

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-12, Canadian Electrical Code, Part 1 (22th Edition), Safety Standard for Electrical Installations.
 - .2 CAN3-C235-83(R2010), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
- .2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
 - .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.
- .3 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
 - .1 IEEE SP1122-2000, the Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

1.3 DEFINITIONS

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

1.4 DESIGN REQUIREMENTS

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
 - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .3 Language operating requirements: provide identification nameplates and labels for control items in English.

1.5 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS for all chemicals supplied.
- .3 Shop drawings:
 - .1 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, wiring connections and other items that must be shown to ensure co-ordinated installation.
 - .2 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.

- .3 Indicate on drawings clearances for operation, maintenance, and replacement of operating equipment devices.
- .4 If changes are required, notify Consultant of these changes before they are made.
- .4 Quality Control: in accordance with Section 01 45 00 - Quality Control.
 - .1 Provide CSA certified equipment and material.
 - .2 Where CSA certified equipment and material is not available, submit such equipment and material to authority having jurisdiction for special approval before delivery to site.
 - .3 Submit test results of installed electrical systems and instrumentation.
 - .4 Permits and fees: in accordance with General Conditions of contract.
 - .5 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.
 - .6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Engineer.
- .5 Manufacturer's Field Reports: submit to Consultant manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system testing, as described in PART 3 - FIELD QUALITY CONTROL.

1.6 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.
- .2 Qualifications: electrical Work to be carried out by qualified, licensed electricians or apprentices in accordance with authorities having jurisdiction and as per the conditions of Provincial Act respecting manpower vocational training and qualification.
 - .1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
 - .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.
- .3 Health and Safety Requirements: follow all provincial and corporate occupational health and safety requirements.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Material Delivery Schedule: provide Consultant with schedule within 3 weeks after award of Contract.

1.8 WASTE MANAGEMENT AND DISPOSAL

- .1 Remove from site and dispose of all packaging materials and waste materials.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal.

1.9 SYSTEM START-UP

- .1 Instruct Consultant and operating personnel in operation, care and maintenance of systems, system equipment and components.
- .2 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.
- .3 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 aspects of its care and operation.

1.10 OPERATING INSTRUCTIONS

- .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
- .2 Operating instructions to include following:
 - .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
 - .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
 - .3 Safety precautions.
 - .4 Procedures to be followed in event of equipment failure.
 - .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.

Part 2 PRODUCTS

1.11 SUSTAINABLE REQUIREMENTS

- .1 Materials and products in accordance with Section 01 61 00 – Material and Equipment.
- .2 Do verification requirements in accordance with requirements outlined in the various sections.

1.12 MATERIALS AND EQUIPMENT

- .1 Provide material and equipment in accordance with Section 01 61 00 - Material and Equipment.
- .2 Material and equipment to be CSA certified. Where CSA certified material and equipment is not available, obtain special approval from authority having jurisdiction and inspection authorities before delivery to site and submit such approval as described in PART 1 - SUBMITTALS.
- .3 Factory assembled control panels and component assemblies.

1.13 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.

- .2 Control wiring and conduit: in accordance with Section 26 29 03 - Control Devices except for conduit, wiring and connections below 50 V which are related to control systems specified in mechanical sections and as shown on mechanical drawings.

1.14 WARNING SIGNS

- .1 Warning Signs: in accordance with requirements of authority having jurisdiction and inspection authorities.
- .2 Decal signs, minimum size 175 x 250 mm.

1.15 WIRING TERMINATIONS

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.

1.16 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates as follows:
 - .1 Nameplates: Lamicoid 3 mm thick plastic engraving sheet, black finish face, white core, lettering accurately aligned and engraved into core mechanically attached with self tapping screws.
 - .2 Sizes as follows:

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

- .2 Wording on nameplates to be approved by Owner Representative and Consultant prior to manufacture.
- .3 Allow for minimum of twenty-five (25) letters per nameplate.
- .4 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .5 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .6 Terminal cabinets and pull boxes: indicate system and voltage.
- .7 Transformers: indicate capacity, primary and secondary voltages.

