

Part 1 General

1.1 REQUIREMENTS

- .1 This Section covers items common to Sections for Electrical work this section supplements requirements of Division 0 and 1.
- .2 This Section covers items common to Sections of Electrical Contractor. This section supplements requirements of Division 1.

1.2 SECTION INCLUDES

- .1 Provide complete and fully operational electrical systems with facilities and services to meet requirements described herein, as shown on the drawings, and in complete accord with applicable codes and ordinances.
- .2 Only those items that are specifically indicated as not in contract (N.I.C.) will be omitted.
- .3 Contract documents of this Division are diagrammatic and approximately to scale, unless detailed otherwise. They establish scope, material and installation quality, and are not detailed installation instructions.
- .4 Follow manufacturers' recommended installation details and procedures for equipment supplemented by details given herein and on plans subject to approval of the Departmental representative.
- .5 Examine all drawings to ensure that work under this Division can be properly installed without interference.
- .6 Where discrepancies, ambiguities, obvious omissions or errors have been made in drawings and specifications, it shall be the responsibility of the contractor to clarify same prior to tender closing. No allowance will be made after contract award for any expense incurred by him for having to adjust his work to properly conform.

1.3 CODES AND STANDARDS

- .1 Do complete installation in accordance with the 2012 Canadian Electrical Code and Saskatchewan supplements, Saskatchewan Human Rights Accessibility Standard, local by-laws and utility requirements. Work involving fire protection shall be in accordance with the Underwriter's Laboratory of Canada, National Building Code, and National Fire Protection Code.
- .2 The electrical installation shall comply with all SaskPower and Sasktel requirements and regulations.
- .3 In the event of any inspection authority requesting deviation from the design, notify the Departmental representative and obtain approval before proceeding with any change.

- .4 In no instance, shall the standard established by the drawings and specification be reduced by any code or ordinance.
- .5 All references to codes and standards shall be to the latest edition and any errata or addenda.

1.4 CARE, OPERATION AND START-UP

- .1 Instruct operating personnel in the operation, care and maintenance of systems, system equipment and components.
- .2 Connect to equipment furnished in other Divisions and by Departmental Representative including start-up and test.
- .3 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.
- .4 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with all aspects of its care and operation.
- .5 Provide labour and materials required to install, test and place into operation a complete electrical system. When necessary, in the opinion of the Departmental Representative, provide additional materials and labour to modify or correct job conflicts and unsatisfactory work.

1.5 VOLTAGE RATINGS

- .1 Operating voltages: to CAN3-C235-83.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

1.6 PERMITS, FEES AND INSPECTION

- .1 Submit to Electrical Inspection Department and Supply Authority necessary number of drawings and specifications for examination and approval prior to commencement of work.
- .2 Pay associated fees.
- .3 Notify Departmental Representative of changes required by Electrical Inspection Department prior to making changes.
- .4 Furnish Certificates of Acceptance from Electrical Inspection Department and authorities having jurisdiction on completion of work to Departmental Representative

1.7 MATERIALS AND EQUIPMENT

- .1 Provide materials and equipment in accordance with Section 01 61 00 - Common Product Requirements.
- .2 All goods and materials shall be new and carry CSA approval seal. Equipment and material to be CSA certified. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from the Departmental Representative and the Electrical Inspection Department.
- .3 No deviation from specified materials shall be allowed, except where alternative materials have been specifically accepted in writing.
- .4 Where materials are not directly specified by catalogue number and manufacturer's name, a high industry specification grade product shall be provided. The Departmental Representative shall be the sole judge of whether this standard is being met.
- .5 Each major component of equipment shall have manufacturer's name, address, catalogue and serial number in a conspicuous place.
- .6 Upon request, provide a complete list of all materials and their manufacture. The contractor will be required to use the materials indicated. Changes in manufactures at a future date will not be acceptable.
- .7 Factory assembled panels and component assemblies.
- .8 All floor mounted equipment shall be mounted on 100 mm concrete housekeeping pads unless otherwise specified.

1.8 FIELD QUALITY CONTROL

- .1 All work under this Division shall be executed in a workmanlike and substantial manner, neat in its mechanical appearance and arrangement.
- .2 All electrical work shall be conducted under the on site direction of a journeyman electrician.
- .3 A competent representative shall constantly supervise the work of this Division from beginning to completion and final acceptance. So far as possible, the same supervisor and workmen shall be employed throughout the project's duration.
- .4 Material and workmanship not meeting the standard intended and required by this specification shall, upon instruction from the Departmental Representative, be properly replaced without further charge or consideration.
- .5 Inspection and testing:
 - .1 During construction and up to final acceptance, make accessible any equipment or wiring for inspection purposes.

- .2 All electrically operating equipment shall be left as a complete installation in perfect operating condition, and receive final test in the presence of the Departmental Representative.
- .3 On the request of the Departmental Representative, a staff supervisor shall be made available to assist in this inspection work.
- .4 At the completion of the installation, voltage tests shall be conducted in the presence of the Departmental Representative.
- .5 Acceptance tests and commissioning shall be conducted for systems and/or equipment where indicated in the specifications. Acceptance tests shall include, but not be limited to, the following Sections:
 - .1 260521 - Wires and Cables (0-1000 V)
 - .2 260528 - Grounding – Secondary
 - .3 262814 - Fuses Low Voltage
 - .4 262823 - Disconnect Switches
 - .5 262910 – HVAC motor starters to 600V
- .6 Acceptance tests shall meet requirements as required by manufacturer, as outlined in ANSI – NETA and additional requirements described on drawings and specified herein. All tests shall be documented as per ANSI – NETA standards and shall include testing results, testing date, testing technician and representative present.
- .7 Certification of all acceptance tests and commissioning shall be submitted to the Departmental Representative for approval. Tests not conducted to the satisfaction of the Departmental Representative shall be repeated, and no further costs will be considered. Written documentation bearing name and signature of Contractor, Departmental Representative and Departmental Representative's personnel present during acceptance tests shall be included in certification reports.
- .8 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.
- .9 Provide instruments, meters, equipment and personnel required to conduct test during and at conclusion of project.

1.9 ELECTRICAL DRAWINGS

- .1 They indicate the general location and route of conduit and cable to be installed. Conduit shall be installed in coordination with other services to conserve head room and space through which they pass.
- .2 Install equipment generally in locations and routes shown, close to building structure with minimum interference with other services or free space. Remove and replace improperly installed equipment to the satisfaction of the Departmental Representative at no extra cost.
- .3 Ceiling and floor outlet symbols are scaled to centre line of symbol; symbol does not indicate the size or shape. Mounting height shall be measured to the lowest point on ceiling mounted equipments, and above finished surface for wall mounted equipment.

- .4 Wall outlets are scaled to the perpendicular centre line of the symbol. Mounting heights for all wall mounted outlets shall be measured to the horizontal centre line.
- .5 Where outlets are mounted in masonry walls, outlets should be mounted to the nearest coursing line.

1.10 WORK PROVIDED FOR OTHER DIVISIONS

- .1 Provide electrical connections, circuit protection and disconnect devices for all equipment supplied by other Divisions, including the Departmental Representatives. Provide motor starters, disconnect switches, thermal switches, etc., for motors supplied by Mechanical Contractor.

