus RTU

Profibus DP

RS-485 DF1

RS-485 HVAC

Remote I/O

 Profinet I/O

 BACnet/IP

* + - * 1. Enclosure Door Mounted Human Interface Module (HIM)

VFD shall provide a HIM with integral LCD display, operating keys and programming keys.

NTS: Insert at (--1--) either NEMA/UL Type 1 or NEMA/UL Type 4/12.

An enclosure door-mounted HIM, rated (--1--), shall be provided.

An optional VFD-mounted HIM, rated NEMA/UL Type 1, may be provided and shall be capable of connecting via a separate cable for use as a handheld terminal.

The HIM shall have the following features:

A seven (7) line by twenty-one (21) character backlit LCD display with graphics capability.

Shall indicate drive operating conditions, adjustments and fault indications.

Shall be configured to display in the following three distinct zones:

The top zone shall display the status of direction, drive condition, fault / alarm conditions and Auto / Manual mode.

The middle zone shall display drive output frequency.

The bottom zone shall be configurable as a display for either programming menus / information or as a two-line user display for two additional values utilizing scaled units.

Shall provide digital speed control.

The keypad shall include programming keys, drive operating keys (Start, Stop, Direction, Jog and Speed Control), and numeric keys for direct entry.

* + - 1. Enclosure

NTS: Insert at (--1--) either NEMA/UL Type 1 or NEMA/UL Type 12.

* + - * 1. Shall be rated (--1--)
				2. Shall be painted per the manufacturer’s standard.
				3. Shall provide entry and exit locations for power cables.
				4. Shall contain a label for UL508.
				5. The drive system nameplate shall be marked with system Short Circuit Current Rating (SCCR).
			1. Drive Enclosure Input Disconnect

NTS: Insert at (--1--) either fusing, or disconnect, or thermal magnet circuit breaker, or motor circuit protector

* + - * 1. Provide an enclosure door interlocked disconnect with (--1--)
				2. Operator Handles

Provide externally operated main disconnect handle.

Handles shall be lockable with up to three lockout / tagout padlock positions.

* + - 1. Branch Circuit Protection

NTS: Insert at (--1--) either input fusing, motor circuit protector (MCP), or inverse time circuit breaker.

* + - * 1. (--1--) shall be provided
			1. Bypass
				1. Manual Bypass Option:

Shall provide a means to manually switch a single motor from drive control to bypass (across the line operation).

Shall provide separate drive output and bypass contactors. The contactors shall be electrically and mechanically interlocked.

Shall provide a Drive/Off/Bypass selector switch, mounted on the enclosure door, for selection of Drive and Bypass modes of operation.

Provide a Class 10 overload for motor protection while operating in the bypass mode.

* + - * 1. Automatic Bypass Option:

Shall provide a means to automatically (upon a drive fault) switch a single motor from drive control to bypass (across the line operation).

Shall provide separate drive output and bypass contactors. The contactors shall be electrically and mechanically interlocked.

Shall provide a Drive/Off/Bypass selector switch, mounted on the enclosure door, for selection of Drive and Bypass modes of operation.

Shall provide an Auto Bypass/Off/On selector switch, mounted on the enclosure door, for selection of Auto Bypass mode of operation.

Provide a Class 10 overload for motor protection while operating in the bypass mode.

* + - * 1. SMC Flex / Pump Option Bypass:

Shall provide a means to switch a single motor from drive control to bypass via a soft start (across the line operation).

Shall provide separate drive output and bypass contactors. The contactors shall be electrically and mechanically interlocked.

Shall provide a Drive/Off/Bypass selector switch, mounted on the enclosure door, for selection of Drive and Bypass modes of operation.

Provide a Class 20/30 overload for motor protection while operating in the bypass mode.

Shall provide smooth deceleration when stopping in bypass mode.

Shall provide a door-mounted HIM.

Shall provide bypass fusing on input of RVSS bypass unit.

* + - 1. Control Power Transformer
				1. Provide a control power transformer mounted and wired inside of the drive system enclosure.
				2. The transformer shall be rated for the VFD power requirements.
			2. Harmonic Mitigation Techniques
				1. Drive Input Line Reactor

Provide a drive input line reactor mounted within the drive system enclosure for drives that are less than 100 horsepower.

The line reactor shall meet the following specifications:

NTS: Insert at (--1--) either 3 or 5.

The construction shall be iron core with an impedance of (--1--)percent

The winding shall be copper or aluminum wound.

The insulation shall be Class H with a 115 °C rise over 50 °C ambient.

The unit shall be rated for system voltage, ampacity, and frequency.

* + - * 1. 18-pulse VFD (greater than 100 horsepower) with Auto Transformer

Provide VFD with a single 18-pulse converter.

The converter bridge shall be a parallel 18-pulse diode bridge assembly with DC snubber (board or assembly). Diodes shall be rated (devices) with a blocking voltage minimum of 1600V.

The converter shall incorporate 1000V three phase block style MOV protection rated 85 °C.