1.17 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, numbered on both ends of phase conductors of feeders and branch circuit wiring. Conductor identification markers shall be proper sized white heat shrink wire markers with permanent black thermal printed mechanically reproduced characters.
 - .1 All accessible branch circuit power conductors shall be individually identified, using conductor markers, which carry the source panel name and circuit number. Neutral conductors shall carry the source panel name and the single letter 'N'.
 - .2 All DC power conductors are to be identified using conductor markers.
 - .3 All instrumentation, control, communication, data and alarm conductors shall be individually identified, using conductor markers, which carry the number as indicated or scheduled and if not specified then the source connected terminal number in its entirety.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.

1.18 CONDUIT AND CABLE IDENTIFICATION

- .1 Every conduit and cable assembly shall be identified at the points from which it originates and terminates including any intermediate intersecting box or panel and both sides of wall, floor or ceiling penetrations. Conduit and cable markers to be fastened in two locations by a nylon tie-wrap. Markers to be flexible white PVC coated, suitable for use in associated black thermal transfer printer. Markers shall be approved equal to Brady B109 Wire Tag – M71-12-109 and associated Brady BMP71 printer.
- .2 Power branch circuit conduits or cable assemblies to be identified as scheduled, or if not scheduled as follows:
 - .1 Carry the source (system) identification, i.e. Voltage, Unit Type, Unit Number, plus all conductors contained within the conduit / cable.
 - .2 Identification format to be:

POWER (Feeders)

P X-XXX – XXX

| | _____

Destination (Equipment Tag ID - as approved by engineer)

| _____

Source (Equipment Tag ID - as approved by engineer)

Voltage (2 - 120/208, 4 - 277/480, 6 - 347/600)

POWER (Branch Circuit)

PX - X XX - xx - xx

| | | |

Power Circuit Number(s) (as approved by engineer)

| | |

Unit Number (1 to 99) (as approved by engineer)

| |

Unit Type (DP, LP, MCC, etc.)

|

Voltage (2 - 120/208, 4 - 277/480, 6 - 347/600)

.3 Control conduits or cable assemblies to identify as follows:

- .1 Carry the source (system) identification, i.e. Panel Number plus all cable conductors' numbers contained within the conduit / cable.

CONTROL

C - XXX - XXX

| |

Cable Number(s)

|

Panel Number

Instrumentation conduits or cable assemblies to identified as follows:

- .2 Carry the source (system) identification, i.e. Panel Number plus all cable conductors' numbers contained within the conduit / cable.

INSTRUMENTATION

I - XXX - XXX

| |

Cable Number(s)

|

Panel Number

.4 Fire Alarm & Security conduits or cable assemblies to identified as follows:

- .1 Carry the physical zone number identification plus device numbers contained within the conduit / cable.

INSTRUMENTATION

XX- XXX - XXX

| | |

Cable Number(s)

|

Panel Number

|

System (FA, S)

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.
 - .1 Paint outdoor electrical equipment "equipment green" finish.
 - .2 Paint indoor switchgear and distribution enclosures light gray to EEMAC 2Y-1.

Part 3 EXECUTION

1.20 INSTALLATION

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
- .2 Do overhead and underground systems in accordance with CSA C22.3 No.1 except where specified otherwise.

1.21 NAMEPLATES AND LABELS

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

1.22 CONDUIT AND CABLE INSTALLATION

- .1 Install conduit and sleeves prior to pouring of concrete.
 - .1 Sleeves through concrete: schedule 40 steel pipes, sized for free passage of conduit, and protruding 50 mm.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

1.23 LOCATION OF OUTLETS

- .1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.
- .4 Locate light switches on latch side of doors.
 - .1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

1.24 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 Local switches: 1400 mm.
- .2 Wall receptacles:
 - .1 General: 450 mm.
 - .2 Above top of continuous baseboard heater: 200 mm.
 - .3 Above top of counters or counter splash backs: 175 mm.
 - .4 In mechanical/electrical rooms: 1200 mm.
- .3 Panelboards: as required by Code or as indicated.
- .4 Telephone and interphone outlets: 450 mm.
- .5 Wall mounted telephone and interphone outlets: 1500 mm.
- .6 Fire alarm stations: 1500 mm.
- .7 Fire alarm bells/horns: 2100 mm.
- .8 Television outlets: 450 mm.
- .9 Wall mounted speakers: 2100 mm.
- .10 Clocks: 2100 mm.
- .11 Door bell pushbuttons: 1500 mm.