1.11 COORDINATION WITH OTHER DIVISIONS

- .1 Cooperate fully with the Departmental Representative and other trades of electrically operated equipment to ensure proper arrangement of and provision for all electrical equipment.
- .2 Where outlets or equipment may affect architectural or site treatment desired, contact Departmental Representative and for instructions or detailed drawings.
- .3 Supply and install all motor connections, including starters and overload protection and disconnecting devices at motors where required. All motor driven equipment shall be provided with a lockable disconnecting device.
- .4 Supply and install complete wiring requirements for full voltage in-line devices on single phase equipment such as thermostats, multi-speed switches for unit heaters, force flows, cabinet heaters, etc. Single phase type motor thermal switches that are located in entrance vestibules shall be flush mounted, key operated type to prevent tampering by unauthorized personnel.
- .5 Check other Divisions to ensure that suitable provisions have been provided for all motors. It is possible that some motors may vary in size, numbers and characteristics, depending on the equipment manufacturer's specific requirements. Any variations in this regard will not constitute cause for further consideration. The mechanical coordination schedule supplied on the drawings shall be updated with nameplate specifications as part of the as-built drawing submission.
- .6 Assume full responsibility for layout of this work, and for any damage caused the Departmental Representative or other Divisions by improper location or carrying out of this work.
- .7 Before commencing work, examine the work of other Divisions, and report at once any defects or interference affecting the work under this Division, or the guarantee of same.
- .8 Allow for all hoisting and setting of material and equipment.

1.12 DEPARTMENTAL SUPPLIED EQUIPMENT

- .1 Connect all electrically operated equipment supplied by the Departmental Representative, as designated on the drawings.

1.13 SHOP DRAWINGS

- .1 Submit shop drawings, where specifically called for, or as requested. Shop drawings shall show detailed dimensional and technical information, and shall properly describe each piece of equipment. Where applicable, shop drawings shall include complete schematics and wiring diagrams. These shop drawings shall be sufficiently detailed to permit the Departmental Representative's technicians to trouble-shoot and repair the equipment. Equipment shall not be ordered and/or fabricated until shop drawings have been reviewed by the Departmental Representative. Shop Drawings shall include, but not be limited to the following Sections on systems and equipment:
 - .1 262823 - Disconnect Switches
 - .2 262910 - HVAC motor starters to 600V
- .2 Review of shop drawings shall be for general design, arrangement and appearance only. This Division shall check and correct, if necessary, all manufacturer's drawings before submitting, and shall so indicate on each copy, along with a dated approval stamp. All shop drawings must bear an approval stamp and be signed by the Contractor. This review does not relieve this Division from the responsibility for the final installation being correct in all detail, and fully acceptable to the Departmental Representative.
- .3 Refer to General Conditions of the Contract.
- .4 Provide one (1) printed copies and one PDF copy for each Section. Each shop drawing shall be complete with a cover page with the following information:
 - .1 Specification Section and name
 - .2 Project name, Departmental Representative's name and address
 - .3 Number of pages in submittal
 - .4 Contractor and Supplier's name and contact information
 - .5 Approval stamps with room for Departmental Representative's stamp
- .5 Shop drawings for complementary systems and/or equipment shall be submitted at the same time. Partial submittals of related equipment will be rejected or held until all other related shop drawing information has been submitted (i.e. submit all shop drawings for power equipment at the same time). Submittals of shop drawings that are incomplete will be rejected.
- .6 Commissioning forms shall be provided with all shop drawings and the original copy shall be maintained up to date on site. Departmental Representative shall provide commissioning forms prior to shop drawing submittals.

1.14 CHANGES

- .1 Where changes to design occur, materials shall be priced at published standard trade net cost. Labour shall be established by N.E.C.A. units. The maximum labour rate shall not exceed the prevailing union rate, and an average of eight men. The eight men shall consist

of one foreman, three journeymen, two 4th year apprentices, one 3rd year apprentice and one 2nd year apprentice. Non-productive labour, estimating, material handling, supervision, telephone, storage, tools, etc., shall not exceed 30% of the above average labour rate. Payroll burden shall not exceed 40% of the above total, and mark-ups for overhead and profit shall be in accordance with the general and supplementary conditions.

- .2 Changes to design involving an extra net difference shall be calculated on the same basis as indicated above, but the mark-up shall only apply to the net difference.
- .3 Deletions only shall be credited with a minimum mark-up of 5%.
- .4 Submit complete itemized breakdowns of all extras, deletions, and changes to the Departmental Representative. Breakdown to include quantities, unit costs and extensions. If requested, support claim by certified copies of supplier's invoices.
- .5 The right is reserved to move equipment 3000 mm from location shown without further charge or consideration, provided that such re-location is requested prior to finish being applied.

1.15 OPERATING INSTRUCTIONS AND SERVICE MANUALS

- .1 Upon completion of the installation, provide three (3) complete and comprehensive identical sets of operating and maintenance manuals. Refer top Section 01 78 00 – Closeout Submittals
- .2 The Departmental Representative shall review the operating and maintenance manuals and approve same prior to the manuals being sent to the Departmental Representative.
- .3 The operating and maintenance manuals shall include but not be limited to the following information:
 - .1 Certification reports.
 - .2 Documentation indicating Departmental Representative's receipt of operating instructions.
 - .3 Complete list of all materials turned over to the Departmental Representative c/w receipts for same.
 - .4 Shop drawings properly indexed and contained in suitably sized envelopes.
 - .5 Commissioning forms.
 - .6 Schematic drawings for all systems indexed and contained in suitably sized envelopes.
 - .7 Catalogue brochures for Disconnects, VFD, etc.
 - .8 Overcurrent coordination and arc fault study and documentation of associated tests.
 - .9 Phase rotation confirmation by the contractor.
 - .10 Certificate of Departmental Representative's electrical equipment training.
 - .11 Acceptance Testing and Commissioning reports.
 - .12 Complete electrical load data from operating tests: Voltages on all phases, line to line and line to neutral and ampacity on each phase, with the building in normal operating condition. Measurements to be taken on the main incoming feeder.
 - .13 Recommended maintenance procedures for various systems.

The above information shall be bound in black, hard-backed, three-ring, letterhead size binders. Incomplete or poorly reproduced manuals will be rejected.

- .4 Maintain, on a daily basis, a complete set of marked-up prints as as-built drawings that show in complete detail the final arrangement and location of all electrical components and the interconnecting wiring. All riser conduits, panel feeds, conduit shall be marked on plans. These are to be maintained in a neat and substantial manner, so as to properly and fully illustrate the way in which the installation has been completed.
- .5 Present finalized as-built mark up drawings to Engineer\ Departmental Representative at time of Substantial Performance inspection. Incomplete or inaccurate as-builts will not be accepted and will be returned for completion.
- .6 The Departmental Representative's personnel shall be instructed in the operation and maintenance of miscellaneous equipment for a total of one (1) hours.
- .7 The above instructions shall be given by personnel experienced in the operation of the particular system or equipment. Each item or type of equipment, and all controls, shall be operated in the presence of the Departmental Representative's personnel to ensure their understanding of equipment function and individual working parts. The Own Departmental Representative reserves the right to set the period or periods during which the instruction shall be given. The contractor shall submit a program of instruction for approval by the Departmental Representative.
- .8 Operating and maintenance manuals shall include written documentation bearing name and signature of Departmental Representative's personnel who received the above instructions.
- .9 Operating and maintenance manuals, as well as all Departmental Representative instructions, shall be complete before substantial completion (as outlined by the Builders' Lien Act) will be considered. Also, preliminary maintenance manuals must be submitted prior to 70% completion. No further progress payments will be permitted until these preliminary maintenance manuals have been submitted and approved.

