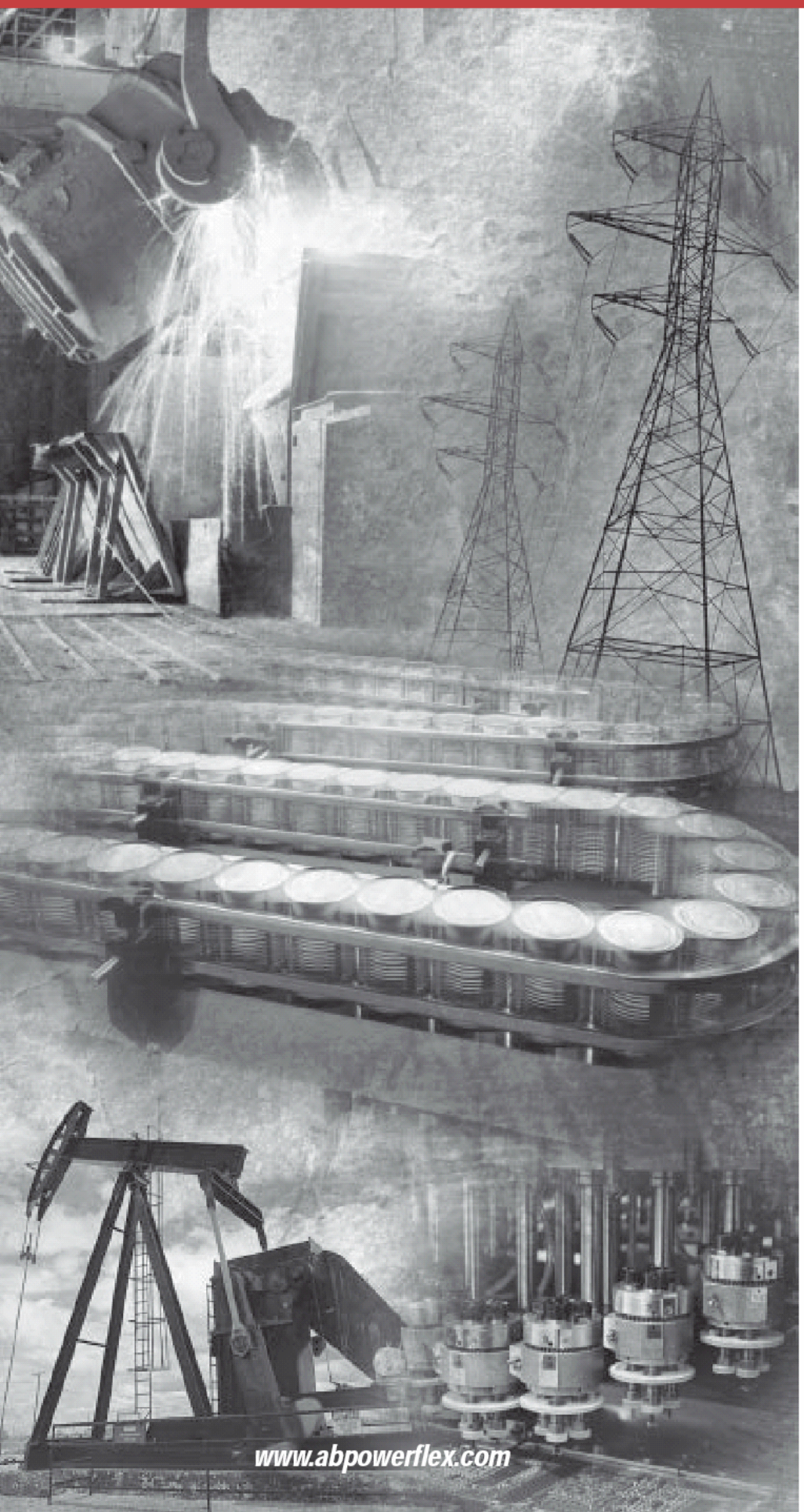

Allen-Bradley

PowerFlex™ 7000

Medium Voltage AC Drives

PowerFlex 7000/7000L (Air-Cooled/Liquid-Cooled)

Specification Guide

Rockwell Automation

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

POWER FLEX 7000 / 7000L MEDIUM VOLTAGE AC DRIVES

SPECIFICATION GUIDE

1.0 SCOPE

1.1 This specification covers the design, manufacture, test, supply and delivery of medium voltage AC drive(s) including, but not limited to, isolation transformer, VFD, input starter, power factor correction controller, in accordance with this Specification and Attachments.

1.2 The VFD shall be factory pre-wired, assembled and tested as a complete package by the VFD supplier. Customer specific drive, motor, and application data shall be pre-loaded into the operator interface and tested prior to shipment.

1.3 The following related work will be performed by others: receiving, storage, installation and connection of equipment at site (supply, installation and connection of power and control cables).

2.0 GENERAL

2.1 Attached data sheets (Appendix A and Appendix B) shall form part of this document. The Purchaser will complete Appendix A. The VFD supplier shall complete and submit Appendix B with the proposal.

2.2 The drive shall be of modular design to provide for ease and speed of maintenance. Metal or glastic barriers shall be provided between each vertical section and between the low voltage compartment and the power cell. Personnel shall have access to the low voltage compartment, with the VFD energized, without being exposed to any medium voltage.

2.3 Acceptable Manufacturers

1) Rockwell Automation
2)
3)

2.4 Experience

The VFD supplier shall demonstrate at least ten years experience in manufacturing VFDs at medium voltage for similar applications at the desired voltage and power ratings. A user list, complete with contact names and telephone numbers, shall be furnished upon request.

2.5 Source and control voltage

2.5.1 The VFD shall accept nominal plant power of:

❑ 2400V ❑ 3300V ❑ 4160V ❑ 6600V
❑ Other_____ ❑ 60Hz ❑ 50 HZ

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

2.5.2 Low voltage, 3 phase auxiliary power will be provided by customer to power the VFD cooling system and VFD control circuits. The auxiliary power voltage shall be 208 – 575 volt, 3 phase as specified on the attached data sheet (Appendix A).

2.6 Environmental Conditions

2.6.1 The VFD shall operate in an ambient temperature range of 0°C to 40°C (32°F to 104°F) with a relative humidity of up to 95% (non-condensing), unless specified otherwise.

2.6.2 The equipment shall be capable of being stored in an environment with an ambient temperature range of -20°C to 65°C (-4°F to 149°F).

2.6.3 The equipment shall operate at altitudes from 0 to 1000 m (3,300 ft.) above sea level, without de-rating. For applications above 1000 m, the maximum ambient temperature and Basic Impulse Levels (B.I.L.) of the controllers shall be de-rated, and vacuum contactors shall be compensated for operation at the specified altitude.

