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| Version | Date | Description of Revisions |
| 1 | August 30, 2006 | Approved final document. |
| 2 | November 2, 2006 | Modification to section 2.1 |
| 3 | February 19, 2010 | Modified ‘Related Sections’ and approved suppliers |
| 4 | July 3, 2013 | Incorporation of new Commissioning and Computerized Maintenance Management System Data Requirements Specification cross references. Incorporated several enhancements from Newfoundland Labrador Specifications. |
| 5 | July 30, 2014 | Changes to reflect renaming of commissioning specification and final review (AV) |
| 6 | March 2, 2015 | Finalized Specification – Reference eDOCS #5630503 v7 (AV) and amending of a company corporate name |
| 7 | December 3,2018 | iMCC standards update (MS) |

NOTE:

This is a CONTROLLED Document. Any documents appearing in paper form are not controlled and should be checked against the on-line file version prior to use.

**For each project the Consultant is responsible for the correct application of the specifications and for updating and modifying all highlighted items, as well as updating and modifying those sections that are directly applicable to the project. All updates and modifications to this standard document are to be highlighted to the Region for review and acceptance on each project.**

**Notice:** This Document hardcopy must be used for reference purpose only.

**The on-line copy is the current version of the document.**

# GENERAL

## Related Sections

### [Under "Related Sections", identify other Sections that are related to, and/or dependent on, the work results or information specified elsewhere. The list should be limited to Sections with specific information that the reader might expect to find in this Section, but is specified elsewhere. For example, if hardware for aluminum entrances is specified in the aluminum entrance Section, a cross-reference would be appropriate in the finish hardware Section. The purpose of this cross-referencing is for information only, to aid in finding those other requirements—not to define the scope of the Section.

### Cross-referencing here may also be used to coordinate assemblies or systems whose components may span multiple Sections and which must meet certain performance requirements as an assembly or system.

### This Section is to be completed/updated during the design development by the Consultant. If it is not applicable to the Section for the specific project it may be deleted.]

### [List Sections specifying installation of products supplied but not installed under this Section and indicate specific items.]

### Section [\_\_\_\_\_\_ – \_\_\_\_\_\_\_\_\_\_\_\_]: Execution requirements for ...[item]... specified under this Section.

### [List Sections specifying products installed but not supplied under this Section and indicate specific items.]

### Section [\_\_\_\_\_\_ – \_\_\_\_\_\_\_\_\_\_\_\_]: Product requirements for ...[item]... for installation under this Section.

### [List Sections specifying related requirements.]

### Sections:

#### Section 01425 – Computerized Maintenance Management System Data Requirements

#### Section 01430 – Operation and Maintenance Data

#### Section 01600 – Material and Equipment

#### Section 01740 – Cleaning

#### Section 01810 – Equipment Testing and Facility Commissioning

#### Section 01820 – Demonstration and Training

#### Division 01 – General Requirements (insert applicable specifications)

#### Division 11 – Equipment (insert applicable specifications)

#### Division 40 – Process Interconnections (insert applicable specifications)

#### Division 15 – Mechanical (insert applicable specifications)

#### Division 16 – Equipment (insert applicable specifications)

#### Design Guidelines Section 17 – Operation Manual Guideline

#### Product requirements for [item]... for installation under this Section.

## Submittals

### The Contractor shall provide the following O&M documentation: manufacturers’ printed O&M documentation; installation instructions; specifications; operation manuals, including electrical drawings, and plumbing diagrams; sales literature; materials; and training materials as applicable.

### Comply with the requirements of Division 1.

### Provide all necessary licenses, permits, approvals and certificates required in order to complete the work.

### Submittals include but are not necessarily limited to Shop Drawings, Product Data, Samples and other Documents for Review and Submittals for Information Only.