The drive system shall incorporate an 18-pulse phase shifting auto transformer with line reactor as an assembly. The 18-pulse assembly shall be wired into the VFD System enclosure where possible. The auto transformer shall have the following minimum features:

Rated for input rectifier duty and matched to VFD overload capability.

Copper or aluminum wound.

Class 180 or 220 insulation.

Power factor of 0.98 or better at rated load and nominal line voltage.

Open core construction.

One normally closed thermoswitch contact in each coil wired into a VFD control circuit.

The drive system shall be compliant with IEEE519-1992 standards at the input VFD terminals based upon the input power phase imbalance within 0.5% of nominal line voltage and under full VFD output current ratings.

* + - 1. Auxiliary Relays
				1. Provide relays for Drive Alarm, Drive Fault, Drive Run, and System Status Faults (as required).
				2. The relays shall be Allen-Bradley 700-HC (2 N.O. & 2 N.C.). The relay contacts shall be rated for 115V AC/30V DC, 5.0 amp resistive, 2.5 amp inductive.
			2. Control Interface
				1. The control terminals shall be rated for 115V AC.
				2. The control interface shall provide input terminals for access to VFD functions that include start, stop, external fault, speed select, and enable, as required.
			3. Motor Heater Control
				1. The drive system shall provide the drive control circuitry to energize an existing motor heater whenever the motor is not running via remote power.
				2. The heater control shall be interlocked with the drive and/or bypass and shall be energized whenever the motor is not running. The source shall be remotely provided.
				3. A pilot light with LED (Allen-Bradley Bulletin 800T (30mm) NEMA Type 4/13 shall be mounted on the drive system enclosure door for indication of Motor Heater On.
			4. Local-Off-Remote Selector Switch
				1. Provide a "Local-Off-Remote" selector switch, mounted on the enclosure door.
				2. The "Local-Off-Remote" selector switch shall start the drive in the “Local” mode and stop the drive in the “Off” mode.
				3. In the “Remote” mode the drive shall be started and stopped from a remote “RUN” contact.
				4. In all modes, Auxiliary and Enable inputs to the drive control interface board must be present before the drive will start.
				5. When a HIM is present, the stop function shall always be available to stop the drive regardless of the selected mode (“Local” or “Remote”). The HIM will be non-functional (except for the display and programming) when the switch is in “Off” mode. The HIM shall stop the drive if the switch is in the “Remote” mode with the remote start contact initiated.
				6. The drive speed reference shall be controlled from the HIM, unless a separate door-mounted potentiometer is provided, when in “Local” mode (factory default setting).
				7. The PowerFlex 755 drive shall have the capability of smoothly transferring from the automatic speed reference to the manual speed reference on the HIM, without perturbation in the speed reference.
				8. The drive speed reference shall be controlled by a remote 4…20 mA input when in “Auto” mode.
				9. The device shall be an Allen-Bradley Bulletin 800T (30mm). NEMA Type 4/13, mounted on the drive system enclosure door.
			5. Drive Disable Mushroom Push Button
				1. Provide a maintained mushroom style push button, mounted on the enclosure door that when pushed, will open the drive enable input.
				2. The device shall be an Allen-Bradley Bulletin 800T (30mm). NEMA Type 4/13, mounted on the drive system enclosure door.
			6. Pilot Lights
				1. Provide LED pilot lights, mounted on the enclosure door, for indication of the following status:

Run

Drive Fault

Control Power On

Motor Fault

* + - * 1. The device shall be an Allen-Bradley Bulletin 800T (30mm), NEMA Type 4/13, mounted on the drive system enclosure door.
			1. Motor Run Time Meter
				1. Provide a digital, non-resettable, door-mounted elapsed time meter.
				2. The meter shall be electrically interlocked with the Drive Run relay and Bypass contactor to indicate actual motor operating hours.

NTS: Choose one of the options, then delete the others.

* + - 1. Output Filtering
				1. 3% output line reactor
				2. 5% output line reactor
				3. 1321 Reflected Wave Reduction (RWR) output filter
				4. DV/DT output filter (may affect the system SCCR rating)
	1. WIRING AND DEVICE IDENTIFICATION:
		1. Provide control wiring and device identification shall be per Identification for Electrical Systems 26 05 53.
	2. SOURCE QUALITY CONTROL

NTS: Factory tests specified in paragraph “A”, below, are standard, non-witnessed tests. When witness tests are required, edit this section as required. Coordinate witness testing with project requirements and the driven equipment specified in other sections.