3.0 CODES AND STANDARDS (VFD & CONTROLLERS)

3.1 The Supplier's equipment shall comply with the applicable requirements of the latest standards published by the following organizations:

- Canadian Standards Association (CSA) *"Industrial Control Equipment C22.2 No. 14"*
- American National Standards Institute (ANSI) *"Instrument Transformers C57.13"*
- Institute of Electrical & Electronic Engineers (IEEE)
- National Electrical Code (NEC)
- Electrical & Electronic Manufacturers Assoc. of Canada (EEMAC)
- Occupational Safety & Health Act (OSHA)
- Guide for Harmonic Control and Reactive Compensation of Static Power Converters (IEEE 519-1992)
- National Electrical Manufacturers Association (NEMA) *"Medium Voltage Controllers Rated 1501 to 7200V AC ICS 3-2 (formerly ICS 2-324)"*
- Underwriters Laboratories, Inc. (UL) *(High Voltage Industrial Control Equipment 347)*
- UL 347A Medium Voltage Power Conversion Equipment Preliminary Standard
- International Electrotechnical Commission (IEC) 61800-5 AC Drives Standard
- European Directives for Safety and EMC

Note: It shall be the responsibility of the user and/or installer to know and meet all local codes, standards, and OSHA requirements if applicable.

4.0 CODES AND STANDARDS (RECTIFIER DUTY DRIVE ISOLATION TRANSFORMERS)

4.1 Rectifier duty drive isolation transformers shall comply with the following standards:

- IEEE C57.12.00-1993, IEEE Standard General Requirements for Liquid-Immersed Distribution and Regulating Transformers.
- IEEE C57.12.01-1989, IEEE Standard General Requirements for Dry-Type Distribution and Power Transformers.
- ANSI C57.12.10-1988, American National Standard for Transformers – 230 KV and Below 833/948 through 8333/10417 KVA, Single-Phase, and 750/862 Through 60000/80000 KVA with load TAP Changing – Safety Requirements.
- ANSI C57.12.51-1981, American National Standard Requirements for Ventilated Dry-Type Power Transformers, 501 KVA and Larger, Three-Phase with High-Voltage 601 to 34500 volts, Low-Voltage 208Y/120 to 4160 Volts.
- ANSI C57.12.70-1978, American National Standard Terminal Markings and Connections for Distribution and Power Transformers.
- IEEE C57.12.90-1933, IEEE Standard Test Code for Liquid-Immersed Distribution, Power and Regulating Transformers and IEEE Guide for Short Circuit Testing of Distribution and Power Transformers.
- IEEE C57.12.91-1995, IEEE Standard Test Code for Dry-Type Distribution and Power Transformers.
- IEEE C57.18.10-1998, IEEE Standard Practices and Requirements for Semiconductor Power Rectifier Transformers.
- IEEE C57.124-1991, IEEE Recommended Practice for the Detection of Partial Discharge and the Measurement of Apparent Charge in Dry-Type Transformers.
- IEC 60076-1, Power Transformers: General.
- IEC 60076-2, Power Transformers: Temperature rise.
- IEC 60076-3, Power Transformers: Insulation levels and dielectric tests, Ammendment No.1.
- IEC 60076-3-1, Power Transformers: Insulation levels and dielectric tests. External clearances in air.
- IEC 60076-4, Power Transformers: Tappings and Connections.
- IEC 60076-5, Power Transformers: Ability to withstand short circuit.

- IEC 60616, Terminal and Tapping Markings for Power Transformers.
- IEC 60722, Guide to the Lightning Impulse and Switching Impulse Testing of Power Transformers and Reactors.
- IEC 60726, Dry-type Power Transformers.
- IEC 61378-1, Converter Transformers, Part 1: Transformers for Industrial Applications.

5.0 VFD PERFORMANCE REQUIREMENTS

5.1 The VFD shall produce a variable voltage and variable frequency output to provide continuous operation over the application speed range. The VFD shall be capable of operating with the output short circuited at full current or with the output open circuited at rated voltage.

5.2 VFD shall be capable of operating one of the following motors of equivalent power and speed rating over the speed range specified in Appendix A:

- ❑ Standard AC squirrel cage induction motor
- ❑ Standard AC synchronous motor (DC brush type or AC brushless type)
- ❑ Standard AC wound rotor induction motor

5.3 The drive system shall provide controlled speed over the range specified. Speed accuracy within this range, expressed as a percent of top speed, shall be within 0.1% of base speed without encoder or pulse tachometer feedback (0.01% with encoder or pulse tachometer feedback).

5.4 The VFD shall have a “normal duty” rating of 100% continuous current with a short-time duty rating of 110% overload for one minute, once every 10 minutes (suitable for variable torque loads). A “heavy duty” rating shall be available with 100% continuous current with a short time duty rating of 150% overload for one minute, once every 10 minutes (suitable for constant torque loads). The VFD shall be capable of 100% breakaway torque without tachometer feedback. Breakaway torque with tachometer feedback shall be 150% or as specified in Appendix A. (The breakaway torque shall not exceed 80% of the motor break down torque.)

5.5 For high inertia loads, a preference shall be given to VFDs capable of regenerative motor braking. For overhauling loads, regenerative braking capability shall be mandatory.

5.6 The VFD shall utilize sensorless direct vector control or full vector control, with pulse tachometer feedback, for optimum performance.

5.7 Motor Compatibility

5.7.1 The VFD shall provide near sinusoidal voltage and current waveforms to the motor at all speeds and loads. Output current THD shall be less than 5%. Standard induction or synchronous motors shall not require de-rating or upgraded turn-to-turn insulation and shall not require additional service factor. The motor insulation system shall not be compromised thermally or due to dv/dt stress. Dv/dt at the motor terminals (line-to-line) shall be limited to 10 volts per microsecond. If dv/dt at the motor terminals (line-to-line) exceeds 10 volts per microsecond, the vendor must state the actual value in the attached data sheets and include steps taken to guarantee the long term life of the motor insulation system.

5.7.2 The motor insulation system shall not be compromised due to excessive peak voltage of the output waveform. Motor peak line-to-line output voltage shall be limited to the following values:

Line-to-Line Stator Rated Voltage (Vac RMS)	Peak Line-to-Line Output Voltage (Vpk)
2400	3394
3000	4243
3300	4667
4160	5883
6000	8485
6600	9334

If the motor peak line-to-line output voltages exceed the values listed in the above table, the vendor shall clearly state the actual value with the proposal and in the attached data sheets.

5.7.3 The VFD shall provide stable operation of the motor without compromising the motor insulation system, regardless of motor cable distance. The vendor shall clearly state the limitations in motor cable distance with the proposal. If an output filter is required to mitigate reflected waves, or to meet any special requirements of the application, it must be integral to the VFD controller.

5.7.4 If output filters are used in the VFD, a selective harmonic elimination (SHE) switching technique must be available to eliminate a potential harmonic resonance in the operating speed range.

5.7.5 VFD induced torque pulsations to the output shaft of the mechanical system shall be less than 1% to minimize the possibility of exciting a resonance.

5.8 Line Side Harmonics

5.8.1 VFDs shall comply with the latest edition of IEEE 519 Harmonic Guidelines.

5.8.2 The following VFD rectifier solutions are acceptable:

1) PWM rectifier (Active Front End) with AC line reactor or isolation transformer
2) 18-pulse rectifier with 3 winding secondary phase shifting isolation transformer
3) 6-pulse rectifier with AC line reactor or isolation transformer, with or without harmonic filter (Air-Cooled VFD only)

5.8.3 Preference shall be given to drive systems that meet IEEE 519 harmonic guidelines with the lowest possible design complexity. The VFD supplier shall detail the number of main power components supplied in the VFD and number of secondary windings on the isolation transformer on attached Appendix B – Technical Data Sheet.