1.16 STORAGE AND PROTECTION

- .1 Maintain and protect all work provided under this Division. Store all materials within a protected enclosure to prevent exposure to weather or construction dirt.
- .2 Protect all finished and unfinished work of this and other divisions from damage during the course of construction. Cover floors and other surfaces, if necessary. Any damaged work or finishes shall be repaired or replaced without further charge to the Departmental Representative.

1.17 WARRANTY

- .1 All materials and workmanship shall be guaranteed for a period of one year from date of substantial completion.

- .2 Properly repair and replace all defective work and other work which becomes defective during the term of warranty.
- .3 Service on equipment or systems critical to the Departmental Representative's operation shall be provided on an emergency basis which may necessitate overtime and service outside of normal working hours. The contractor shall ensure that all suppliers comply with this requirement.

1.18 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 All control wiring is provided by the Mechanical Contractor. Electrical Contractor shall provide 21mm Conduit from VFD to mechanical controls location.

1.19 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
- .2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint. Where necessary the entire surface shall be redone.
- .3 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

1.20 ABBREVIATIONS

- .1 Abbreviations used in this specification are common to and in general use within the related trades.

1.21 IDENTIFICATION

- .1 Nameplates shall be provided on each new piece of electrical equipment. Nameplates for each new electrical panel shall indicate panel designation, mains voltage and panel and circuit number from which this panel is fed.
- .2 Nameplates for new disconnects and contactors shall indicate equipment being controlled, and voltage.
- .3 Nameplates for new terminal cabinets shall indicate system and voltage and load of area served.
- .4 Nameplates for Normal Power Equipment shall be made from black-white-black Lamecoid with bevelled edges and white engraved letters. Nameplates shall be fastened with self tapping metal screws to equipment in a conspicuous location.
- .5 Allow for average of twenty-five (25) letters per nameplate and label.

NAMEPLATE SIZES

| | | | |
|--------|-------------|---------|--------------------|
| Size 1 | 10 x 50 mm | 1 line | 3 mm high letters |
| Size 2 | 12 x 70 mm | 1 line | 5 mm high letters |
| Size 3 | 12 x 70 mm | 2 lines | 3 mm high letters |
| Size 4 | 20 x 90 mm | 1 line | 8 mm high letters |
| Size 5 | 20 x 90 mm | 2 lines | 5 mm high letters |
| Size 6 | 25 x 100 mm | 1 line | 12 mm high letters |
| Size 7 | 25 x 100 mm | 2 lines | 6 mm high letters |

- .6 Typical identification standards shall be used for new equipment throughout the project as follows:

- .1 Lighting, receptacle and power panels shall each be identified with an engraved Lamecoid plate secured to top interior trim as:

| | |
|--------------------|--------|
| Panel 202 | Size 6 |
| 120/208 volts | Size 7 |
| Fed from Panel 601 | Size 7 |

- .2 Each panel shall be supplied with a directory card holder welded to inside of door, complete with a neatly typewritten list showing information as follows:

| | |
|-----------------|---------------|
| Panelboard name | 2PB11 |
| Panel voltage | 120/208 volts |

| <u>Circuit Number</u> | <u>Description</u> | <u>Load</u> |
|-----------------------|--|-------------|
| 1 | Lighting Room 200 (Main Area) | 1200W |
| 2 | Receptacles Room 200 (Main Area) | 6-15A |
| 3 | Room 220 H.P. Fan | 1/3 |

Spaces and spares shall be left blank so as to facilitate future description. Also, existing panels where adjustments have been made in the circuitry shall be field checked in their entirety and new directory cards shall be provided.

- .3 List shall be covered with a 1 mm thick clear plastic sheet to protect it.
- .4 Other cabinets and plywood back boards for low voltage systems, such as signals and communications, shall be identified as panelboards with a directory showing circuit numbers and room locations, plus a blank for "Remarks", as well as a Lamecoid plate designation panel name.

EXAMPLE: if cabinet is for telephone
.....TP - 2nd floor

- .5 Equipment not listed above, such as incoming service cables, communicating cables, switchgear, transformers, disconnects, motors, instruments, fire alarm and control panels, shall be identified in a similar manner, showing name and number of the equipment, voltage and load information.
- .6 Identification to be English
- .7 Wording on nameplates and labels to be approved by Engineer Departmental Representative prior to manufacture.
- .7 All plug-in type receptacles on all levels shall be identified by means of a self adhesive label approximately 8 mm x 30 mm, and contain the panel and circuit number in 4 mm high lettering. The cover plates for all receptacles fed from the ground fault interrupters shall also contain the wording "G.F.I."
- .8 The circuits controlled by all light switches shall be neatly printed with waterproof ink on the side of the switch outlet box so that the panel and circuit number are clearly legible when the coverplate is removed. It shall not be necessary to remove the switch from the outlet box in order to read the panel or circuit number.

1.22 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour code: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.
- .5 Connections in equipment shall be made Phase 'A', 'B', 'C' from left to right when viewing wiring from front or accessible direction.
- .6 Labels:
 - .1 Embossed plastic labels with 6 mm high letters unless specified otherwise.
- .7 Colour coding shall be carried through from incoming utility supply down to and including panels, and shall be as follows:
 - .1 Incoming utility service lines shall be identified by Red - Phase 'A'; Black - Phase 'B'; Blue - Phase 'C'; with colour coded PVC tape.
 - .2 Switchgear buswork in each switchboard and unit substation cubicle shall be banded with 3M tape identified in accordance with service lines colour coding. In addition, where neutral bus is introduced, it shall be banded white. Ground bus shall be banded green.
 - .3 Feeder and sub-feeder bus or conductors shall be banded as above.

- .4 Lighting and power panels shall conform to the Canadian Electrical Code, and shall have main bus banded with tape as follows:

| | | |
|-------|---|-----------|
| Red | - | Phase 'A' |
| Black | - | Phase 'B' |
| Blue | - | Phase 'C' |
| White | - | Neutral |
| Green | - | Ground |

1.23 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Feeder pull boxes and junction boxes shall be identified with waterproof ink, showing feeder or system concerned.
- The outside of the box shall also be identified in this way so as to readily determine the system within the conduit system. The cover of each junction box for branch circuits shall describe the voltage being used by means of a waterproof ink.
- .3 No colour code is required for regular lighting and power circuits, but voltage class shall be displayed on all pull boxes and panels, and 347 volt ballast covers.

1.24 WIRING TERMINATIONS

- .1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.

1.25 MANUFACTURERS AND CSA LABELS

- .1 Visible and legible, after equipment is installed.