* + 1. Tests:
			1. Perform factory tests on each low-voltage variable frequency drive prior to shipping. Tests shall consist of simulating expected load to be driven by operating load through speed ranges specified for driven equipment, for minimum of two hours per drive unit.
			2. Provide factory control and alarm tests on each drive unit by simulating each control signal and each alarm function to verify proper and correct drive unit action.
			3. Perform specified tests in addition to standard factory tests typically performed.
1. EXECUTION
	1. EXAMINATION
		1. Verify that location is ready to receive equipment.
		2. Verify that the building environment can be maintained within the service conditions required by the manufacturer of the VFD.
	2. INSTALLATION
		1. Installation shall be in compliance with all manufacturer requirements, instructions and drawings.
	3. START-UP SERVICE FOR LOW VOLTAGE VFDS
		1. At a minimum, the start-up service shall include:
			1. Perform pre-power check
			2. Megger motor resistances: phase-to-phase and phase-to-ground
			3. Verify system grounding per manufacturer’s specifications
			4. Verify power and signal grounds
			5. Check connections
			6. Check environment
		2. Drive power-up and commissioning:
			1. Measure incoming power phase-to-phase and phase-to-ground
			2. Measure DC bus voltage
			3. Measure AC current unloaded and loaded
			4. Measure output voltage phase-to-phase and phase-to-ground
			5. Verify input reference signal
		3. All measurements shall be recorded.
		4. Drive shall be tuned for system operation.
		5. Drive parameter listing shall be provided.
		6. Communication adapter parameters shall be provided.
		7. Provide copy of Field Start Up Report to Engineer.
	4. INSPECTION
		1. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.
	5. INSTALLATION
		1. Install equipment in accordance with manufacturer’s recommendations and instructions and in conformance with Laws and Regulations, and the Contract Documents.

NTS: Insert at No. 1 “section 26 05 29, Hangers and Supports For Electrical Systems”, when section 26 05 29 is included in the project manual, unless the project has multiple prime contracts and other than the electrical Contractor provides concrete equipment pads.

* + 1. Unless otherwise shown or indicated, install equipment on concrete bases (--1--).
		2. Install equipment with sufficient access and working space provided for ready and safe operation and maintenance.
		3. For installations against masonry walls, provide an insulation board, 1/4-inch minimum thickness, between equipment and wall for corrosion protection. Trim board neatly within outline of equipment.
		4. Install all terminations, lugs, and required appurtenances necessary to properly terminate power supplies.
		5. Install control wiring terminations and appurtenances necessary to complete installing control and monitoring devices.
		6. Immediately prior to Substantial Completion, replace all enclosure filters and frames provided under this Contract with new filters and frames, except expanded metal filter types. Immediately prior to Substantial Completion, clean expanded metal filters.
	1. FIELD QUALITY CONTROL
		1. Site Tests:
			1. After installation, inspect, adjust, and test each low-voltage variable frequency drive at the Site. Testing and inspection shall be in accordance with manufacturer’s recommendations and be performed by manufacturer’s factory-trained representative. Through Contractor, manufacturer’s factory-trained representative shall inform Owner and ENGINEER when equipment is correctly installed and ready to be energized. Do not energize equipment without permission of Owner.
			2. Perform the following equipment inspection and testing and provide reports documenting procedures and results.
				1. Verify all device settings and drive adjustments.
				2. Inspect all mechanical and electrical interlocks and controls for proper operation.
				3. Test each drive through specified speed ranges and loads for a minimum of two hours per drive unit.
				4. Test each drive by using actual control signal for remote and local operation.
				5. Test each drive alarm function.
				6. Perform other tests recommended by equipment manufacturer.

NTS: Insert at No. 1, No. 2, and No.3 the number of eight-hour days required when systems are extensive or desired. Delete otherwise.

* + 1. Manufacturer Services:
			1. Post-installation Check: Manufacturer’s factory-trained representative shall check and approve the installed equipment before initial operation. Manufacturer shall calibrate, set and program low-voltage variable frequency drives provided. Services by manufacturer’s representative under this paragraph shall be at least (--2--) eight-hour days at the Site.
			2. Manufacturer’s factory-trained representative shall adjust the system to final settings.
			3. Manufacturer’s factory-trained representative shall test the system as specified in Paragraph 3.6. A Site Tests of this Section. Representative shall operate and test the system in presence of ENGINEER and verify that equipment is in conformance with the Contract Documents. Services by manufacturer’s representative under this paragraph shall be at least (--3--) eight-hour days at the Site.
			4. Representative shall revisit the Site as often as necessary until all deficiencies are corrected, prior to readiness for final payment.
			5. Provide services of manufacturer’s factory-trained representatives to correct defective Work within 72 hours of notification by Owner during the correction period specified in the General Conditions as may be amended by the Supplementary Conditions.
			6. Replacement parts or equipment provided during the correction period shall be equal to or better than original.

NTS: Coordinate with section 01 79 23, Instruction of Operations and Maintenance Personnel, to specify the duration of training required, number of sessions, and operating shift for each.

* + - 1. Training: Provide services of qualified factory trained specialists from manufacturer to instruct Owner’s operations and maintenance personnel in recommended operation and maintenance of equipment. Training requirements, duration of instruction, and other qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
	1. ADJUSTING
		1. Immediately prior to Substantial Completion, when testing is acceptably completed and low-voltage variable frequency drives are operating, manufacturer’s representative shall return to the Site and make final adjustments as required to each variable frequency drive furnished under this Section.

+ + END OF SECTION + +