5.8.4 The VFD shall meet local requirements for telephone interference restrictions.

5.9 Efficiency

VFD system efficiency shall be a minimum of 96% at 100% speed & 100% load. System efficiency shall include VFD, input transformer or line reactor, harmonic filter (if applicable) power factor correction unit (if applicable), and output filter (if applicable). Control power supplies, control circuits, cooling fans or pumps, shall be included in all loss calculations.

5.10 Audible Noise Level

Maximum audible noise from the VFD or associated VFD system shall comply with OSHA standard 3074, Hearing Conservation, which limits noise level to 85 dB(A). The VFD system shall comply with the OSHA standard at a distance of one meter from the front of the equipment (with doors closed at any speed or load condition). VFD systems with audible noise in excess of this limit must be provided with sufficient noise abatement treatment to reduce the sound pressure level below 85 dB(A).

5.11 Power Factor

The VFD shall be capable of maintaining a minimum true power factor (Displacement P.F. X Distortion P.F.) of .98 from 30-100% power. If the VFD vendor cannot meet the true power factor requirement, then a power factor correction unit shall be quoted as an option. The true power factor that can be met (with and without power factor correction unit) shall be stated clearly in the proposal.

6.0 RELIABILITY

6.1 Availability

The VFD system shall be designed for a minimum availability of 99.9%.

6.2 Mean Time Between Failures

The VFD system shall be designed for a Mean Time Between Failures (MTBF) of 100,000 hours.

6.3 Life Expectancy

The VFD system shall be designed for a minimum life expectancy of 20 years.

6.4 Reliability

6.4.1 In order to optimize reliability and minimize complexity, inverter power switch component count shall be minimized by utilizing high peak inverse voltage (PIV) rated devices. Preference will be given to designs exhibiting the lowest overall power component count.

6.4.2 The VFD shall have a control power monitoring system that monitors all power supply voltages and signals.

6.5 Diagnostics

6.5.1 Fiber optic interface boards shall be used to provide gating and diagnostic feedback signals for power semiconductor devices. The diagnostic feedback system shall allow constant control of the device as well as constant monitoring of device health and temperature feedback.

6.5.2 Field programmable gate arrays (FPGA) shall be utilized on drive control boards to provide high speed handling of diagnostics and fault handling routines. High-speed digital control systems shall continuously monitor all hardware and software faults including sensing of all power circuit voltage and currents as well as any internal equipment faults.

6.5.3 Power switch device diagnostics shall detect and protect against device short, over or under gate voltage, loss of gating, loss of diagnostic feedback, heat sink temperature feedback as well as overload monitoring and protection.

6.5.4 The VFD shall have an optional modem that provides remote diagnostic capability and interaction with the drive for factory based troubleshooting. Firmware upgrades shall be available via the Internet.

6.6 Ride Through

The VFD shall be capable of riding through a loss of power of 5 cycles. If specified in the attached data sheet, an optional UPS shall be supplied for extended ride through.

6.7 Auto-Restart Capability

The VFD shall be capable of automatically restarting in the event of a momentary loss of power, or a clearing of a drive trip.

6.8 Power Sag Ride-Through

The VFD system shall be capable of operating with a voltage sag of 30% on the input power line. (The motor shall not be allowed to reach a pull out condition.)

6.9 "Flying Re-Start" Capability

The VFD shall be capable of restarting and taking control of a motor attached to a spinning load in the forward or reverse direction.

6.10 Drive Protection

The VFD shall have the following minimum protection features:

At Input Source Side:

1. Under voltage (adjustable)
2. Over voltage (adjustable)
3. Instantaneous over current (adjustable)
4. Ground fault (adjustable)
5. Overload (adjustable)

On System Level:

6. Gate driver power supply under voltage
7. Control power over / under voltage and signals
8. Over temperature protection

At Output Motor Load Side:

9. Short circuit protection (instantaneous over current)
10. Overload (delayed over current)
11. Over voltage (adjustable)
12. Motor over speed (adjustable)

6.11 Motor Protection

a) Electronic motor overload protection shall be supplied as standard.

b) If specified on the data sheet, An optional RTD relay for sensing actual motor temperature and drive shutdown shall be supplied.

c) A motor stall protective function will be supplied on all units. The amount of time the drive will be allowed to run at current limit under minimum speed shall be adjustable.

d) If specified on the data sheet, a multi-functional motor protection relay (MPR) shall be supplied when a bypass starter is requested.

e) If specified on the data sheet, motor space heater control shall be provided.

7.0 OPERATOR INTERFACE AND COMMUNICATIONS

7.1 Operator Interface

The VFD shall have a user-friendly operator interface terminal with the following minimum features:

- Large LCD display screens (minimum 16 line – 40 characters) that are easy to read and provide 'at a glance' indication of drive operating status
- User configurable bar type LCD metering for motor speed, load, torque, and voltage
- Elapsed time indication
- Extensive diagnostic functions that provide separate fault and warning queues in non-volatile memory that retain information under all conditions
- On-line help that provides enhanced fault text messages
- Trend buffers for at least 8 variables that allow one-shot or multi-shot trending
- Multi-level password access to ensure that only qualified personnel have access to critical parameters but still allow easy access to other levels of personnel
- Extended use of plain language messages to eliminate need to look up error codes or decipher the meaning of error messages
- Start-up wizard, including auto tuning, that is interactive and user-friendly

7.2 Communications

When specified on the attached data sheet Appendix A, the VFD shall be provided with digital communication capability to allow direct control and status communication with a PLC, SCADA or other control system. The communication protocol shall be that specified on the data sheet. Communication modules for Remote I/O, DeviceNet, and ControlNet will be suitable for DIN rail mounting or communication board mounting.

7.3 Inputs and Outputs

7.3.1 Sixteen (16) isolated digital inputs and sixteen (16) isolated digital outputs shall be available as standard on the drive, rated from 12V to 260V AC or DC.

7.3.2 Isolated analog signal interfaces (maximum of four (4)) shall be configurable for:

- Speed reference input (4-20 mA input signal).
- Speed output (4-20 mA output signal).
- Voltage output (4-20 mA output signal).
- Current output (4-20 mA output signal).
- Load (kW) output (4-20 mA output signal).
- Torque output (4-20 mA output signal).

7.3.3 If requested in the attached data sheet, a Windows based application software shall be quoted as an option to monitor and edit drive parameters, upload and save parameters to a file, download parameters to the drive, print parameters, and view and clear faults/alarms in the drive.

7.3.4 The VFD shall be controlled locally via start/stop push buttons, emergency stop push button, local/remote selector switch, and speed reference potentiometer.

8.0 SERVICE AND MAINTENANCE

8.1 Component Replacement

Failed power switch components shall be replaceable without removal of the entire power module. Special tools or force measuring transducers shall not be required. Failed power switch components shall be replaceable in less than 5 minutes for air cooled VFD and less than 15 minutes for liquid cooled VFD.

