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| Version | Date | Description of Revisions |
| 1 | August 30, 2006 | Approved final document. |
| 2 | February 19, 2010 | Modified ‘Related Sections’ and approved suppliers |
| 3 | March 22, 2011 | Minor edits |
| 4 | July 8, 2013 | Final Draft – Consolidated Comments Spec Update Project. Incorporation of new Commissioning and Computerized Maintenance Management System Data Requirements Specification cross references. |
| 5 | July 29, 2014 | Changes to reflect renaming of commissioning specification and final review (AV) |
| 6 | February 9, 2015 | Updated, Finalized Specification – Reference eDOCS #5630496 v6 (AV) |
| 7 | April 10, 2017 | Corrected cited product name for Eaton (subsection 2.8.2) AV |
| 8 | December 7, 2017 | Updated reference to Design Guideline 35 (AAM) |
| 9 | December 3, 2018 | iMCC standards update (MS) |
| 10 | November 25, 2021 | 2.2, 2.3 Replaced obsolete product info (BM) |

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)

#### 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 16, 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

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

#### UL

#### CUL

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

#### ICS 7.0: Industrial Control and Systems: Adjustable-Speed Drives

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

#### Fulfill an EMC immunity requirements

### Institute of Electrical and Electronics Engineers, Inc. (IEEE)

#### IEEE 519-2014: IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems

### Canadian Standards Association International

#### CAN/CAS-C22.2 No. 14-18: Industrial control equipment

# PRODUCTS

## General

### The following installation requirements are in addition to or deviations from the requirements set forth 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 2HP to 200HP

### Provide six-pulse drive units complete with integrated passive filtering and integrated DC chokes or line reactors. External line reactors shall be included on VFDs up to 50HP. VFDs 50HP up to 200HP to include external harmonic filters. Load reactors shall be used when distance to motor is between 7.5m to 60m and under 150HP. DV/DT filters shall be used when distance to motor exceeds 60m and on VFDs 150HP and above.

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

### VFD shall be installed as part of the MCC line up as shown on contract drawings unless otherwise noted.

### 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 | ABB | ACQ580 Series |
| 2 | Allen Bradley | Powerflex 753 Series |
| 3 | Eaton | DG1 Series |

#### 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 2HP to 200HP

First Named Manufacturer:

|  |  |
| --- | --- |
| Manufacturer | ABB |
| Model | ACQ580 Series |
| Voltage | 600V, 3 phase [consultant to confirm] |
| HP/KW | 2-200HP/1.5-150kW [consultant to confirm] |
| Enclosure Type | NEMA 12/4/4X/MCC [consultant to choose] |
| Input Filter | Integrated DC Choke and External Line Reactor [Line Reactor for 75HP and above] |
| Output Filter | [to be determined by consultant based on distance to motor] |
| HIM Module | Assistant Control Panel c/w panel mount kit (DPMP-EXT) |
| I/O Option | Standard + Relay output extension (CMOD-01) |
| Communication | Ethernet/IP (FEIP-21) |

Second Named Manufacturer:

|  |  |
| --- | --- |
| Manufacturer | Allen-Bradley |
| Model | Powerflex 753 Series |
| Voltage | 600V, 3 phase[consultant to confirm] |
| HP/KW | 2-200HP/1.5-150kW [consultant to confirm] |
| Enclosure Type | NEMA 12/4/4X/MCC [consultant to choose] |
| Input Filter | Integrated DC Choke and External Line Reactor |
| Output Filter | [to be determined by consultant based on distance to motor] |
| HIM module | Enhanced (20-HIM-C6S) c/w cable and panel mount kit |
| I/O Option | Standard + Extended I/O kit (20-750-2262D-2R) |
| Communication | Ethernet/IP |

Third Named Manufacturer:

|  |  |
| --- | --- |
| Manufacturer | Eaton |
| Model | DG1 Series |
| Voltage | 600V, 3 phase [consultant to confirm] |
| HP/KW | 2-200HP/1.5-150kW [consultant to confirm] |
| Enclosure Type | NEMA 12/4/4X/MCC [consultant to choose] |
| Input Filter | Integrated DC Choke and External Line Reactor |
| Output Filter | [to be determined by consultant based on distance to motor] |
| HIM Module |  |
| I/O Option | Standard + 3xRelay Dry Contact card (DXG-EXT-3R0) |
| Communication | Ethernet/IP |

## VFD range from 200HP to 700HP

### Provide low harmonic VFD units with integrated active front-end filtering. Higher pulse model VFD’s will not be considered an alternate solution to drives with integrated active front-end filtering.