1.26 WARNING SIGNS

- .1 As specified and to meet requirements of Electrical Inspection Department and Departmental Representative.
- .2 Decal signs, minimum size 175 x 250 mm.

1.27 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.

1.28 TEMPORARY AND TRIAL USAGE

- .1 Temporary and trial usage by the Departmental Representative, or the Contractor, of any of the electrical apparatus or equipment, or any work or materials supplied under this Division before final completion and written acceptance, is not to be construed as evidence of acceptance of same by the Departmental Representative.
- .2 Temporary and trial usage may be made as soon as this Division deems the work sufficiently advanced for making a complete and thorough test of same, and that no claim may be made for the injury to or the breaking of any part of such work which may be so used, whether caused by weakness or inaccuracy of structural parts, or by defective material or workmanship of any kind.

1.29 SITE EXAMINATION

- .1 The contractor shall visit the existing construction site during the tendering period to familiarize himself with the construction conditions and electrical work provided to date. The contractor shall thoroughly satisfy himself that the work contained in these drawings and specifications can be carried out and that all costs have been included in the tender submitted.

1.30 CUTTING AND PATCHING

- .1 Should any cutting or repairing of either unfinished or finished work be required, the contractor shall employ the particular trade whose work is involved, to do such cutting and patching, and shall pay for any resulting costs.
- .2 All holes within buildings shall be fire stopped when penetrating a fire rated structure.
- .3 Holes required in existing construction to accommodate conduits or wireways shall be approved by the Departmental Representative prior to cutting or drilling.

1.31 COORDINATION OF PROTECTIVE DEVICES

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 2012 Canadian Electrical Code
- .2 CSA C22.2 No .0.3-09, Test Methods for Electrical Wires and Cables.
- .3 CAN/CSA-C22.2 No. 131-07(R2012), Type TECK 90 Cable.

1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

Part 2 Products

2.1 BUILDING WIRES

- .1 All conductors shall be copper, minimum No. 12 gauge, unless specifically noted otherwise.
- .2 All conductors # 12 AWG and up shall be rated for minimum 600V RW-90 XLPE. All conductor for motor feeds from variable frequency drives, shall be rated for minimum 1000V RW-90 XLPE.
 - .1 Copper conductors: size as indicated, with 600V or 1000V insulation of chemically cross-linked thermosetting polyethylene material rated RW90, RWU90, or R90.
- .3 Grounding conductors: bare copper, or where installed within conduit raceways, grounding conductor shall be insulated.
- .4 Aluminum conductors are not permitted for any wiring unless specifically shown on drawings.
- .5 Wire shall be as manufactured by Nexans, Alcan, Pirelli, BICC General Wire or Superior Essex.

2.2 TECK CABLE

- .1 Cable: to CAN/CSA-C22.2 No. 131.
- .2 Conductors:
 - .1 Grounding conductor: copper.
 - .2 Circuit conductors: copper, size as indicated.
- .3 Insulation:
 - .1 Chemically cross-linked thermosetting polyethylene rated type RW90, 600V to 1000V as noted above.
- .4 Fastenings:

- .1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
- .2 Channel type supports for two or more cables.
- .3 Threaded rods: 6 mm dia. to support suspended channels.
- .5 Connectors:
 - .1 Watertight approved for TECK cable.

Part 3 Execution

3.1 INSTALLATION OF BUILDING WIRES

- .1 All branch circuit conductors shall be sized to limit the voltage drop to a maximum of 3% based on the circuit load of 80% of the circuit protective device.
- .2 Termination for #8 AWG and larger shall be by means of approved solderless connector lug. For parallel conductors, a common lug with separate termination for each conductor shall be employed.
- .3 Conductor splices shall be made in accordance with specifications. Provide sufficient length for joint remake, and no less than 200 mm spare length. On through wiring, leave 300 mm loop.
- .4 Wiring in cabinets, pull boxes, panels and junction boxes shall be neatly trained and held with nylon cable ties.
- .5 Conductors shall be tag identified where passing through junction boxes.
- .6 Conductor length for parallel feeders to be identical.
- .7 All feeders and branch circuits must contain a green bonding conductor, sized to code requirements.
- .8 All wiring shall be installed in raceway. Wiring shall not be permitted to be installed in the free air unless otherwise noted.

3.2 INSTALLATION OF TECK CABLE 0 -1000 V

- .1 Install cables.
 - .1 Group cables wherever possible on channels.
- .2 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - 0-1000V.
- .3 All cables shall be terminated and spliced with suitable compression type connectors, as recommended by the cable manufacturer. The connectors shall satisfy the bonding and grounding requirements at the supply end.
- .4 All cables shall be single conductor and copper, unless otherwise specified.

- .5 All cable shall be rated for 1000 volts, insulated with cross-linked polyethylene and rated for operation at 90 degrees C. Cable shall have a FT4 rated outer jacket.
- .6 All cable shall meet the CSA requirements for cold bend and impact testing at minus 40 degrees C.
- .7 All cable shall be protected by a corrugated aluminum sheath or by interlocked aluminum armour. PVC jackets shall be required on all metallic sheathed cables.
- .8 The jackets shall meet the FT4 flame spread requirements and be identified on the P.V.C. jacket.
- .9 All cables shall be installed in accordance with the manufacturers recommendations, in suitable cable tray as specified within the specifications.
- .10 The cables shall be terminated at the supply end on a non-ferrous metallic plate and at the load end on a non-metallic rigid fibre board plate. The cable sheaths shall be bonded at the supply end only.
- .11 Tech cabling shall be used only where noted on plans.
- .12 Cables shall be manufactured by Nexans, Alcan, Superior Essex, General Wire or Pirelli.

3.3 INSTALLATION OF CONTROL CABLES

- .1 Install control cables in conduit.
- .2 Ground control cable shield.

3.4 IDENTIFICATION

- .1 Colour code metallic sheathed cables.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour code to latest edition of CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.
- .5 Conductors shall be color coded. Conductors 2 AWG and smaller shall have color impregnated into insulation at time of manufacture. Conductors size No. 1 AWG and larger may be color coded with adhesive color coding tape, but only black insulated conductors shall be employed in this case, except for neutrals, which shall be white wherever possible. Where color coding tape is utilized, it shall be applied for a minimum of 75 mm at all terminations, junction and pull boxes and conduit fittings. Conductors shall not be painted under any condition. Color coding shall also apply to busing in panels and bus ducts. If it can be shown that colored conductors are not available at the time of installation, permission may be granted to tape color code. Color coding shall be as follows:

Phase 'A' - Red
Phase 'B' - Black
Phase 'C' - Blue

Neutral - White
Control - Orange

- .6 Colour coding of non-phase wires shall be as follows:
 - .1 Bonding and ground wires: green or bare. Isolated ground wires: green with orange stripe.
- .7 Conductors shall be tag identified where passing through junction boxes.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 01 - Common Work Results - Electrical.

1.2 REFERENCES

- .1 Canadian Standards Association, (CSA International)
- .2 Electrical equipment and wiring shall be grounded in accordance with the Canadian Electrical Code, Part 1, C22.1-2012 and local inspection authority's rules and regulations.