8.2 Module Repair Time

Converter power modules shall be repairable in 5 minutes or less for air cooled VFD, 15 minutes or less for liquid cooled VFD. If entire power module is replaced, vendor to specify mean time to repair failed power modules.

9.0 COOLING SYSTEM

9.1 Air Cooling System

9.1.1 The VFD system shall be air-cooled unless otherwise specified in the attached data sheet.

9.1.2 Air-cooled VFDs shall be provided with a mixed flow cooling fan, mounted integral to the VFD enclosure. The VFD shall include air-flow pressure switches and temperature detectors to monitor proper operation of the air cooling system. If a fan fails, the system must generate alarm indication of the fan failure. Vane type air-flow switches are not acceptable.

9.1.3 If specified on the attached data sheet, provision shall be made for ducting VFD exhaust air outside the control room.

9.2 Liquid Cooling Requirements

9.2.1 The VFD system shall be liquid-cooled when specified in the attached data sheet. The cooling liquid shall be iron and chloride-free ethylene glycol mixed with de-ionized water to provide a service temperature range of -45°C to +70°C. The coolant conductivity shall be 1-2 micro-Siemens / cm.

9.2.2 Liquid to air and liquid to air type heat exchangers shall be offered as standard options. Liquid to liquid type heat exchangers shall be integral to the VFD pump panel. Liquid to liquid type heat exchangers shall be stainless steel plate with nickel braze material. The liquid to liquid heat exchanger requires a separate source of cooling water supplied by the customer. Clean cooling water shall be used at a maximum temperature of 30°C and a maximum pressure of 165 psi.

9.2.3 The VFD pump panel shall be integral to the VFD cabinet and shall include a redundant pump that is automatically switched over during a failure of the main pump. A PLC in the control panel shall automatically switch the main and redundant pumps every 8 hours to exercise both pumps.

9.2.4 Liquid coolant shall be monitored for temperature, conductivity, and pressure. A reservoir tank shall be provided inside the pump panel with low and high level sensors.

9.2.5 If a Liquid-to-air heat exchanger is specified, it is to be installed outdoors by others. Piping and power and control wiring between the VFD and the heat exchanger is by others. The coolant liquid shall be supplied by the VFD vendor. Liquid to air heat exchangers shall include a redundant fan as standard.

9.2.6 Liquid cooled drive isolation transformers will not be accepted. If required, isolation transformers shall be outdoor oil-filled to reduce control room size and losses

10.0 ENCLOSURE

10.1 Enclosure Rating / Construction

10.1.1 VFD enclosures for air-cooled and liquid cooled VFDs shall be NEMA 1G (IEC IP21). Liquid cooled drives will also have an option for NEMA 12 with forced ventilation and filters (IEC IP42). Door vents shall consist of louver-panel assemblies that can be removed from the front in order to replace air filters. Safety screens shall be located behind each louver panel. Cabinets and doors shall be fabricated using minimum 12 gauge (2.64 mm thick) steel for sturdy construction. All doors shall be gasketed to provide environmental protection and secure fits.

10.1.2 Door latches shall be heavy-duty ¼-turn type units which are operated with an Allen wrench. The converter cabinet door and cabling cabinet door shall be interlocked with up-stream isolators or breakers with a key lock. Interlocking shall be fully coordinated to prevent access to all medium voltage compartments.

10.1.3 The VFD shall be designed for front access to all components. Equipment that requires rear or side access will not be accepted.

10.2 Structure Finish

10.2.1 As standard, all VFD exterior and interior metal parts (except for the power cell back plates and low voltage panel) shall be painted Sandtex Gray (low voltage control door and front wireway cover shall be Sandtex Black). All metal back plates in the power cell and low voltage compartments shall be painted high gloss white for high visibility. Optional field touch-up spray can(s), matching the enclosure color, shall be supplied when requested.

Description	Hybrid epoxy powder paint – Sandtex
Standard color.....	Sandtex gray/black (optional ANSI 49 medium light gray or ANSI 61 light gray)
Procedure.....	Continuous paint line. All parts shall be painted before assembly.
Preparation.....	Alkaline wash/rinse/iron phosphate rinse/iron-chrome sealer rinse/recirculated de-ionized water rinse and virgin de-ionized water rinse.
Painting	Air-atomized electrostatic spray. Total paint thickness – 0.002” (0.051 mm) minimum
Baking	Natural gas oven at 179°C (355°F) minimum.

10.2.2 Notes:

1. When optional custom paint color is specified, all external surfaces shall be painted to the custom color requirement, except for the external isolating switch handle assembly, lifting angles, lifting brackets, low voltage door, and low voltage wireway cover.

2. All unpainted steel parts shall be plated with a zinc plate/bronze chromate process for corrosion resistance.

10.3 Seismic Qualifications

The equipment, when bolted down (mounted) per the Seller's recommended installation instructions, shall withstand horizontal and vertical accelerations (seismic zone 4) without overturning or lateral movement.

10.4 Cabling

10.4.1 The VFD shall contain a power cable termination assembly designed for easy termination and access to line and load cables. The termination assembly cabinet shall allow for top and bottom entry and exit of line and load cables.

10.4.2 A low voltage wire way shall be provided at the top front of the VFD and shall be available with a removable cover.

10.4.3 All power and control terminations and termination strips shall be identified in accordance with all schematics and wiring diagrams.

10.4.4 Low voltage control wire shall be TEW tinned, 600 volt AC rated.

10.4.5 All VFD internal power connections shall be made with tin plated copper bus or 8 kV (minimum) insulated power cable.

11.0 RECTIFIER DUTY TRANSFORMERS AND AC LINE REACTORS

11.1 Line Impedance

The VFD supplier shall provide one of the following input impedance devices:

1) Indoor, dry type rectifier duty transformer
2) Outdoor, oil-filled rectifier duty transformer
3) AC line reactor integral to VFD

11.2 Indoor, Dry Type Transformers (Non-integral to VFD)

The following minimum standard features will be provided: (Refer to RA Specification 80001-005 for more complete details.)

1) One (1) normally closed auto reset thermal switch per coil, wired in series to a terminal strip.
2) 220 ℃ insulation class, 150°C rise, AA Cooling Class.
3) HV and LV bus to ends.
4) Secondary winding insulation levels per RA Transformer Specification 80001-005
5) Delta primary with 2 -5% taps, 1 FCAN, 1 FCBN.
6) Wye secondary winding (6 pulse or PWM rectifier).
7) Three (3) secondary windings: One (1) Delta, two (2) extended Delta at Delta – 20 degrees and Delta +20 degrees (18 pulse).
8) 5 to 8 percent impedance
9) Fully insulated from phase to ground and neutral to ground.
10) Fully insulated between secondary windings (18 pulse).
11) Lifting eyes on core and coil assembly - complete unit.
12) Removable jacking and lifting provisions on enclosure base assembly - complete unit.

13) Tap changing via solid bus jumpers.
14) Diagrammatic nameplate.
15) Two (2) enclosure ground pads - 2 hole stainless steel.
16) Base suitable for jacking, pulling and rolling.
17) ANSI 49, light gray, Type 1 ventilated indoor enclosure, extra wide for bottom or top cable entry/exit.
18) The transformer shall be designed for continuous operation at its base kVA rating (natural cooling) without exceeding the temperature rise. The short time rating shall be adequately designed to deliver the power demanded by the drive without loss of insulation life.
19) Forced cooled transformers are not allowed.