### DV/DT filters shall be included as part of the VFD design.

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

### VFD shall be provided as a standalone unit and not as part of an MCC line-up. Enclosure to be suitable for top/bottom ***[Consultant to select appropriate option]*** cable/conduit entry/exit. Only one source of power shall be required to unit. Transformation shall be provided in unit to power all ancillary equipment.

### Acceptable Manufacturers

#### Acceptable manufacturers are listed in the following table in no order of 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 755TL Series |
| 2 | ABB | ACS880-37 Series |
| 3 | Or Equivalent |  |

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

## VFD range from 200HP to 700HP – Low Harmonic VFD’s

First Named Manufacturer:

|  |  |
| --- | --- |
| Manufacturer | Allen-Bradley |
| Model | Powerflex 755TL Series |
| Voltage | 600V, 3 phase [consultant to confirm] |
| HP/KW | 200-700HP/150-522kW [consultant to confirm] |
| Enclosure Type | NEMA 12/4/4X[consultant to choose] |
| Output Filter | DV/DT Filter |
| HIM Module | Enhanced (20-HIM-C6S) c/w cable and panel mount kit |
| I/O Option | Standard + Extended I/O kit (20-750-2262D-2R) (qty. as required) |
| Communication | Ethernet/IP |

Second Named Manufacturer:

|  |  |
| --- | --- |
| Manufacturer | ABB |
| Model | ACS 880-37 Series |
| Voltage | 600V, 3 phase [consultant to confirm] |
| HP/KW | 200-700HP/150-522kW [consultant to confirm] |
| Enclosure Type | NEMA 12/4/4X [consultant to choose] |
| Output Filter | DV/DT Filter |
| HIM module | Assistant Control Panel (ACS-AP-W) c/w panel mount kit |
| I/O Option | As per ACS 880-37 Series (A41 inverter control unit)(TBC) |
| Communication | Ethernet/IP (FENA-21) |

## Manufactured Units

### Enclosure: Compartmentalized, steel, EEMAC 4 Design ***[Consultant to confirm]***, completely front accessible to internal components and wiring connections.

### Access doors: Hinged with automotive type door handles and three point latches, key operated with two sets of keys. Interlock door opening mechanism with main disconnecting device operating handle.

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

### Cooling fans: Minimum additional 25% extra capacity. Cooling fans shall be thermostatically controlled and field adjustable.

### Location of expendable parts, (fuses and similar items): Close to front for ease of replacement.

### Conduit/cable entry points: Top and bottom. ***[Consultant to confirm]***

### Cable support: cable support clips.

### Ground bus: Tin plated copper.

### 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.

### Furnish output line filters/reactors. Output line filters to protect motor from damaging switching spikes.

### Radio Frequency Suppression to ensure VFDs do not affect the operation of equipment susceptible to Radio Frequency noise

### Suppress generation of radio frequencies through the use of RFI filters or similar methods.

### Primary Disconnect Device

### Main power disconnecting device: Moulded circuit breaker type automatic, rated for full load current of drive, and capable of closing onto an available system fault current of 28 kA symmetrical. [Consultant to confirm]

### Shunt trip on breaker: as indicated or as required for safety shutdown.

### Breaker handle: Operable from outside without opening cubicle doors, mechanically interlocked to prevent door from being opened with circuit breaker in ON position.

### Fuses and similar protection devices: As recommended by VFD manufacturer.

### Control Transformer: Dry type, fused primary and secondary windings, sized for 125% of maximum system control circuit requirements, including external circuits.

### Secondary voltage: 120V, 60 Hz.

## Performance Requirements

### Environmental conditions: Ambient operating temperature range 0°C to 40°C, humidity range 5% to 90% RH non-condensing, altitude 1000 m maximum above sea level.