### Indicate:

#### Mounting method and dimensions

#### Dimensioned outline drawings and conduit routing locations

#### VFD size and type

#### Unit description including amperage ratings, enclosure ratings, fault ratings, nameplate information, etc.

#### Layout of identified internal and front panel components

#### Enclosure types

#### Wiring diagram for each type of drive

#### Interconnection power and control diagrams

#### Product Data Sheets on all major components including but not limited to the following:

##### Contactors

##### Circuit breaker and fuse

##### Control power transformers

##### Pilot devices

##### Relay/timers

#### Test procedures shall be per manufacturer’s standards

### The Contractor shall furnish copies of the manufacturer’s warranties.

### Include operation and maintenance data for each type and size of VFD including:

#### Service and Contact Information

#### VFD and Operator Interface User Manuals

#### Troubleshooting/Service Manuals

### Provide Final as shipped drawings

### Provide a complete list of recommended list of spare parts for each different size and type of VFD.

### Provide a complete list of parameters indicating;

#### Digital Input Assignment to align with schematics and control intent

#### Digital Output Assignment to align with schematics and control intent

##### Identify Digital Outputs that are to be controlled from the PAC

#### Analog Input Assignment to align with schematics and control intent

#### Analog Output Assignment to align with schematics and control intent

#### Ethernet/IP Parameter setup for reading Digital Inputs from the PAC

#### Ethernet/IP Parameter setup for writing Digital Inputs from the PAC

#### Ethernet/IP Parameter Assignment for Communication with the PAC

#### Ethernet/IP Parameter setup for reading power, fault, and/or additional information from the PAC to align with the SCADA software requirements.

### Indicate;

#### Drive Firmware revision

#### Drive EDS revision

## Measurement and Payment

*[Choose one of the following payment language provisions that best suits the individual project.*

*If this Section is not specifically referenced by an item in the Bid Form, please use the following language:*

.1 The work of this Section will not be measured separately for payment. All costs associated with the work of this Section shall be included in the Contract Price.

*OR If this Section is specifically referenced in the Bid Form, use the following language and identify the relevant item in the Bid Form:*

.1 All costs associated with the work of this Section shall be included in the price(s) for Item No(s). \_\_\_ in the Bid Form.

*If the work of this Section is to be measured and paid for by several different methods, please amend the standard wording given above to reflect the different methods of measurement and payment.*]

## Warranty

### Refer to Division 1, the Articles of Agreement and the General Conditions for warranty details. Where a conflict exists between these requirements and additional requirements within Division 40, the Contractor shall meet the more stringent requirement.

### The warranty for products supplied under this section shall be by a local Canadian distributor in the Province of Ontario.

## References

### NEMA Contactors and motor-starters.

### Institute of Electrical and Electronic Engineers (ISSS)

#### IEEE 519-1992: Guide for harmonic content and control

### Underwriters Laboratories (UL508C: Power Conversion Equipment)

#### UL

#### CUL

### National Electrical Manufacturer’s Association (NEMA)

#### ICS 7.0: Industrial Controls & Systems for AFD.

### IEC 61800-2 and -3. EN 50082-1 and -2

#### Fulfill an EMC immunity requirements

### Institute of Electrical and Electronics Engineers, Inc. –IEEE 519 -IEEE Standard Practices and Requirements for Harmonic Control in Electrical Power Systems.

### Canadian Standards Association International – CAN/CAS-C22.2 No. 14-05

# PRODUCTS

## General

### The following installation requirements are in addition to or deviations from the requirements set forth for in Section 16010 – Electrical General Requirements.

### Design Requirements

#### Continuous duty, solid state, modular, adjustable variable frequency drive (VFD) system suitable for operation on plant electrical power system, controlled locally or remotely as indicated.

#### Obtain motor data and coordinate characteristics of driven equipment with VFD system, regardless whether motor is supplied under this Contract or by The Region or is part of existing plant.

#### Design drive system against:

##### Premature breakdown of motor insulation.

##### Higher than rated motor temperature rise as dictated by motor manufacturer, under intended operating speed and load range.

## VFD range from 500HP to 3000HP

### VFD to meet all performance and functional requirements as outlined in this specification.

### Acceptable Manufacturers

#### Acceptable Manufacturers are listed in the following table in no order or preference. The design has been completed around the first named supplier. The Contractor is responsible for all costs associated with any changes required to the design to accommodate an alternate manufacturer.

|  |  |  |
| --- | --- | --- |
|  | Manufacturer | Model |
| 1 | Allen Bradley | PowerFlex 7000 |
| 2 | ABB | ACS2000 |
| 3 | Approved Equivalent |  |

#### The Contractor shall select the appropriate options to suit the application and the requirements of the Section.

#### Where an alternate manufacturer is provided, they shall meet the performance specifications of the first named manufacturer.