11.3 Outdoor, Mineral Oil-filled Type Transformers

The following minimum standard features will be provided: (Refer to RA Specification 80001-005 for more complete details.)

1) Welded tank cover, sealed tank construction.
2) Cover lifting eyes.
3) Hand hole with bolted cover.
4) Lifting hooks - complete unit.
5) Pressure-vacuum gage.
6) Mineral oil filled.
7) Oil drain valve and upper filling device
8) 65 ℃ rise, OA Cooling Class.
9) Magnetic liquid level gage and alarm contacts.
10) Top oil thermometer gage and alarm contacts.
11) De-energizer tap changer with padlockable handle.
12) Panel type cooling radiators - Welded type.
13) Diagrammatic nameplate.
14) Two (2) tank ground pads - 2 hole stainless steel.
15) Base with jacking, pulling and rolling provisions.
16) Pressure relief device
17) Control box, NEMA 3R (IP34).
18) HV and LV air filled terminal chambers.
19) Automatic/manual pressure relief valve.
20) OA cooling class.
21) Secondary winding insulation levels per RA Transformer Specification 80001-005
22) Delta primary with 4 – 2.5% taps, 2 FCAN, 2 FCBN.
23) Wye secondary winding (6 pulse or PWM rectifier).
24) Three (3) secondary windings: One (1) Delta, two (2) extended Delta at Delta –20 degrees and Delta +20 degrees (18 pulse).
25) 5 to 8 percent impedance.
26) Fully insulated from phase to ground and neutral to ground.
27) Fully insulated between secondary windings (18 pulse).
28) ANSI 61, light gray enclosure.

11.4 AC Line Reactors

11.4.1 Where possible, line reactors may be supplied instead of transformers, provided the line reactor and VFD system are designed to provide at least equivalent harmonic isolation and overall efficiency of a transformer and VFD system.

11.4.2 Line reactors shall be integral to the VFD line-up.

11.4.3 The line reactor K-factor shall be designed for rectifier service (6 pulse or PWM rectifier).

11.4.4 The line reactor shall be convection cooled with Class H insulation.

11.4.5 The line reactor shall include thermal protection.

11.5 Output Transformers

Output transformers or step-up transformers are not acceptable for use with AC Variable Frequency Drives.

12.0 AUXILIARY EQUIPMENT

12.1 Input Disconnecting Means

For power circuit protection and isolation of the VFD from the main supply, an input starter (sized for motor current) shall be provided with the following minimum design criteria:

12.1.1 The structure shall consist of a metal enclosed free-standing dead-front vertical steel assembly. It shall contain:

- Tin-plated, copper, horizontal power bus
- A copper ground bus
- A main non-load-break isolating switch
- A vacuum break contactor
- A low voltage contactor control panel

12.1.2 The power cell shall be designed to accept bolt-on or clip-on current limiting fuses for class E2 operation.

12.1.3 The structure will be divided into isolated compartments as follows:

1. Main power bus and ground bus compartment
2. Power cell compartment
3. Low voltage compartment
4. Low voltage wireway across the roof of the structure

12.1.4 Each structure shall also have a non-removable base channel and removable lifting angles for ease of installation.

12.1.5 Main Power Bus

12.1.5.1 The main horizontal power bus shall be located in the center, at the back of the structure, to provide optimum heat distribution, ease of maintenance and splicing. The power bus shall be mounted on edge to a molded bus support insulator in a common vertical plane. This shall provide better short-circuit withstand ability and protect against the accumulation of dust and tracking between phases. The power bus shall be made of tin-plated copper and be available in one of the following continuous current ratings: 1200, 2000 or 3000 amps.

12.1.5.2 Access shall be provided to the bus compartment from the front or the rear of the structure to allow for installation and regular maintenance of the power and ground bus splice connections.

12.1.5.3 The horizontal buswork, the cabling/bus from the main power cell shall be braced and tested in accordance with NEMA ICS 3-2 and UL 347 (paragraph 30).

12.1.5.4 When optional insulated power bus is specified for the main horizontal bus, a sleeve-type, heat shrink insulating material with good flame resistance and self-extinguishing properties, shall be used. This material shall have a minimum wall thickness of 1.4 mm (0.055 in.)

12.1.6 Bus Bracing

12.1.6.1 The horizontal/vertical buswork and the cabling/bus in the main power cell(s) shall be braced and tested in accordance with NEMA ICS 3-2 and UL 347.

12.1.6.2 The buswork and cabling shall be braced to withstand the let-through energy allowed by the largest fuse during a short circuit fault.

12.1.7 Ground Bus

A continuous copper ground bus shall be provided along the entire length of the controller line-up. A mechanical lug for #8 to #1/0 AWG or #6 to 250 MCM cable shall be supplied at the incoming end of the line-up. The ground bus shall be 1/4" x 2" (6.4 mm x 51 mm) bare copper.

12.1.8 Vacuum Contactor Specifications

12.1.8.1 The electrically (magnetically) held medium voltage contactor shall be the Allen-Bradley Bulletin 1502 vacuum type or equivalent.

12.1.8.2 The following (open) current ratings shall be used:

- 400 A
- 800 A

12.1.8.3 The contactor shall have visual contact wear indicators. No special tools are required for checking contact wear.

12.1.8.4 Vacuum bottle and coil maintenance shall not require removal of the vacuum contactor.

12.1.8.5 The vacuum input contactor shall be fixed mounted inside the power cell. Fixed mounting provides solid, continuous contact while lowering maintenance requirements considerably. The contactor shall be interlocked with the non-load-break isolating switch, both electrically and mechanically, which shall provide the following safety features:

- Prevent the isolating switch from being opened or closed when the contactor is in the closed position.
- Prevent the opening of the medium voltage door when the isolating switch is in the closed position.
- Prevent the closing of the isolating switch when the medium voltage door of the controller is open.
- Remove control power from the control power transformer (CPT), power transformers (PTs) or external power source to the control circuit when the isolation switch and contactor are in the open position.

12.2 Bypass Controllers

If specified in the attached Appendix A data sheet, a bypass starter shall be provided. The manufacturer for the bypass starter must be the same as the VFD and input starter. The bypass starter shall always be located on the left-hand side of the input starter. A double power bus configuration shall be utilized in the bus compartment (one is the main power bus, the other is the variable frequency bus). The variable frequency bus shall be located above the main power bus. In order to ensure maximum safety and to allow fully isolated service access to the VFD while on bypass, an output vacuum contactor, isolating switch, mechanical and electrical interlocking shall be included with the bypass starter.