1.3 REQUIREMENTS

- .1 Electrical equipment and wiring shall be grounded in accordance with the Canadian Electrical Code, and local inspection authority's rules and regulations.
- .2 All panel feeds shall include a ground conductor.

Part 2 Products

2.1 EQUIPMENT

- .3 Insulated grounding conductors: green.
- .4 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
 - .1 Grounding and bonding bushings.
 - .2 Protective type clamps.
 - .3 Bolted type conductor connectors.
 - .4 Thermit welded type conductor connectors.
 - .5 Bonding jumpers, straps.
 - .6 Pressure wire connectors.
- .5 All connections to the ground bus or risers shall be thermowelded, or shall utilize the Burndy Hy-Ground compression connections. Clamp type connections shall only be allowed to individual pieces of equipment.

Part 3 Execution

3.1 INSTALLATION GENERAL

- .1 Electrical equipment and wiring shall be grounded in accordance with the Canadian Electrical Code, and local inspection authority's rules and regulations.
- .2 Install compete permanent, continuous grounding. Where EMT is used, run ground wire in conduit.

- .3 All metallic raceways and shall be grounded.
- .4 Install connectors in accordance with manufacturer's instructions.
- .5 Protect exposed grounding conductors from mechanical injury.
- .6 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .7 Soldered joints not permitted.
- .8 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit. All motors with flexible connections shall have separate ground wire run bridging the flexible connections. This ground wire shall be run from the motor back to the nearest junction box or motor control centre where the termination can be readily inspected. Insulation for this wire shall be green.
- .9 All grounding conductors outside the electrical rooms and closets shall be insulated and installed in conduits, unless otherwise noted.
- .10 All panel feeds and distribution at 600 volt and 208 volt shall include a building network ground conductor.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CAN/CSA C22.2 No. 18-98, Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware.
 - .2 CAN/CSA C22.2 No. 18.2-2006, Nonmetallic Outlet Boxes
 - .3 CSA C22.2 No. 56-2013, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .4 CSA C22.2 No. 83-M1985(R2013), Electrical Metallic Tubing.

1.2 REQUIREMENT

- .1 Runs of conduit and cables, where shown, are indicated only by general location and routing. Conduits and cables shall be installed to provide maximum head room, and to interfere as little as possible with free use of spaces through which they pass.
- .2 Holes shall not be cut in structural members without permission being first obtained from the Departmental Representative.
- .3 Junction boxes or cable anchor boxes shall be installed wherever necessary for proper pulling or anchoring of cables. They shall be installed to be accessible after building is completed, and shall be set to come within finished lines of the building.
- .4 EMT may be used in furred ceilings, brick or concrete block walls, stud partitions, or exposed where no danger of mechanical damage exists for 120/208 volt or low voltage wiring.

Part 2 Products

2.1 CONDUITS

- .1 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.
- .2 Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal.

2.2 CONDUIT FASTENINGS

- .1 One hole steel straps to secure surface conduits 50 mm and smaller. Two hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps shall be used to attach conduit or cables to exposed steel work. Beam clamps shall be:
 - Fast Clamp, as supplied by Cantab Industries
 - Caddy Fasteners as manufactured by Erico Products
- .3 Channel type supports for two or more conduits at 1.5 m oc.
- .4 Threaded rods, 6 mm dia., to support suspended channels.

2.3 CONDUIT FITTINGS

- .1 Set-screws and watertight fittings for EMT.
- .2 Condulets shall be of a type wherein cover screws do not enter the wire chamber.
- .3 Steel, double bevel sealing ring for liquid-tight flexible metal conduit. T & B 5200 series or equivalent.
- .4 All others as manufactured for use with conduit specified. Coating: same as conduit.
- .5 Factory "ells" where 90° bends are required for 1 (27) trade size and larger conduits.
- .6 Conduit fittings shall be manufactured by:

| | |
|----------------|---------|
| Crouse Hinds | Kondu |
| Thomas & Betts | Killark |
- .7 Running threads not accepted. Use Erickson couplings.
- .8 Flexible conduit entering boxes or enclosures shall be terminated with nylon insulated liquid tight zinc alloy or steel connectors.
- .9 All couplings and connectors for EMT conduit shall be malleable iron or steel.
- .10 EMT entering boxes or enclosures shall be terminated with nylon insulated steel or zinc alloy concrete tight connectors.
- .11 All conduits shall be terminated with a suitable bushing.
- .12 Conduit seals shall be as manufactured by:

| |
|----------------------------------|
| Thomas & Betts or approved equal |
|----------------------------------|
- .13 Condulets with suitable covers shall be used where condulets are exposed. Each conduit fitting shall be of a type suitable to its particular use, and of a type which will allow installation of future conduits without blocking covers of existing condulets.
- .14 Flexible conduit and EMT connectors shall be of the insulated throat type.
- .15 Flexible conduit connections to all mechanical equipment shall be of 'Sealtite' manufacture.

2.4 FISH CORD

- .1 Empty conduits shall be cleaned of all construction material and be provided with a pullwire or polytwine.

Part 3 Execution

3.1 INSTALLATION

- .1 Conduit shall be installed as close to building structure as possible so that where concealed, necessary furring can be kept to a minimum. Conduits installed in suspended ceilings shall be arranged to provide minimum interference with removal of tiles.
- .2 Install conduits parallel with building lines.
- .3 Group conduits wherever possible on existing channels.
- .4 Conduit and cables shall be installed to avoid proximity to water and heating pipes. They shall not run within 150 mm of such pipes, except where crossings are unavoidable, in which case they shall be kept at least 25 mm from covering of pipe crossed.
- .5 Use electrical metallic tubing (EMT) except where specified otherwise.
- .6 Conduit shall be of sufficient size to permit easy removal of conductors at any time. Conduit sizes, where shown on drawings, are minimum and shall not be reduced.
- .7 Cap ends of all conduits to prevent entrance of foreign matter during construction. Manufactured caps shall be employed.
- .8 Use liquid tight flexible metal conduit for connection to motors, instruments and sensors.
- .9 No conduit shall be less than 20 mm I.P.S. unless noted otherwise, Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .10 Mechanically bend steel conduit over $\frac{3}{4}$ (21) trade size.
- .11 Expansion joints shall be provided in conduit runs where they cross building expansion joints.
- .12 Not more than four (4) 90 degree bends or equivalent offsets will be permitted between pull boxes. When maximum number of bends are used, the total run between pull boxes shall not exceed 18000 mm.
- .13 Conduits and cables shall be supported, at regular intervals, with corrosion resisting clamps. Lead anchors or expansion bolts shall be used to attach clamps to masonry walls.
- .14 Where conduits become blocked, remove and replace blocked section. Do not use liquids to clean out conduits.
- .15 Dry conduits out before installing wire.
- .16 Where elbows 45 degree and larger are required to pass through a wall provide a pull box instead.

- .17 Pull boxes utilized for turning corners shall be square and sized at six (6) times the diameter of the largest conduit.
- .18 Pull boxes for straight runs shall be sized at eight (8) times the diameter of the largest conduit in length.
- .19 Expansion joints shall be installed with ground jumper.
- .20 All low voltage cabling shall be installed in conduit unless noted otherwise. Low voltage wiring of different systems shall not share the same conduit.