1.25 CO-ORDINATION OF PROTECTIVE DEVICES

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

1.26 FIELD QUALITY CONTROL

- .1 Load Balance:
 - .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
 - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
 - .3 Provide upon completion of work, load balance report as directed in PART 1 - SUBMITTALS: phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
 - .1 Power generation and distribution system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.
 - .3 Lighting and its control.
 - .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
 - .5 Systems: fire alarm system and communications.
 - .6 Insulation resistance testing:
 - .7 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
 - .8 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
 - .9 VLF Hi-Pot test all medium voltage feeders at level recommended based on cable voltage rating.
 - .10 Check resistance to ground before energizing.
- .3 Carry out tests in presence of Owner and/or Consultant.
- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

- .5 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

1.27 CLEANING

- .1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

END OF SECTION

Part 1 General

1.1 SCOPE

- .1 The following forms are to be used as directed in the specification or as indicated on the drawings:

<u>FORM</u>	<u>DESCRIPTION</u>
1	Shop Drawing Cover Sheet
2	Electrical Contract Price Breakdown
3	Electrical Progress Claim
4	Quality Control Report - Equipment/System Verification Check List
5	Product Data Summary Sheet

Part 2 Products

- .1 Not Used.

Part 3 Execution

3.1 FORM 1

- .1 Submit with each shop drawing, completed in its entirety by Contractor, except for "Consultant's Review" area.

3.2 FORM 2

- .1 Submit per specification Section 26 05 00.

3.3 FORM 3

- .1 Submit with every application for payment.

3.4 FORM 4

- .1 Submit for all major electrical equipment and/or systems. Following list is a representative sample of major equipment and/or systems:
- .1 Individual form for each panelboard.
 - .2 Individual form for each motor starter or variable control drive.

3.5 FORM 5

- .1 Reference: Section 26 05 00; submit individual form preceding each item contained in the Operation and Maintenance Manual.

SHOP DRAWING COVER SHEET

This sheet shall remain attached to the shop drawings at all times.

Form 1

PROJECT:

Contract No:

PRODUCT:

Description: _____

Contract Identifier/Tag: _____

Manufacturer, model and number: _____

Supplier Name & Address: _____

Number of Pages Not Including This Cover: _____

CONTRACTOR'S APPROVAL:

Name: _____

Address: _____

TEL: _____

FAX: _____

☐ Approved ☐ Approved As Noted

(Signature)

(Date)

Notes: ☐ See Attached

KGS Group Review

KGS Group

Suite 200 – 4561 Parliament Avenue, Regina
Saskatchewan, S4W 0G3
TEL: 306-757-9681

This review is for general design only and does not relieve the Contractor from his responsibility to ensure conformance with the Contract and coordination with other trades.

☐ No Exceptions ☐ Proceed per Comments ☐ Proceed per Comments & Resubmit
☐ Amend & Resubmit ☐ Rejected ☐ Information Only

(Signature)

(Date)

(Vendor No.)

Comments: ☐ See Attached

PROJECT:**Contract No:**

	<u>MATERIAL</u>	<u>LABOUR</u>
<u>GENERAL:</u>		
Permits, Fees, etc.	\$ _____	\$ _____
Record Documents: <i>(Minimum of 3% of Total Electrical Contract for Manuals, As-Built Drawings. & Test Records)</i>	\$ _____	\$ _____
Equipment/Material Identification <i>(Minimum of 2% of Total Electrical Contract)</i>	\$ _____	\$ _____
CABLES, CONDUCTORS, RACEWAYS & BOXES:	\$ _____	\$ _____
Feeder & Branch Circuits, Raceways & Boxes		
LV POWER DISTRIBUTION:	\$ _____	\$ _____
Panelboards, Breakers		
ILLUMINATION SYSTEMS:	\$ _____	\$ _____
Luminaires		
RENOVATIONS:	\$ _____	\$ _____
System Re-configurations		
DEMOLITION REMOVAL:	\$ _____	\$ _____
System Decommissioning & Removal		
OTHERS (Specify):	\$ _____	\$ _____
TOTAL ELECTRICAL CONTRACT:	\$ _____	\$ _____