12.3 Synchronous Transfer

If specified on the attached data sheet, synchronous transfer control from VFD to line frequency (and line frequency back to VFD) shall be quoted as a separate option. The VFD control system shall include a synchronizing regulator to adjust the drive speed reference as required to synchronize the motor to the line. The VFD control shall include the following adjustable parameters for synchronous transfer control:

- Synchronous Transfer Lead Angle
- Synchronizing Regulator Gain
- Synchronizing Regulator Error
- Synchronous Transfer Mask
- Synchronizing Time
- Synchronous Transfer Time
- Synchronous Transfer Off Delay

12.4 Output Contactor

If the motor is capable of being driven by a separate electrical or mechanical source, while the drive is being serviced, then an output contactor shall be supplied to provide safe isolation.

13.0 SYSTEM CONSIDERATIONS

13.1 Torsional Analysis

13.1.1 If specified on the attached Appendix A data sheet, a torsional analysis shall be quoted as a separate option. This service shall determine natural rotational frequencies of vibration, resonant points (critical speeds where natural frequencies coincide with torsional excitations within the speed range) and steady state stresses using computerized analysis. The drive train shall be modeled into lumped masses and connecting shafts represented by inertias and stiffnesses, creating the number of masses required to obtain accurate natural frequencies of vibration. The system model shall be detected in a Mass Elastic Diagram.

13.1.2 A report shall be supplied with the proposal including a summary of torque and stress levels. Vibratory displacements shall be tabulated with shaft location and identified as critical speeds in the results.

13.2 Tachometer Requirements

If requested in the attached Appendix A data sheet, speed feedback by pulse tachometer or encoder shall be required. Tachometer feedback is recommended under the following conditions:

1. When speed regulation accuracy must be between 0.01 – 0.02% of nominal speed.

2. In forward or reverse direction. When the zero speed breakaway torque needed is greater than 90% of continuous running torque.

3. When continuous running speed is greater than or equal to 0.1 Hz, but less than 6 Hz.

4. For minimizing restart times using the flying start capability.

14.0 COMMISSIONING AND TRAINING

14.1 Start-Up Commissioning Services (Optional)

14.1.1 Start-up will be performed at the User's site.

14.1.2 The Supplier shall provide the following:

- A pre-installation meeting with the User to review:
  – The start-up plan
  – The start-up schedule
  – The drive's installation requirements
- Inspect the drive's mechanical and electrical devices enclosed
- Perform a tug test on all internal connections within the drive and verify wiring.
- Verify critical mechanical connections for proper torque requirements.
- Verify and adjust mechanical interlocks for permanent location.
- Confirm all sectional wiring is connected properly.
- Re-verify control wiring from any external control devices.
- Set up all drive internal power supplies and thyristor control circuits.
- Verification of proper phasing from isolation transformer to drive.
- Confirm cabling of drive to motor, isolation transformer and line feed.
- Perform Megger test.
- Apply medium voltage to the drive and perform operational checks.
- Bump motor and tune drive to the system attributes. (If the load is unable to handle any movement in the reverse direction, the load should be uncoupled prior to bumping the motor for directional testing.)
- Run the drive motor system throughout the operational range to verify proper performance.

14.2 Factory Training (Optional)

14.2.1 The Supplier shall offer Medium Voltage Drives Training at the Supplier's factory. The training sessions shall be designed for maintenance and operations personnel and should include troubleshooting and maintenance of the Medium Voltage drives installed. Manuals and documentation will be provided to each participant.

14.2.2 The training shall cover the following minimum topics:

- Basic motor theory
- Theory of operation
- Drive hardware
- Drive firmware
- Cooling system operation
- Operator interface
- Board replacement procedures
- Power device replacement procedures
- Fault analysis and troubleshooting
- Preventative maintenance procedures

14.2.3 Hands-on labs shall be included in the training. Demos shall be provided to allow the students to apply the lecture material to a functional demo unit.

14.3 On-Site Training (Optional)

14.3.1 If specified, the Supplier shall provide a qualified instructor to provide user's personnel with training that is specific to the system installed at the facility. The Supplier shall outline the training session duration and content. Manuals and documentation shall be provided for each participant (maximum of eight participants per training course).

14.3.2 The training shall cover the following minimum topics:

- Basic motor theory
- Theory of operation
- Drive hardware
- Drive firmware
- Cooling system operation
- Operator interface
- Board replacement procedures
- Power device replacement procedures
- Fault analysis and troubleshooting
- Preventative maintenance procedures

15.0 OBLIGATIONS OF SUPPLIER

15.1 Deviations

Any exceptions or deviations shall be defined in writing at the time of bid.

16.0 DRAWINGS AND MANUALS

16.1 Information Drawings

Orders shall include a submittal of three (3) bond paper prints of the dimension drawing and electrical drawings (two for Purchaser and one for Supplier's local representative) at the time engineering is finalized. These drawings shall be suitable for photo copying.

16.2 Approval Drawings

Approval drawings, if required, shall be available at no charge. The approval submittal shall include (3) bond paper prints of the dimension drawing and electrical drawings. Approval drawings can be sent electronically via the Internet, as an alternative to sending them by mail. The Supplier shall quote additional lead time required for approval drawings.

Note: Supplier shall allow the Purchaser two (2) weeks to review the drawings. This period starts on the date that the drawings are shipped to Purchaser and ends on the date that the drawings are returned to the supplier. If drawings are returned earlier than two (2) weeks, then the supplier will notify the Purchaser if the lead-time will be adjusted accordingly.

16.3 Final Drawings and Manuals

Certified drawings, instruction and maintenance manuals (3 sets) shall be sent within 30 days of final product shipment. Final drawings shall be available in DXF format at no charge.

17.0 SPARE PARTS

17.1 Spare Parts

Recommended spare parts list and prices shall be supplied with the bid. Also, the address of the Supplier's closest parts stocking location to the User shall be provided.

17.2 Critical Spares

Spare parts that are identified as being associated with long lead times and/or are critical to the unit's operation. These spares should be held in reserve by the Purchaser to limit unforeseen downtime.

17.3 Maintenance Spares

17.3.1 Spare parts that are identified as being required to regularly perform scheduled maintenance on their equipment. These spares include, but are not limited to, consumable spares that are required to be exchanged during scheduled maintenance periods.

17.3.2 Supplier shall assist in determining an appropriate level of spare parts in conjunction with the Purchaser's bill of material (which may include circuit breakers, full voltage starters, load break switches and other auxiliary equipment, including variable speed drives) and the current installed base.

18.0 ON-SITE INVENTORY AGREEMENT (OPTIONAL)

18.1 Supplier shall offer an on-site inventory agreement, in which the Supplier will stock and supply, as needed, all of the spare parts required by the User in the closest stocking location. The User shall have a controlled/immediate access to this inventory 365 days a year.

19.0 QUALITY ASSURANCE

19.1 All inspection and testing procedures shall be developed and controlled under the guidelines of the Supplier's quality system. This system must be registered to ISO 9001 and regularly reviewed and audited by a third party registrar.

19.2 All incoming material shall be inspected and/or tested for conformance to quality assurance specifications.

19.3 All sub-assemblies shall be inspected and/or tested for conformance to Supplier's engineering and quality assurance specifications.

20.0 STANDARD TESTING

20.1 The following tests shall be carried out in accordance with applicable requirements and/or specifications of Canadian Standards Association (CSA), Underwriters Laboratories (UL), National Electrical Manufacturers Association (NEMA), European Standard (EN), and International Electrotechnical Commission (IEC).