3.2 SURFACE CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel where possible.
- .4 Group conduits wherever possible on suspended surface channels.
- .5 Do not pass conduits through structural members except as indicated.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation for fused and non-fused disconnect switches.

1.2 REFERENCES

- .1 2012 Canadian Electrical Code
- .2 Canadian Standards Association (CSA International).
 - .1 CAN/CSA C22.2 No.4-04 (R2013), Enclosed Switches.
 - .2 CSA C22.2 No.39-13, Fuseholder Assemblies.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data described herein and in accordance with Section 01 33 00 - Submittal Procedures and 26 05 01 – Common Work Results, Electrical

Part 2 Products

2.1 DISCONNECT SWITCHES

- .1 Fusible and non-fusible disconnect switch in CSA Enclosure, size as indicated.
- .2 Mechanically interlocked door to prevent opening when handle in ON position.
- .3 Fuses: size as indicated, in accordance with Section 26 28 14 - Fuses - Low Voltage. Switch fuse units shall be available in 30 through 1200 amp standard industry sizes. They shall be readily removable and interchangeable without modification to bus work or mounting rails
- .4 Fuseholders: suitable without adaptors, for type and size of fuse indicated unless noted otherwise.
- .5 Quick-make, quick-break action.
- .6 Fusible switches shall be quick-make, quick-break, visible blades, integral handle mechanism, deionizing arc quenchers, front operation, high pressure fuse clips and recessed live parts.
- .7 Operating handles to have provision for padlocking in either 'on' or 'off' position.
- .8 Handle to be marked to clearly indicate switch contact positions.
- .9 Switch fuse units shall be available in 30 through 1200 amp standard industry sizes.
- .10 Shall be readily removable and interchangeable without modification to bus work or mounting rails.

- .11 All switches shall be manufactured by Cutler Hammer or Schneider Electric.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Lamecoid nameplates, approximately 75 mm x 25 mm, shall be provided on front doors of each switch for identification, showing the name and rating.

Part 3 Execution

3.1 INSTALLATION

- .1 Install disconnect switches complete with fuses if applicable. Disconnects located outdoors shall be weatherproof construction with weatherproof fittings.

END OF SECTION

PART 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 01 - Common Work Results - Electrical.

1.2 REFERENCES

- .1 National Electrical Manufacturers Association (NEMA)
- .2 International Electrotechnical Commission (IEC)
- .3 Canadian Electrical Code (CEC)
- .4 UL 508 - UL Standard for Safety Industrial Control Equipment.
- .5 UL 508C - UL Standard for Safety Power Conversion Equipment.
- .6 NEMA ICS 7.1

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 A submittal package, including drawings shall be furnished for the Contractor's approval and this Departmental Representative's review prior to factory assembly of the AC Drives. These packages shall consist of
 - .1 Elementary power and control wiring diagrams on one drawing
 - .2 Enclosure outline drawings. The enclosure drawings shall include front and side views of the enclosures with overall dimensions and weights shown, and conduit entrance locations.
 - .3 Standard catalogue specification sheets showing voltage, horsepower and maximum current ratings shall be furnished as part of the submittal package.
 - .4 Mounting method and dimensions.
 - .5 Starter size and type.
 - .6 Layout of identified internal and front panel components.
 - .7 Enclosure types.
 - .8 Wiring diagram for each type of starter.
 - .9 Interconnection diagrams.
 - .10 All Filters for use with VFD's.
 - .11 All overcurrent types for all starters including VFD's

1.4 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Include operation and maintenance data for each type and style of starter.

PART 2 Products

2.1 MATERIALS

- .1 The VFD and all associated optional equipment shall be UL Listed according to UL 508 C - Power Conversion Equipment. As verification, a UL label shall be attached on the inside of the combination enclosure. A UL508A panel builders label does not meet this specification.
- .2 The VFD shall be designed, constructed and tested in accordance with UL, CSA, NEMA, and CEC standards.

2.2 VARIABLE FREQUENCY DRIVES

PART 1 GENERAL DESCRIPTION

- .1 All VFDs and ancillary components shall be supplied by one manufacturer in order to assure an integrated system and one point of contact for service. Each manufacturer shall have a local Saskatchewan service capability. All motor control equipment shall be of the same manufacture, and shall be manufactured by one of the following:
Schneider Electric "C-Flex Drive Package"
or approved equals by Eaton , Siemens, General Electric
- .2 Provide variable frequency drives (VFD) where designated by the motor control schedule and drawings. These drives shall have the following features:
 - .1 The drives shall be capable of continuously operating any standard squirrel cage induction motor, NEMA design A, B, or C self-ventilated or force ventilated and inverter duty motors. It shall be designed for operation of mechanical air handling units, supply and return fans, exhaust fans, chilled water pumps, hot water pumps, cooling tower fans and pumps and other mechanical HVAC type equipment.
 - .2 The unit's specific control interface shall be pre-programmed for HVAC variable torque operation for ease of setup and operation. It shall be suitable but not limited to end damper control, smoke purge relays and fire/freeze stats for full speed fire safety overrides and lock-out terminations.
 - .3 The variable speed drive shall be the pulse width modulated (PWM sinusoidal) output type with programmable adjustable carrier frequencies.
 - .4 Unless otherwise noted, all horsepower/Kilowatt drive ratings are to be based on a variable torque load and FLA of motor being controlled.
 - .5 The memory shall retain and record run status and fault type of the past eight faults.

PART 2 CONSTRUCTION

- .1 The starter shall be enclosed within a NEMA Type 3R enclosure. Operation of drive shall be possible in environmental temperatures of -10°C to +50°C.
- .2 The variable speed drive package shall consist of a circuit breaker disconnect, line reactor, EMI/RFI filter, 2 contactor bypass (where specifically noted as being required), 120V control transformer, control circuit terminal board for digital and analog field wiring.
- .3 The drive door shall have mounted and wired, Hand-Off-Auto switch, Manual Speed Potentiometer and VFD Off-Bypass switch (where specifically noted as being required).

- .4 The AC Drive power converter shall be enclosed in a NEMA Type 1 enclosure with a circuit breaker disconnect, user terminal strip connections and bypass controls. The enclosure shall provide dedicated user terminals for power and control device connection.
- .5 Provisions shall be included for locking the disconnect in the OFF position with a padlock.
- .6 All enclosure and heat sink fans shall be accessible from the front and shall not require the removal of the AC drive power converter for fan replacement.
- .7 The displacement power factor shall not be less than .98 lagging under any speed or load condition.
- .8 The AC Drive shall operate from an input frequency range of 60 Hz (\pm) 5%.
- .9 The efficiency of the AC Drive at 100% speed and load shall not be less than 97%.
- .10 The variable torque rated AC Drive over current capacity shall be not less than 110% for 1 minute.
- .11 The output carrier frequency of the AC Drive shall be programmable at 0.5, 1, 2, 4 or 8 kHz. In addition, the output carrier frequency shall be randomly modulated about the selected frequency.
- .12 Input line reactors shall be provided with a minimum impedance of 3%. Ensure adequate ventilation is provided for proper heat dissipation.
- .13 Control power input terminals shall be separate from the input power terminals to facilitate start-up, trouble-shooting, and diagnostics without power to the DC bus.
- .14 Chassis mounted terminal strips shall be removable without disturbing the control wiring and must have a locking system resistant to vibration. Each input and output shall be identified. All plug-in connectors inside the unit shall be identified with permanent labels on each termination.