PROJECT:		Contract No:	
Electrical Contractor:		KGS's Use Only	
General Contractor:		File: 17-0006-001	
Claim: Number:		Date:	
Claim Period: From: To:		Review By:	
Authorized Rep: _____		Recommended Payment	
<i>(Name -Print)</i>		<input type="checkbox"/> - As Shown <input type="checkbox"/> - As Modified	
<i>(Signature)</i>		<input type="checkbox"/> - Rejected <input type="checkbox"/> - Attachment	
		<input type="checkbox"/> - Other _____	
		Signature:	

CATEGORY	TOTAL CONTRACT	THIS CLAIM	TOTAL TO DATE
General Electrical			
Cables, Conductors & Raceways & Boxes			
LV Power Distribution			
Illumination Systems			
Renovations			
Demolition Removal			
Others (Specify)			
Contract Change Orders:			
TOTALS			

QUALITY CONTROL REPORT
Equipment/System Verification Check List

Form 4

PROJECT: _____

File: _____

CONTRACTOR: _____

Date: _____

Page: _____

Equipment / System: _____

Tag: _____

Installation Checks	A	B	C	D	Initials	Comments
Visual inspection & cleanup						
Location, position & alignment						
Grounding / bonding						
Spare parts & accessories						
Nameplates & identification						

Pre-Start-up Checks	A	B	C	D	Initials	Comments
Manuals / As-built drawings						
Point to point connections						
Product data summary sheets						
Insulation tests/reports						
Voltage & phase rotation						
Protective element settings						

Functional Checks	A	B	C	D	Initials	Comments
Calibration / documentation						
Programming / documentation						
Electrical tests / documentation						
Mechanical operation						
Electrical operation						

Operating Checks	A	B	C	D	Initials	Comments
Manual operation						
Automatic operation						
Load tests						

A - Checked & Okay

B - Faulty & Corrected

C - Faulty & NOT Corrected

D - NOT Checked

Manufacturer's Representative in attendance

YES ☐

NO ☐

CERTIFIED READY FOR OPERATION:

DATE: _____
(Day-Month-Year)

SIGNED: _____
(Contractor's Authorized Representative - Printed Name)

(Contractor's Authorized Representative - Signature)

PROJECT: _____

File: _____

CONTRACTOR: _____

Date: _____

Page: _____

Component / System:

Tag:	
Item Description:	
Manufacturer:	
Manufacturer Model No.:	
Manufacturer Catalogue No.: (Complete)	
Features / Options:	
Supplier:	

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation for wire and box connectors.

1.2 RELATED SECTIONS

- .1 Section 26 05 00 – Common Work Results – For Electrical.

1.3 REFERENCE

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-C22.2No.18-04, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
 - .2 CSA C22.2No.65-03(R2008), Wire Connectors.
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
 - .1 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3 National Electrical Manufacturers Association (NEMA)

Part 2 Products

2.1 MATERIALS

- .1 Pressure type wire connectors to: CSA C22.2No.65, with current carrying parts of copper or sized to fit copper conductors as required.
- .2 Fixture type splicing connectors to: CSA C22.2No.65, with current carrying parts of copper or copper alloy sized to fit copper conductors 10 AWG or less.
- .3 Bushing stud connectors: to EEMAC 1Y-2 to consist of:
 - .1 Connector body and stud clamp for stranded and round copper conductors or bar.
 - .2 Clamp for stranded and round copper conductors or bar.
 - .3 Stud clamp bolts.
 - .4 Bolts for copper conductors or bar.
 - .5 Sized for conductors and bars as indicated.
- .4 Clamps or connectors for armoured cable, aluminum sheathed cable and flexible conduit, as required to: CAN/CSA-C22.2No.18.

Part 3 Execution

3.1 INSTALLATION

- .1 Remove insulation carefully from ends of conductors and:
 - .1 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2No.65.
 - .2 Install fixture type connectors and tighten. Replace insulating cap.
 - .3 Install bushing stud connectors in accordance with EEMAC 1Y-2.

END OF SECTION

Part 1. General

1.1 RELATED SECTIONS

- .1 Section 26 05 00 – Common Work Results – For Electrical.
- .2 Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

1.2 REFERENCES

- .1 CSA C22.2 No .0.3-01(R2005), Test Methods for Electrical Wires and Cables.
- .2 CAN/CSA-C22.2 No. 131-M89(R2004), Type TECK 90 Cable.