20.2 Functional checks shall be performed wherever possible; otherwise, inspection and continuity checks shall be made.

20.3 A "HI-POT" dielectric withstand test shall be performed on all buswork and cables from phase-to-phase and phase-to-ground (except solid-state components, low voltage controls and instrument transformers). The voltage level used for this test depends on the product's nominal AC voltage.

20.4 Component devices shall be functionally operated in circuits as shown on electrical diagrams or as called for by specific test instructions.

20.5 Instruments, meters, protective devices and associated controls shall be functionally tested by applying the specified control signals, current and/or voltages.

20.6 Medium Voltage Drives shall be inspected for the following:

- Control Power Failure Test
- Rectifier Gating Checks
- Inverter Gating Checks
- Line Converter Tests
- Machine Converter Tests
- Load Tests
  - Drives shall be accelerated to the test motor's nominal frequency, under load, decelerated to 10 Hz, then accelerated back to test motor's nominal frequency, with a ramp time of approximately ten seconds. This cycle shall be repeated continuously for up to one hour.
  - Drives shall be tested under load at the test motor's nominal frequency.

21.0 PHYSICAL INSPECTION

21.1 The product must meet all applicable engineering and workmanship standards and specifications. All components shall be verified against engineering documentation to be present and correctly installed.

21.2 Warning plates, isolation barriers, and mechanical interlocks must provide sufficient safety/isolation for personnel and equipment.

- Warning labels and nameplates must be present and in their specified positions to advise personnel of possible hazards.
- Isolation barriers must be in place within the cabinet. Such barriers protect personnel from touching live medium voltage components in an area that otherwise does not have power supplied to it.
- Operation of isolation switch handle and door interlocks must be verified. The interlocking prevents the opening of any medium voltage door on a medium voltage cabinet when the isolation switch handle has been moved to the full ON position.

21.3 All bus and bus connections shall be checked for proper clearance, creepage, phasing, and torque.

22.0 FACTORY INSPECTIONS (OPTIONAL)

22.1 Visual Inspection of Equipment

22.1.1 If requested, a review of the electrical and mechanical drawings for the purchased equipment will be done with the Supplier's Application Engineer or Project Manager prior to commencing the inspection.

22.1.2 The visual inspection shall consist of a Purchaser visit to the factory, with prior notification and coordination with the Customer Service Coordinator or the Project Manager, with the intent to view the customer-specific equipment at the various stages of build during the visit. (There is no preparation of the equipment in any way for this inspection and is a means to allow the Purchaser to verify the progress of the order without any disruption to the manufacturing cycle.)

22.2 Witness Testing

22.2.1 If requested, witness testing shall be quoted as a separate option, including a review of the electrical and mechanical drawings for the purchased equipment to be done with the Supplier's Application Engineer or Project Manager prior to commencing the tests. Any questions or clarifications, prior to commencing the test, will be addressed at this time. The Application Engineer will then host the Purchaser for the duration of the actual testing. At the conclusion of testing, the customer will reconvene with the Application Engineer or Project Manager to discuss any concerns or issues that arose during the test. Any modifications or changes requested by the Purchaser will be documented and discussed at this meeting. The Project Manager or Applications Engineer will respond to the Purchaser at the earliest possible time with an outline of the financial and/or schedule impact of the changes.

22.2.2 The witness test shall include a Drive System Run Test that shall consist of operating the variable frequency drive connected to a 1250 hp dynamometer (minimum). During the testing of the drive, a demonstration of the operator interface and functionality will be provided as well as demonstration of the operation of the drive.

22.2.3 The drive will be tested up to rated horsepower or 1250 hp, whichever occurs first, at both steady state and varying speeds.

22.2.4 The drive will also be tested for verification of service factor if within the limits of the dynamometer.

22.2.5 The drive will be tested with the facility isolation transformer, facility input contactor and facility DC link.

22.2.6 For liquid-cooled drives, the test facility heat exchanger will be utilized.

22.2.7 The following equipment, if purchased, shall be tested at additional cost above the base cost of the standard tests:

- Isolation devices
- Contactors
- Harmonic filters
- Bypass starters
- Synchronous transfer
- Remote communications options

22.2.8 A Certified Test Report will be issued to the Purchaser.

22.3 Combination Drive-Motor Witness Testing (Optional)

If specified on the attached data sheet, an optional price shall be shown separately in the proposal for a combined drive-motor witness test. The combination Drive-Motor System Run Testing shall include the following:

- A review of the electrical and mechanical drawings for the purchased equipment will be done with the Applications Engineer or Project Manager prior to commencing the tests.
- Operation of the VFD and the motor at rated voltage, current, and base frequency until a steady state motor operating temperature is reached.
- A log of the winding and bearing temperatures will be made during the test.
- A test report shall be forwarded to the purchaser

22.4 Custom Testing (Optional)

If requested, the Supplier shall be prepared to provide custom testing of VFD and associated equipment. The Purchaser specifications for the custom test must be provided to the Supplier at least two months prior to the testing date at which time the Supplier will provide a cost and schedule impact for completing the testing requirements.

Appendix A – Technical Data Sheet
(To Be Completed By Purchaser)

Project Reference: _____ R.F.Q. Reference: _____

Spec. Reference: _____ Date: _____

Supply System Voltage (± 10%)
☐ 2400 V ☐ 3300 V ☐ 4160 V
☐ 6000 V ☐ 6600 V ☐ 7200 V
☐ Other _____ V

Line Frequency: ☐ 60 Hz ☐ 50 Hz

VFD Auxiliary 3-Phase Power
60 Hz: ☐ 208 V ☐ 480 V ☐ 575 V
50 Hz: ☐ 400 V

Load/Application Requirements
Type of Load: ☐ Fan ☐ Pump ☐ Other _____
Torque Profile: ☐ Variable ☐ Constant
☐ Other _____
Gearbox Ratio: ☐ _____ to _____ ☐ None
Speed Range: _____ Hz to _____ Hz

Breakaway Torque
☐ 0-100%
☐ 101-150%
☐ >150% _____

Short-Term Overload Duty
☐ 110% for 1 minute
☐ 150% for 1 minute

Speed Regulation
☐ 0.1%
☐ 0.01%
☐ Other _____%

Torque Mode
☐ Motoring
☐ Regeneration
☐ Reversing

Motor Data
hp/kW: _____ New or Existing? _____
FLA: _____ Vendor: _____
S.F.: _____ Enclosure: _____
Voltage: _____Base Speed: _____ RPM
Space Heater: _____ V
Motor Rated to Start on Bypass: ☐ Yes ☐ No

RTDs (2-Winding/Phase, 1 per bearing)
☐ 100 Ohm Platinum
☐ 10 Ohm Copper
☐ 100 Ohm Nickel
☐ 120 Ohm Nickel

VFD Cooling Methods
☐ Air Cooled
☐ Provision for ducting exhaust air
☐ Liquid Cooled
☐ Water-Air Heat Exchanger
☐ Water-Water Heat Exchanger

Options
☐ Diagnostic Printer
☐ Door-mounted Analog Meters for output speed, voltage, current, load
☐ Bar type Metering on LCD display for output speed, voltage, current, load