PART 3 PROTECTION

- .1 Upon loss of the analog process follower reference signal, the AC Drive shall be programmable to display a detected fault code
- .2 The AC drive shall have a programmable ride-through function, which will allow the logic to maintain control for a minimum of one-second (60 cycles) without faulting.
- .3 There shall be three skip frequency ranges that can be programmed to a bandwidth of 0.1 Hz to 10 Hz.
- .4 The enclosure shall provide a fully coordinated 100,000 AIC current rating marked on the enclosure nameplate. Short circuit coordination to UL 508C Power Conversion Equipment and NEMA ICS 7.1.
- .5 The AC Drive shall be protected against short circuits, between output phases and to ground.
- .6 The VFD shall not be sensitive to incoming power feeder phase sequence.

- .7 The drive shall be designed and constructed to operate at a maximum altitude of 1000 m without derating and an ambient temperature between 0° C and 40° C. The drive shall operate in an environment with a relative humidity up to 90% with no condensation.

PART 4 OPERATOR CONTROLS

- .1 A keypad display interface shall offer the modification of AC Drive adjustments through a touch keypad. All electrical values, configuration parameters, I/O assignments, application and activity function access, faults, local control, and adjustment storage, and diagnostics shall be accessible.
- .2 Two voltage-free relay output contacts will be provided. One of the contacts will indicate AC Drive fault status. The other contact shall indicate a drive run status.
- .3 The combination enclosure shall have the following dedicated operator controls:
- .1 Hand-Off-Auto switch
 - .1 "Hand" for local control of VFD or Bypass starter. VFD is operated by panel mounted keypad pushbuttons, speed controlled by the keypad.
 - .2 Motor cannot be started or remain running in Off position
 - .3 In "AUTO" position, the VFD operates by remote start/stop command, the speed is controlled by the isolated 4–20 mA input signal from the BMS and Fire Alarm Panel.
 - .2 Manual Speed Potentiometer
 - .3 VFD-Off-Bypass switch
- .4 The combination enclosure shall include terminal point connection for fire /freeze state interlock, to prevent drive (or bypass if present) operation. The interlock shall shut down the motor in the both the VFD and VFD bypass run modes.
- .5 The drive shall incorporate a point to point serial link operating through a 20mA current loop, or RS232C port. This function shall facilitate the interface of the drive to a programmable controller or a microcomputer with a single link. The data exchanges shall be programmed according to a simple protocol, and enable:
- .1 Adjustment of speed controller setting parameters
 - .2 Control of the speed drive
 - .3 Access to all control and signaling data
- .6 The drive shall be capable of multi-drop bus via communication modules for the following protocols:
- .1 MODBUS
 - .2 LonWorks
 - .3 Profibus
 - .4 Metasys
 - .5 Ethernet
 - .6 BACnet
 - .7 Unitelway
 - .8 Apogee P1
- .7 The drive shall have the following pilot lights on the VFD enclosure.

- .1 (RED LED) - VFD "Power On"
 - .2 (GREEN LED) - VFD "RUN"
 - .3 (YELLOW LED) - VFD "FAULT"
 - .4 (YELLOW LED) - VFD "Auto". If Bypass present, then revise to YELLOW LED – VFD "Bypass"
- .8 The drives shall operate at 208 volts, 600 volts as applicable + 10% or 15%, 60Hz, 3ph. Drives which require isolation transformers or are rated at 575 volt are not acceptable.
- .9 The VFD shall have an I/O extension card containing the following:
- .1 0-20mA output
 - .2 4 logic inputs
 - .3 2 logic outputs
 - .4 2 analog inputs
 - .5 1 differential analog output
- .10 The drive shall be capable of a speed signal as set by an analog signal of 0-10Vdc, 4-20mA, or 0-20mA +/- 10Vdc. Provide initially 0-10Vdc and 4-20mA control modules.
- .11 The drive shall have the capability of incorporating Dynamic Breaking Resistors.
- .12 The VFD shall be capable of operating with the VFD output open circuited (i.e/ no motor connected) with no fault or damage to any part of the drive.
- .13 The drive shall have the capability to energize and control a currently 'spinning' load regardless of the direction of rotation of the load.
- .14 When the controlled load is turning in a "reverse" direction, and a forward start is called for, the VFD shall gently catch the load and slowly ramp the load speed down to zero. It shall be held there for a variable time between 1 and 4 seconds. The load shall then assume its normal start procedure.
- .15 Provide a bump-less speed transfer from remote control to local control or local control to remote control without setting the motor to zero.
- .16 Provide a speed droop feature that reduces the speed of the drive on transient overloads. The drive shall return to set speed after transient is removed. The drive shall automatically compensate on transient overloads to prevent drive trip.
- .17 The setting controls shall be accessible from the front of the control board, from a commissioning terminal, or from a serial link with an IBM compatible computer.
- .18 The following functions shall be independently field adjustable:
- .1 Acceleration rate: 0.2 to 990 seconds. Set initially to 30 seconds.
 - .2 De-acceleration rate: 0.2 to 990 seconds. Set initially to 30 seconds.
 - .3 Acceleration and deceleration ramps adaptation: linear.
 - .4 Adjustable minimum speed of 0 to maximum speed.
 - .5 Adjustable maximum speed of minimum speed to max. frequency.
 - .6 2 adjustable skip frequencies. The bandwidth shall be field adjustable.

- .7 Current limitation value adjustable from 150% to 5%.
- .8 Automatic restart.
- .9 Catching a spinning load in either direction.

- .19 The drive shall, for single motor application, mathematically model the temperature of the motor, based upon the motor speed (and therefore the effect or the reduced air flow over the motor), time in operation, motor current, and motor size. Motor temperature in excess of 118% shall result in a drive fault condition that shall be indicated on the electronic display.

- .20 The drive controls shall facilitate the locking of settings in the speed controller. This shall result in the speed controller's terminal and dialogue unit no longer allowing change in the settings. Unlocking of the settings shall be possible by deactivating this feature.

- .21 The drive shall include a self-diagnostic system to test all main functions and identify any failed elements.

- .22 Provide an Operations and Maintenance manual with the following:
 - .1 Preliminary checks and start up check sheet with list with outline
 - .2 Design and Operation
 - .3 Technical characteristics
 - .4 Installation details
 - .5 Connection details
 - .6 Troubleshooting charts for all device faults.
 - .7 An instruction manual for programming and hardware provided with the equipment at time of shipment.
 - .8 A listing of authorized service depots, spare parts lists and recommended spare parts
 - .9 Final settings of all parameters
 - .10 Input and output filter type and size
 - .11 Specified environmental conditions
 - .12 Voltage and current wave form printout taken from the motor terminals
 - .13 Bolt and lug torque schedule for all current carrying buss and cable connections.