1.3 PRODUCT DATA

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

Part 2. Products

2.1 BUILDING WIRES

- .1 Conductors: stranded for 12 AWG and larger. Minimum size: 12 AWG.
- .2 Copper conductors: size as indicated, with 600 V insulation of chemically cross-linked thermosetting polyethylene material rated RW90.
- .3 Conductors shall be installed in Electrical Metallic Tubing (EMT) type conduit or better. Liquidtight flex or equal shall be used where flexible connections are required.

2.2 TECK CABLE

- .1 Cable: to CAN/CSA-C22.2 No. 131.
- .2 Conductors:
 - .1 Grounding conductor: copper.
 - .2 Circuit conductors: copper.
- .3 Insulation:
 - .1 Chemically cross-linked thermosetting polyethylene rated type RW90, 1000V.
- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: interlocking aluminum.
- .6 Overall covering: polyvinyl chloride material.
- .7 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 at 1500 mm centers.
 - .3 Threaded rods: 6 mm dia. or larger to support suspended channels.
- .8 Connectors:
 - .1 Teck cable connectors to be approved equal to Thomas & Betts Star Teck or Iberville TEK; suitably sized for cable. All connectors and locknuts to be aluminum, watertight and where terminated in a threadless opening shall be fitted with a gasket on the outside of enclosure.

2.3 ARMOURED CABLES

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from aluminum strip.
- .4 Connectors: Armoured cable connectors to be approved equal to Thomas & Betts Star Teck or Iberville TEK; suitable for size and type of cable. All connectors and locknuts to be aluminum, watertight and where terminated in a threadless opening shall be fitted with a gasket on the outside of enclosure.

2.4 CONTROL CABLES

- .1 Type LVT: 2 soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of thermoplastic jacket and armour of closely wound aluminum wire.
- .2 Low energy 300 V control cable: stranded annealed copper conductors sized as indicated, with PVC insulation type TW polyethylene insulation with shielding of metalized tapes over each conductor group and over all conductors and overall covering of PVC jackets and interlocked armour of aluminum strip.

2.5 BX CABLES

- .1 BX cables will not be accepted for any use.

Part 3. Execution

3.1 INSTALLATION OF BUILDING WIRES

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 26 05 33 – Raceway and Boxes for Electrical Systems.
 - .2 In cable troughs in accordance with Section 26 05 36 – Cable Trays for Electrical Systems.
 - .3 In underground ducts and trenches where indicated.
 - .4 In wire ways and auxiliary gutters where indicated.

3.2 INSTALLATION OF TECK CABLES 0 -1000 V

- .1 Group cables wherever possible on cable tray.
- .2 Install cable in trenches where indicated.
- .3 Lay cable in cabletroughs in accordance with Section 26 05 36 – Cable Trays for Electrical Systems.
- .4 Terminate cables in accordance with Section 26 05 20- Wire and Box Connectors - 0 - 1000 V.

3.3 INSTALLATION OF ARMOURED CABLES

- .1 Group cables wherever possible.
- .2 Install cable in trenches where indicated.

- .3 Lay cable in cabletroughs in accordance with Section 26 05 36 – Cable Trays for Electrical Systems.
- .4 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

3.4 INSTALLATION OF ALUMINUM SHEATHED CABLE

- .1 Group cables wherever possible on channels.
- .2 Terminate cables in accordance with Section 26 05 20- Wire and Box Connectors - 0-1000 V.

3.5 INSTALLATION OF CONTROL CABLES

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

END OF SECTION

Part 1. General

1.1 RELATED SECTIONS

- .1 Section 26 05 00 – Common Work Results – For Electrical.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA C22.2 No. 18-98(R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
 - .2 CSA C22.2 No. 45-M198(R1999)], Rigid Metal Conduit.
 - .3 CSA C22.2 No. 56-04, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .4 CSA C22.2 No. 83-M1985(R2003), Electrical Metallic Tubing.
 - .5 CSA C22.2 No. 211.2-06, Rigid PVC (Unplasticized) Conduit.
 - .6 CAN/CSA C22.2 No. 227.3-05, Non-metallic Mechanical Protection Tubing (NMPT).