## VFD range from 500HP to 3000HP

First Named Manufacturer:

|  |  |
| --- | --- |
| Manufacturer | Allen Bradley |
| Model | PowerFlex 7000 |
| Voltage | 4160V, 3 phase **[consultant to confirm]** |
| HP/KW | 500-3000HP/373-2238kW **[consultant to confirm]** |
| Enclosure Type | Type 1(IP21)/Type 12 (IP42) **[consultant to choose]** |
| Line Side Cable Entry | Top/bottom **[consultant to confirm]** |
| Load Side Cable Exit | Top/bottom **[consultant to confirm]** |
| HIM Module | Local mounted 10” WinCE color touchscreen |
| I/O Option | Standard XIO board: 16 DI and 16 DO |
| Communication | Ethernet/IP |

Second Named Manufacturer:

|  |  |
| --- | --- |
| Manufacturer | ABB |
| Model | ACS 2000 |
| Voltage | 4160V, 3 phase **[consultant to confirm]** |
| HP/KW | 500-3000HP/373-2238kW **[consultant to confirm]** |
| Enclosure Type | Type 1(IP21)/Type 12 (IP42) **[consultant to choose]** |
| Line Side Cable Entry | Top/bottom **[consultant to confirm]** |
| Load Side Cable Exit | Top/bottom **[consultant to confirm]** |
| HIM Module | CDP 312 keypad - four line, 16 character |
| I/O Option | Standard: 14 DI and 6 DO |
| Communication | Ethernet/IP |

## Manufactured Units

### Performance Requirements

#### The VFD shall be designed to accept input voltage of 4160V at 60 Hz with ±10% input voltage tolerance and less than ±5% input frequency tolerance.

#### The VFD shall be capable of maintaining a minimum true power factor of 0.97.

#### The efficiency of the VFD system shall be a minimum of 96% at 100% speed and 100% load.

#### The overload capacity shall be:

##### Normal Duty/Variable Torque Load – 110% for 1 minute, every 10 minutes.

##### Heavy Duty/Constant Torque Load – 150% for 1 minute, every 10 minutes.

#### The VFD shall have an output frequency range of 0.2 to 75 Hz.

#### The VFD shall be designed to operate in the following environmental conditions without de-rating:

##### Ambient temperature range – 1°C to 40°C.

##### Relative humidity range – 0% to 95% non-condensing.

##### Elevation – up to 1000 m.

#### The maximum audible noise from the VFD shall be less than 85 dB(A) at a distance of one meter from the front of the equipment.

#### The VFD shall not contribute any significant harmonics to the system and shall comply with the latest edition of IEEE 519 Harmonic Guidelines.

#### All harmonic management devices must be internal to the VFD enclosure and supplied as a complete solution.

#### The VFD shall have an active line supply unit which controls the waveform of the input current and reduces the low order harmonic current drawn.

#### The VFD including Power Factor Correction and/or Harmonic Filter shall never have

#### a leading power factor and take into account any interaction with other system components.

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

#### The VFD shall be capable of automatically restarting in the event of a momentary loss of power. Restart delay shall be adjustable from 0-10 seconds.

#### Resetting after a fault: By reset input and by re-issuing the Run command. Resetting by removing drive input power not acceptable.

#### Internal components, including printed circuit boards: corrosion protected.

#### VFD shall be CSA or cUL approved.

### System Components

#### The variable frequency drive (VFD) system shall include the drive unit and integrated main components:

##### Enclosures

##### Cabling

##### Active Front End Rectifier

##### PWM Inverter

##### Cooling System

##### UPS system

##### Auxiliary Relays

##### Output Filtering

##### Monitoring Hardware

##### Human Interface

##### Input Contactor with Disconnect ***[Consultant to confirm]***

### Enclosures

#### VFD enclosure shall be air-cooled VFD enclosures.

#### The drive enclosure doors shall be interlocked to prevent opening when main power is available.

#### The VFD system shall be designed for front access to allow for installation with no rear access.

#### Ventilation openings: Size to dissipate heat at full VFD capacity, vermin proof screens, sprinkler proof louvers and drip shields where applicable.

#### Finish: Exterior, primed and two coats ASA #61 grey factory standard epoxy enamel or powder coat; interior, matte white and in accordance with Section 09901 Factory Applied Protective and Maintenance Coatings.

#### Ground bus: Tin plated copper.

### Cabling

#### The VFD system shall contain a power cable termination assembly designed for easy termination and access to line and load cables.