- .23 Provide a trouble shooting guide with the following features:
 - .1 Observation, fault code
 - .2 Possible causes
 - .3 Checks to be made
 - .4 Result
 - .5 Remedial action
 - .6 Comments

- .24 The starter shall be equipped with an automatic start mode that shall restart the motor after a power failure without operator intervention. This option shall be controlled by the internal parameter settings. Drives that lock out in a fault

condition due to power outage or transfer from and to emergency power shall not be accepted. The drive shall resume to the last known frequency.

- .25 The automatic start mode shall also be capable of restarting the motor after an individual trip condition without operator intervention. This option shall be controlled by the internal parameter settings. The drive shall resume to the last known frequency. This setting shall initially be set to disabled.
- .26 The drives are to be set for three (3) only restarts, set for a 30 second delay following the return of essential power to the drive. Failure of the drive to restart the motor following these two (2) restarts will necessitate a manual acknowledgement of the fault at the actual drive control panel.
- .27 Prior to any motor control equipment ordering, the Electrical contractor shall coordinate with successful controls contractor and determine the required control, i.e. '2 wire' or '3 wire' control. Equipment shall be ordered as such upon written confirmation from the controls contractor.
- .28 Coordinate all control requirements prior to ordering equipment.
- .29 Each VFD shall be provided with a dry contact assignable to an alarm condition such as a VFD fault. Contact shall be wired to the nearest BMS control panel.
- .30 Each VFD shall provide a speed feedback signal wired to the nearest BMS control panel.
- .31 The Contractor shall co-ordinate with the VFD manufacturer regarding all motor sizes, motor types and motor feeder lengths. Provide LC or LCR filters for all motors equipped with VFD's where the feeder distance exceeds the limits for the pulse rise times shown in the following table:

| Pulse Rise Time (Microseconds) | Critical Lead Length (Meters) |
|-----------------------------------|----------------------------------|
| 1 or greater | 45 |
| 0.5 | 20 |
| 0.1 and less | Always |

All VFD's not requiring an LC or LCR filter shall be equipped with a 5% output load reactor. LCR/LC filters and load reactors shall be manufactured by MTE Corporation, or T.C.I., or approved equal. Coordinate with manufacturer to ensure proper mounting of all output filters (when required). The output filters shall be installed outside of the drive enclosure in a separate enclosure located beneath the VFD enclosure.

- .32 The manufacturer shall provide all necessary assistance, including on-site support, to both mechanical and electrical contractors to determine final drive parameter settings. The VFD manufacturer shall adjust the drive parameter settings to suit on-site conditions prior to commissioning. During the warranty period, this electrical contractor shall allow/provide for the manufacturer to adjust parameters on site utilizing three (3) trips at one (1) working day each.

- .33 Setting of all drive parameters, commissioning, testing and certification of all VFD's shall be completed by the VFD manufacturer. Third party commissioning agents will not be accepted unless prior permission is granted.
- .34 Coordinate all control requirements prior to ordering equipment.

PART 5 DRIVE ISOLATION AND BYPASS CONTACTORS

- .1 The AC Drive shall include mechanically and electrically interlocked isolation and bypass contactors complete with a Class 20 thermal overload relay, circuit breaker disconnect, control circuit transformer and VFD/OFF/BYPASS switch.
- .2 The operator shall have full control of the bypass starter by operation of the VFD/OFF/BYPASS selector switch.
- .3 In the AUTOMATIC mode of operation the bypass contactors shall be sequenced by a 120-volt rated auto start contact provided by the Contractor.
- .4 The isolation contactor for the bypass shall be sequenced to provide motor isolation during a drive ready state of operation.

2.3 CONTROL TRANSFORMER

- .1 Single phase, dry type, control transformer with primary voltage as indicated and 120V secondary, complete with secondary fuse, installed in with starter as indicated.
- .2 Size control transformer for control circuit load plus 20% spare capacity.

2.4 FINISHES

- .1 Apply finishes to enclosure in accordance with Section 26 05 01 - Common Work Results - Electrical.

2.5 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.
- .3 The plates shall be attached with two self-tapping metal screws.

PART 3 Execution

3.1 INSTALLATION

- .1 Install VFD's, connect power and control as indicated.

- .2 For each motor controlled by a variable frequency drive, provide a grounding conductor from the motor case to the internal grounding terminal.
- .3 All VFD control wiring shall be run in separate raceway away from any line voltage or motor feeder power wiring. Motor cables shall be separated from the supply cables at a minimum distance of 600mm and from signal / control cables at a minimum distance of 400mm. The signal / control cables shall be separated from the motor cables at a minimum distance of 900mm. Where signal / control cables must cross power or motor cables, the crossover angle shall be 90 degrees.
- .4 Ensure correct fuses and overload devices elements installed.
- .5 Each manufacturer shall have a local Saskatchewan service capability.
- .6 All motor control equipment shall be of the same manufacture.
- .7 Ensure correct fuses and overload devices elements installed.
- .8 The VFDs shall be cleared of all ambient construction dust prior to commissioning or the energizing of the drive.
- .9 Provide a disconnect for each motor within the room or area that the motor is located. All disconnects shall be sized in accordance with kilowatt ratings of the motor being isolated and shall be quick-make, quick-break type, equipped with lock-off feature.
- .10 Within 900 mm of each motor, provide flexible Sealtite conduit. Provide a separate ground wire bridging the flexible connections.
- .11 All conduit entering top of VFD enclosure shall be c/w water tight connectors with silicone based caulking.
- .12 Control wiring shall be stranded TEW 105°C (220°F) rise.
- .13 Provide wire markers at both ends of all control wires, Electrovert Type Z or approved equal
- .14 Provide isolation and voltage surge suppression for contacts used for external monitoring to limit inductive switching surges to less than 200 V peak. Provide DC coils with freewheeling diodes to limit inductive surges to 28V peak.
- .15 Use shielded twisted pair (STP) wiring for control and signal wiring that connects externally to the VFD.
- .16 Provide separate conduits for VFD control wiring from input and output power wiring.
- .17 Provide black and white lamecoid nameplates to identify each starter. The lamecoids shall be attached with two self-tapping metal screws.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical and manufacturer's instructions.
- .2 The manufacturer in co-ordination with the Contractor shall have voltage and current waveforms taken at the time of final commissioning from the motor terminals of each motor controlled to ensure that the waveforms are within the tolerance limit of the motor and drives. The settings of the waveform capture shall be such that the pulse rise time of the waveform shall be visible and easily evaluated for voltage reflection amplification. Any documentation not meeting this requirement shall be rejected and resubmitted until it is satisfactory to the Departmental Representative.
- .3 Prior to shipment, all VFD units shall be shop tested at the factory or at the VFD OEM/integrator, including, but not limited to a full load test, all auto control functions, and bypass functions.
- .4 Provide factory certified copies of production test results to the Departmental Representative prior to shipment of the equipment.
- .5 Operate switches, contactors to verify correct functioning.
- .6 Perform starting and stopping sequences of contactors and relays.
- .7 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.
- .8 Calibrate VFD display values with Building Management System display output. Verify motor RPM values with Building Management System operators.
- .9 Ensure that voltage waveforms are taken at the motor terminals at a time span that shows the relative rise times of output waveform from drive and that the waveforms are within the tolerance limit of the motor and VFDs.

END OF SECTION