4-20 mA Isolated Analog Outputs
☐ Speed ☐ Current ☐ All
☐ Voltage ☐ Load

Design Standards
☐ UL 347A
☐ IEC 61800-5

Testing
☐ Standard
☐ Witness Test
☐ Drive/Motor Combined Test at Motor Vendor's Facility
☐ String Test at Driven Equipment at Vendor's Facility

Environment
Site Location: _____
Seismic Engineering: ☐ No ☐ Yes Zone _____
Control Room Max. Ambient: _____ °C
Control Room Min. Ambient: _____ °C
Elevation: _____ Meters ASL
Humidity: _____ % Non-condensing
Control Room Dust Level: _____ PPM
Cabinet Space Heater? ☐ No ☐ Yes _____ V

Auxiliary Equipment
☐ Input Starter w/vacuum contactor and fused isolating switch
☐ Bypass Starter
☐ Synchronous Transfer to Line Frequency
☐ Power Control House for Electrical Equipment
☐ Output Contactor

Communication Options
☐ DeviceNet Adapter
☐ RIO Adapter
☐ ControlNet Adapter
☐ Modbus
☐ Modbus Plus
☐ Other: _____

Services
☐ Harmonic Analysis ☐ Factory Training
☐ Torsional Analysis ☐ Onsite Training

Appendix B – Technical Data Sheet
(To Be Completed By Vendor)

General Information
Vendor: _____
Manufacturing location: _____
Manufacturing MV Drives for _____ Years
Manufacturing MV Controllers for _____ Years

Nearest Available Service Reps Location from Customer Site?

_____

VFD Nominal Line Voltage: _____ V
Supply Frequency: _____ Hz
Motor Voltage: _____ V

VFD Topology? _____

Inverter
Power Semiconductor Switching Device:
☐ GTO ☐ SGCT ☐ IGCT ☐ IGBT
Peak Inverse Voltage Rating: _____ V
Controllable On-State Current: _____ A
Total # of Inverter Switching Devices: _____
Total # of Inverter Switches Device Anti-parallel Diodes: _____
Total # of Inverter Neutral Point Diodes: _____
Switching Frequency: _____ Hz

Inverter Switching Device Failure Mode:
☐ Non-rupture ☐ Rupture
☐ Non-arc ☐ Arc

Inverter Switching Device Cooling:
☐ Double-sided ☐ Single-sided

Rectifier
Pulse Number:
☐ 6 ☐ 12 ☐ 18 ☐ 24 ☐ 30
☐ Active Front End (PWM Rectifier)

Power Semiconductor Switching Device:
☐ SCR ☐ SGCT ☐ Diode ☐ IGBT ☐ Other

Peak Inverse Voltage Rating: _____ V _____ A
Total # of Rectifier Switching Devices: _____
Total # of Rectifier Power Fuses: _____
Rectifier Power Fuse Ratings: _____ V _____ A

Pre-Charge Circuit?: ☐ Yes ☐ No ☐ Not Applicable

DC Link Circuit: ☐ Inductor ☐ Capacitors

DC Link Inductor:
☐ Integral to VFD ☐ External to VFD
☐ Non-Saturable ☐ Split Dual Winding Type
DC Link Inductor Life Expectancy? _____ years

DC Bus Capacitors:
☐ Electrolytic ☐ Oil-film Type
Total # of DC Bus Capacitors: _____
DC Bus Capacitor Life Expectancy? _____ Years

Motor Compatibility
Inverter-duty motor required? ☐ Yes ☐ No
Motor De-Rating required? ☐ Yes ☐ No
Motor Voltage Waveform dv/dt? _____ Volts/microsecond
Motor Voltage Waveform Peak Voltage? _____ Volts
Maximum Motor Cable Distance from VFD? _____ Meters

Input Section Isolation
☐ Circuit Breaker ☐ LB Switch
☐ Input Starter with Vacuum Contactor & Fused Isolator
☐ E-Stop Capability? ☐ Yes ☐ No

Source Impedance Device
☐ AC Line Reactor ☐ Isolation Transformer

Isolation Transformer
☐ Indoor Dry Type ☐ Outdoor Oil Type

Winding Material: ☐ Aluminum ☐ Copper
# of Secondary Windings: _____

Cooling: ☐ Convection ☐ Forced Air
VFD Air Used to Cool Transformer: ☐ Yes ☐ No
Efficiency @ Full Load _____ %
Impedance: _____ %
Overload Rating: _____ % for 1 Minute

Performance
Control: ☐ Sensorless Vector ☐ V/Hz
Speed Regulator Bandwidth: _____ Radians/second
Torque Regulator Bandwidth: _____ Radians/second
Speed Regulation: ☐ No tach _____ %
☐ With Tach _____ %
Overload Rating: _____ % for _____ min. every _____ minutes
Output Frequency Range: _____ Hz
VFD Efficiency @ Full Load: _____ %
Sound Level: _____ Db(A)
Regenerative Braking? ☐ Yes ☐ No

Reliability
Inverter Switching Device FIT Rate: _____ failures/billion hrs
Rectifier Switching Device FIT Rate: _____ failures/billion hrs
Availability: _____ %
Switching Device Replacement Time: _____ minutes
Ride-Thru _____ Cycles
Input Surge Protection Type: _____

Rear Access Required? ☐ Yes ☐ No
Multi-shot Trending? ☐ Yes ☐ No
Field Programmable Gate Arrays? ☐ Yes ☐ No
Set-up Wizard on Operator Interface? ☐ Yes ☐ No

Testing
☐ Standard
☐ Witness Test
☐ Drive/Motor Combined Test at Motor Vendor's Facility
☐ String Test at Driven Equipment Vendor's Facility

www.rockwellautomation.com

Corporate Headquarters
Rockwell Automation, 777 East Wisconsin Avenue, Suite 1400, Milwaukee, WI, 53202-5302 USA, Tel: (1) 414.212.5200, Fax: (1) 414.212.5201

Headquarters for Allen-Bradley Products, Rockwell Software Products and Global Manufacturing Solutions
Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation SA/NV, Vorstlaan/Boulevard du Souverain 36, 1170 Brussels, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, 27/F Citicorp Centre, 18 Whitfield Road, Causeway Bay, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

Headquarters for Dodge and Reliance Electric Products
Americas: Rockwell Automation, 6040 Ponders Court, Greenville, SC 29615-4617 USA, Tel: (1) 864.297.4800, Fax: (1) 864.281.2433
Europe/Middle East/Africa: Rockwell Automation, Brühlstraße 22, D-74834 Elztal-Dallau, Germany, Tel: (49) 6261 9410, Fax: (49) 6261 17741
Asia Pacific: Rockwell Automation, 55 Newton Road, #11-01/02 Revenue House, Singapore 307987, Tel: (65) 6356-9077, Fax: (65) 6356-9011

Medium Voltage Products, 135 Dundas Street, Cambridge, ON, N1R 5X1 Canada, Tel: (1) 519.740.4100, Fax: (1) 519.623.8930, www.ab.com/mvb

Publication 7000-SR001F-EN-P – August 2003
Supersedes Publication 7000-SR001E-EN-P – December 2002