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

### Active Front End (AFE) Rectifier

#### The VFD system shall have an AFE rectifier to lower line-side harmonics and near-unity power factor.

#### High Voltage Insulated-Gate Bi-polar Transistors (IGBTs) or Symmetrical Gate Commutated Thyristors (SGCTs) shall be used in the rectifier.

### Cooling System

#### Air-cooled VFDs shall be provided with a thermostatically cooling fan mounted integral to the VFD enclosure.

##### Cooling fans to be sized to provide adequate cooling under the worst case operating conditions/parameters.

##### The system shall generate an alarm indication on the event of a fan failure.

#### A redundant cooling fan with automatic switchover, in event of main fan failure, shall be provided. ***[Consultant to confirm]***

### Output Filtering

#### Provide output filtering to mitigate reflected waves. Filtering to be integral to the VFD controller. ***[Consultant to confirm]***

### Monitoring

#### The VFD shall have the capability of allowing the controller to monitor feedback such as process variable feedback, output speed/frequency, current, % torque, power, kilowatt hours, operating hours, relay outputs, and diagnostic warning and fault information.

### Door Mounted Devices

#### As a minimum, provide the following panel controls and indication on the door panel:

##### 4160V rated disconnect switch

##### LOCAL/REMOTE control mode switch

##### Manual speed control which controls the speed in the local mode. Adjustable range shall be 0–100 per cent.

##### Running L.E.D.

##### Individual L.E.D. for each protection failure

##### Start/stop/emergency stop push buttons

##### Reset pushbutton

### Harmonic Distortion and Noise

#### Voltage Distortion Factor: Intended to meet IEEE 519, 5% maximum at the input terminals for low harmonics.

#### Line notching: Notching area as defined by IEEE 519.

#### Basis for Harmonic Computations: Using a Simplified Plant One-Line Diagram for current and voltage distortion computations, furnish harmonic filters, line reactors, isolation transformers or higher pulse converter arrangements required to meet current/voltage distortion limits.

#### The intent is to limit the VFD harmonic distortion reflected onto the utility system to a voltage and current level as defined by IEEE 519 for general systems applications, by utilizing the standard 3% nominal impedance integral AC three-phase line reactor integrally mounted in the VFD enclosure.

#### Any harmonic calculations shall be done based on the kVA capacity, X/R ratio and the impedance of the utility transformer feeding the installation, as noted on the drawings, and the total system load. The calculations shall be made with the point of common coupling being the point where the utility feeds multiple customers.

#### Total harmonic distortion shall be calculated under worst-case conditions in accordance with the procedure outlined in IEEE standard 519-1992. Copies of these calculations are to be made available upon request. The contractor shall provide any needed information to the VFD supplier three (3) weeks prior to requiring harmonic calculations.

#### The system containing the VFD shall intent to meet the 5% level of total harmonic distortion of line voltage and the line current limits as defined in IEEE 519-1992.

### Operational Features

#### Near sinusoidal voltage and current waveforms provided to the motor at all speeds and loads.

##### Output current Total Harmonic Distortion (THD) shall be less than 5%.

#### The variable frequency drive 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.

#### VFD-induced torque pulsations to the output shaft of the mechanical system no greater than 2%.

#### The VFD shall be capable of producing a variable voltage and variable frequency output to provide continuous operation over the speed range specified.

##### The VFD shall be capable of operating with the output short circuited at full current.

##### The VFD 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.

#### 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.

### Front Mounted Human Interface Module (HIM)

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

#### The operator shall be able to scroll through the keypad menu to choose between the following:

##### Monitor

##### Operate

##### Parameter Setup

##### Actual parameter values

##### Active faults

##### Fault history

##### LCD contrast adjustment

##### Information to indicate the standard software and optional features software loaded.

### Communications

#### Fully functional communication capabilities for interface with Ethernet/IP

### The VFD shall have the necessary I/O interface to meet the status and control functionality as shown on the contract drawings.