1.3 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data: submit manufacturer's printed product literature, specifications and datasheets.
 - .1 Submit cable manufacturing data.
- .3 Quality assurance submittals:
 - .1 Test reports: submit certified test reports.
 - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Instructions: submit manufacturer's installation instructions.

Part 2. Products

2.1 CABLES AND REELS

- .1 Provide cables on reels or coils.
- .2 Mark or tag each cable and outside of each reel or coil, to indicate cable length, voltage rating, conductor size, and manufacturer's lot number and reel number.
- .3 Each coil or reel of cable to contain only one continuous cable without splices.
- .4 Identify cables for exclusively dc applications.

2.2 CONDUITS

- .1 Rigid metal conduit: to CSA C22.2 No. 45, galvanized steel threaded.
- .2 Epoxy coated conduit: to CSA C22.2 No. 45, with zinc coating and corrosion resistant epoxy finish inside and outside.
- .3 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.
- .4 Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal.

2.3 CONDUIT FASTENINGS

- .1 One hole steel straps to secure surface conduits 50 mm and smaller.
- .2 Two hole steel straps for conduits larger than 50 mm.
- .3 Beam clamps to secure conduits to exposed steel work.
- .4 Channel type supports for two or more conduits at 1.5 m on centre.
- .5 Threaded rods, minimum 6 mm diameter, to support suspended channels.

2.4 CONDUIT FITTINGS

- .1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified.
Coating: same as conduit.
- .2 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.
- .3 Watertight connectors and couplings for EMT.
- .4 Set-screws are not acceptable.

2.5 EXPANSION FITTINGS FOR RIGID CONDUIT

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 mm linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.6 FISH CORD

- .1 Polypropylene

Part 3. Execution

3.1 MANUFACTURER'S INSTRUCTION

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.
- .3 Use electrical metallic tubing (EMT) except where specified otherwise.
- .4 Use rigid PVC conduit underground and in corrosive areas.
- .5 Use flexible metal conduit for connection to recessed incandescent fixtures without prewired outlet box, connection to surface or recessed fixtures and work in movable metal partitions.
- .6 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment and in damp, wet or corrosive locations.
- .7 Minimum conduit size for lighting and power circuits: 19 mm.

- .8 Bend conduit cold.
- .9 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .10 Mechanically bend steel conduit over 19 mm diameter.
- .11 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .12 Install fish cord in empty conduits.
- .13 Run 2-25 mm spare conduits up to ceiling space and 2-25 mm spare conduits down to ceiling space from each flush panel.
- .14 Terminate these conduits in 152 x 152 x 102 mm junction boxes in ceiling space or in case of an exposed concrete slab, terminate each conduit in surface type box.
- .15 Remove and replace blocked conduit sections.
- .16 Do not use liquids to clean out conduits.
- .17 Dry conduits out before installing wire.

3.3 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.
- .4 Group conduits wherever possible on suspended or surface channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

3.4 CONCEALED CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Do not install horizontal runs in masonry walls.
- .3 Do not install conduits in terrazzo or concrete toppings.

3.5 CLEANING

- .1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 00 - Common Work Results – For Electrical.

Part 2 Products

2.1 SUPPORT CHANNELS

- .1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted or suspended.

2.2 THREADED RODS

- .1 Steel, size sized to support load, minimum 6mm.

Part 3 Execution

3.1 INSTALLATION

- .1 Secure equipment to hollow masonry, tile and plaster surfaces with lead anchors or nylon shields.
- .2 Secure equipment to poured concrete with expandable inserts. When securing to Double-T members, insure that drilling for support anchors do not hit any of the pre stressed steel bars in the structure.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.
- .5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .6 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel work.
- .7 Suspended support systems.
 - .1 Support individual cable or conduit runs with minimum 6 mm dia threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by minimum 6 mm dia. threaded rod hangers where direct fastening to building construction is impractical.
- .8 For surface mounting of two or more conduits use channels at 1.5 m on centre spacing.
- .9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .11 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .12 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Consultant.

- .13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

END OF SECTION

Part 1 General

1.1 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data for cabinets in accordance with Section 01 33 00 - Submittal Procedures.

Part 2 Products

2.1 SPLITTERS

- .1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2 Connection bars to match required size and number of incoming and outgoing conductors as indicated.
- .3 At least three spare terminals on each set of lugs in splitters less than 400 A.