### VFD system: Pulse width modulating (PWM) technology, 600 V (±10%), 3 phase, 60Hz (±5Hz) input, adjustable frequency and voltage output, suitable for controlling speed of standard AC squirrel cage induction motor.

### Voltage/Frequency ratio (V/Hz): Vary output voltage proportionally with output frequency to maintain a constant V/Hz value over output range of 0.5 to 60Hz. Output voltage to remain constant above 60 Hz.

### Controller: Include power conversion components, power control logic devices and regulator circuitry. Incorporate into regular, microprocessor technology for control of power semi-conductors.

### Motor Speed Control: Stable throughout speed range.

### Rating: 100% continuous motor current under ambient conditions indicated and 150% rated motor current for one minute and a three (3) second overload current rating of 180% when applied to constant or high starting torque loads. 110% current rating for one (1) minute for variable torque drives.

### Displacement power factor: 0.95 minimum lagging over entire speed and load range.

### Control circuitry ride-through capability: 16 milliseconds minimum on complete power loss.

### Drive efficiency: 95% minimum on drives rated 20 kW or less and 96.5% minimum on drives rated greater than 20 kW.

### Motor: Furnish VFD to match motor and driven equipment characteristics. Confirm motor details from motor supplier or onsite if being used with an existing motor.

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

### Design drive to withstand without damage, the following conditions:

#### Phase-to-phase output short circuit

#### Phase-to-ground output short circuit without utilizing an isolation transformer

#### Application of stationary, reverse or forward rotating motor while the drive is starting or while inadvertently running open circuit

#### Momentary loss of line voltage, whether partial or complete

#### Damage to DC bus soft charging circuitry by internal short circuit

### Motor feeder: Corrugated, continuous aluminum sheathed PVC jacketed cable with 3 bonding conductors, 1000V insulation rating and 90oC maximum operating temperature.

### Resetting after a fault: By reset input as well as remotely via communication bus, and by re-issuing the Run command. Resetting by removing drive input power not acceptable.

### Restart after a power outage or low voltage condition: Automatic with ten second delay when powers returns to normal, if run command is maintained

### Current limit: Control logic, accurate over entire speed range, to automatically reduce output frequency when load current exceeds adjusted current limit level.

#### Motor regeneration: Override circuit to limit regenerated energy.

#### Coordination characteristics and integration of variable frequency drive units with manufacturer of motors and driven equipment supplied under this contract, other contract, other contracts or existing

## 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.

### 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 DC choke or line reactor integrally mounted in the VFD enclosure. If VFD cannot comply with IEEE 519 the VFD manufacturer shall provide additional external filtering with drive to ensure limits are met. ***[Not applicable for ABB 880-37 and Allen Bradley PowerFlex 755TL]***

### 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 intend to meet the 5% level of total harmonic distortion of line voltage and the line current limits as defined in IEEE 519-1992.

### Furnish isolating transformers or series reactors, harmonic filters, or other devices and circuits to prevent one drive from adversely affecting operation of other drives supplied from the same bus as well as other plant electronic equipment. ***[Not applicable for ABB 880-37 and Allen Bradley PowerFlex 755TL]***

### Ensure that means are provided to prevent EMI and RFI, and IGBT switching noise that are generated do not reflect back into the power distribution system.

## 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.

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

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

## Wiring

### Unless otherwise specified, minimum sized power wiring shall be #12 AWG copper VFD Rated cable. Refer to Section 16120 Wiring Systems for conductor and other wiring requirements. For units larger than EEMAC Size 1, size conductors in accordance with the Canadian Electrical Code requirements.

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

### Variable Frequency Drives

#### Internal 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 one conductor 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 Consultant three (3) weeks in advance, in writing, of the time, date and place of the factory tests. The initial test may be attended by the Consultant and/or client representatives for drives 200HP and above. 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 UL and NEMA standards.

#### VFD shall be put through a motor load test before inspection and shipping.

#### Provide a full functionality test of all controls and features before inspection and testing.

### 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 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

#### Check connections

#### 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.

## 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