#### The variable frequency drive (VFD) shall have isolated analog and digital interfaces.

#### Analog interfaces shall be configurable for:

##### Speed reference input (4-20 mA input signal).

##### Speed output (4-20 mA output signal).

#### Digital interfaces shall be user programmable.

### Protection Features

#### The VFD shall include at minimum the following protection features:

##### Overtemperature

##### Overcurrent

##### Short circuit detection

##### Motor overload

##### Motor stall

##### Overspeed

##### Communication fault

##### Earth fault

##### Main circuit breaker supervision/tripping.

##### Auxiliary voltage fault

## Wiring

### Refer to Section 16120 Wiring Systems for conductor and other wiring requirements.

### All wiring shall be marked at both ends.

### Variable Frequency Drives

#### Internal control wiring: Copper conductor, stranded, 600 V rated.

#### Wire identification: To correspond to wire numbers on schematic and control diagrams. All wiring to be identified with heat shrinkable slip-on markers c/w type written thermal transfer tag numbers as manufactured by Brady or similar. Slip-on markers must be sized to suit wire size and type.

#### Terminal blocks: Modular, for external wiring connections, 600 V, 25 A rating, DIN rail mounted. Label each terminal with same designation as connecting wire.

#### Group terminal blocks according to voltage or signal level and function. Allow 150 mm space between rows of terminals blocks. Install two conductors per block maximum.

#### Barriers: Covering exposed terminals and terminal blocks against inadvertent contact with thermoset plastic covers designed specifically for the terminals they are covering.

#### Lay-in duct: For wire groupings of six conductors or more. Lead-free PVC, 50oC continuous use temperature rating, CSA/UL certified. For smaller runs, use plastic tie wrap and clips.

#### Warning labels: Lamacoid with 3 mm white letters on red background, on front of compartments where multiple power sources are present.

## Finishes

### Apply finishes to enclosure in accordance with Section 16010 Electrical General Requirements.

## Equipment Identification

### Provide equipment identification in accordance with Section 16010 Electrical General Requirements.

### Provide nameplates indicating system voltage, current, phases and interrupting capacity.

### VFD Warning nameplates: Lamacoid, 5 mm white lettering on red background, indicating

#### Presence of live circuit.

#### Disconnect power before opening.

#### All other warning nameplates as necessary to ensure safe operation.

### Mount on access doors and internal compartment doors or barriers.

# EXECUTION

## Installation

### The following installation requirements are in addition to or deviations from the requirements set forth in Section 16010 – Electrical General Requirements.

### Installation shall be in compliance with all manufacturer requirements, instructions and drawings.

### Ensure correct fuses and overload device elements are installed.

### The Contractor under the technical direction of the manufacturer’s service representative shall perform the following minimum work.

#### Inspection and final adjustments.

#### Operational and functional checks of VFD and spare parts.

### The contractor shall certify that he has read the drive manufacturer’s installation instructions and has installed the VFD in accordance with those instructions.

### Refer to Section 406193 and contract drawings for I/O allocation and configuration.

### Control schematics to be provided in accordance with the Region of York standards. Provide CAD and PDF versions in electronic format. Files in PDF format shall be combined into a single package.

### Control devices mounted on panel door shall such as push-buttons, selector switches, pilot lights shall be according to the Region of York standards. Refer to Division 16 specifications for more details.

## Factory Acceptance Test

### Notify the Engineer three (3) weeks in advance, in writing, of the time, date and place of the factory tests. The initial test is to be attended by the Consultant and/or client. All costs by Consultant and client representatives to be carried by the Contractor. Any subsequent witness tests required to obtain acceptance shall be at the expense of the Contractor, but under the direction of the Consultant. Include all costs applicable to witness testing.

### The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of CSA, cUL and/or NEMA standards.

#### 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.

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

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

#### 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

#### Cycle Testing

##### Drives shall be accelerated to the test motor’s nominal frequency, under load on a dynamometer.

##### Drives shall be decelerated to 10 Hz and 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.

#### Load Testing – Drives shall be tested under full load at the test motor’s nominal frequency on a dynamometer. Testing on load banks not acceptable.

### The manufacturer shall provide three (3) certified copies of factory test reports.

## Start-up

### Upon completion of onsite installation, Vendor shall conduct their own functional tests and assist in functional tests for integration into overall SCADA system with the Region’s SCADA System Integrator to comply with Section 406121.30 Process Control System Site Acceptance Testing.

### Contractor shall retain the services of a qualified manufacturer's employed Field Service Technician to assist the Contractor in installation and start-up of the equipment specified under this section. Field Service personnel shall be factory trained with periodic updates and have experience with the same model of VFD on the job site. Sales representatives will not be acceptable to perform this work. The manufacturer's service representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, installation as specified in manufacturer’s installation instructions, wiring, application dependent adjustments, and verification of proper VFD operation. The technicians are required to assist in the below during start-up to allow for PAC and/or SCADA System Integration;

#### Configure communications module.

#### Confirmation that all discrete and analog signals (both new and existing) to be transmitted to and from the units are available and functioning correctly.

#### Verification that the units are capable of working as specified.

#### The Contractor is to conduct their own I/O check and equipment verification. Contractor completed and signed off I/O Checksheets and equipment verification sheets are to be completed and submitted to the Consultant for review.

#### Assist the Region’s SCADA System Integrator to complete I/O checks to verify field wiring from field device to VFD I/O to the PAC.

#### Verification that all interlocks are functioning as intended and in the correct mode of operation.

#### The equipment testing is to be conducted / witnessed by the facility Start Up Team consisting of the Consultant, the Contractor’s System Integrator, Region PCS Group and Region Operations Group and instrument suppliers as required.

#### Electronic copies of all parameter settings for each drive to be provided.

## VFD Verification

### Conduct VFD manufacturer's recommended tests and start-up procedures.

### IP assignments shall be provided by the Consultant (as obtained from the Region) and must be coordinated in accordance with the requirements of Division 40

### Field check VFDs supplied prior to commissioning equipment. As a minimum, the start-up service shall include:

#### Provide static testing on VFDs to confirm proper IGBT/SGCT operation.

#### Check of control circuits

#### Ensure all connections are tight.

#### Perform pre-Power Check

#### Megger Motor Resistances: Phase-to-Phase and Phase-to-Ground

#### Verify system grounding per manufacturer’s specifications

#### Verify power and signal grounds

#### Verify and adjust mechanical interlocks.

#### Set up all internal power supplies and IGBT/SGCT control circuits

#### Verify NEMA rating and construction of panel is suitable for the environment (check temperature, humidity, dust, etc. of installation location)

### Drive Power-up and commissioning checks:

#### Measure Incoming Power Phase-to-Phase and Phase-to-Ground

#### Measure DC Bus Voltage

#### Measure AC Current Unloaded and Loaded

#### Measure Output Voltage Phase-to-Phase and Phase-to-Ground

#### Verify input reference signal

#### IR Scan under load:

#### .1 Perform thermograms at all connections, plus heat sinks, body, etc.

#### .2 Record ambient temperature and temperature rise above ambient.

#### .3 Compare information with every other subsequent inspection.

#### .4 Compare with the specifications for maximum temperature above ambient and maximum operating temperature. Refer to latest ANSI/NETA standards.

#### .5 Provide documentation that the individual that performed the IR scan is a certified Level 2 thermographer.

### All measurements shall be recorded.

### Drive shall be tuned for system operation.

### Drive parameter listing shall be provided in printed and electronic copy in PDF format. Drive configuration shall include functionality to upload the parameter file to the Drive and HIM. After commissioning, upload parameter listing into Drive and HIM. An electronic copy of the drive file must be provided to the Consultant following commissioning including all protective relay settings and values.

### Measure and record motor amps, under load conditions and compare with full load amps and motor service factor. Report any excessive readings and unbalance. Measure voltage as close to motor terminals as possible while motor is running

### Set all motor circuit protectors to the minimum level which will consistently allow the motor to start under normal starting conditions.

## Spare Materials

### The following spare parts shall be furnished for each size drive:

#### Three of each type power and control fuse.

#### Two power module IGBTs/SGCTs or 20%, whichever is greater.

#### Two spare LEDs of each type used.

#### Two spare control relays of each type used.

#### Two sets of all replacement air filters.

#### One set of all control printed circuit boards.

## Field Quality Control

### The Contractor shall ensure that the VFD Supplier will provide the services of a factory representative on Site for the purpose of start-up, tuning, calibration and commissioning. Refer to Section 01810 – Equipment Testing and Facility Commissioning.

### Operate switches, contactors to verify correct functioning.

### Perform starting and stopping sequences of contactors and relays.

### Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

## Training

### Provision shall be made for a period of demonstration and training as specified in Section 01820 – Demonstration and Training.

### Train The Region’s staff in aspects of VFD operation, maintenance and start-up procedures.

#### Training to include two (2) sessions of four (4) hours duration and to be completed by VFD manufacturer's representative.

#### Training program to include operation, troubleshooting and maintenance.

end of section