2.2 JUNCTION AND PULL BOXES

- .1 Welded steel construction with screw-on flat covers for surface mounting.
- .2 Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes.

2.3 CABINETS

- .1 Type E: sheet steel, hinged door and return flange overlapping sides, handle and catch, for surface mounting.
- .2 Type T: sheet steel cabinet, with hinged door, latch, lock, 2 keys, containing 19 mm G1S plywood backboard for surface or flush mounting as indicated.

Part 3 Execution

3.1 SPLITTER INSTALLATION

- .1 Install splitters and mount plumb, true and square to the building lines.
- .2 Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2 m above finished floor.
- .3 Install terminal block as indicated in Type T cabinets.
- .4 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30 m of conduit run between pull boxes.

3.3 IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results – For Electrical.
- .2 Install size 2 identification labels indicating system name, voltage and phase.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 CSA C22.1-2012, Canadian Electrical Code, Part 1.

Part 2 Products

2.1 OUTLET AND CONDUIT BOXES GENERAL

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm square or larger outlet boxes as required for special devices.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 347 V outlet boxes for 347 V switching devices.
- .6 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 SHEET STEEL OUTLET BOXES

- .1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .2 Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.
- .3 102 mm square or octagonal outlet boxes for lighting fixture outlets.
- .4 102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster walls.

2.3 CONDUIT BOXES

- .1 Cast FS or FD aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacles.

2.4 FITTINGS – GENERAL

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

Part 3 Execution

3.1 INSTALLATION

- .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.

- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation for standard and custom breaker type panelboards.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 06 10 00 - Rough Carpentry.
- .3 Section 26 05 00 - Common Work Results – For Electrical.
- .4 Section 26 28 16.02 - Moulded Case Circuit Breakers.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2No.29-M1989 (R2004), Panelboards and enclosed Panelboards.

1.4 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

Part 2 Products

1.5 PANELBOARDS

- .1 Panelboard type shall be identified by the following designations:
 - .1 DP - Distribution Panelboard (600V), (Square-D type I-Line or equal from Cutler-Hammer, G.E., Siemens)
 - .2 PP - Power Panelboard (250V or 600V), (Square-D type NF or equal from Cutler-Hammer, G.E., Siemens)
 - .3 LP - Lighting Panelboard (250V), (Square D type NQOD or equal from Cutler-Hammer, G.E., Siemens)
- .2 Panelboards: to CSA C22.2No.29 and product of one manufacturer.
 - .1 Install circuit breakers in panelboards before shipment.
 - .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.
- .3 600 V and 250 V panelboards: bus and breakers rated as indicated.
- .4 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.

- .5 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated. Panelboard shall be supplied with a minimum of 20% space for future single pole branch circuit breakers, not required for this project
- .6 Panelboards designated as DP, if not I-Line type; shall have all spare spaces configured as "prepared spaces" including but not limited to having all bus links and standoff hardware installed. Prepared spaces are to have at least one prepared space for 800 amps (or maximum rating of switchboard) two 400 amp and the remainder split between 100 amp and 200 amp frame size.
- .7 Panelboards designated as DP, shall be provided with sufficient wide wireway sections to provide adequate space for all indicated installed cables as well as space for any future cables based on the available spare spaces.
- .8 Two keys for each panelboard and key panelboards alike.
- .9 Copper bus with neutral of same ampere rating as mains.
- .10 Panelboard shall be equipped with an isolated neutral bar, a non-isolated ground bar and where indicated with an isolated ground bar. Panelboard cabinet size is to be increased to accommodate installation of isolated ground bars and facilitate ease of conductor connection to bar.
- .11 Mains: suitable for bolt-on breakers as indicated.
- .12 Enclosures, with hinged door, shall be EEMAC type 1. Surface mounted panelboards to be supplied with sprinkler hoods.
- .13 Trim with concealed front bolts and hinges.
- .14 Trim and door finish: baked grey enamel.

1.6 BREAKERS

- .1 Breakers: to Section 26 28 16.02 - Moulded Case Circuit Breakers.
- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
- .3 Main breaker (where indicated): separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

1.7 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results – For Electrical.
- .2 Nameplate for each panelboard size 4 engraved as indicated.
- .3 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated.
- .4 Complete circuit directory with typewritten legend showing location and load of each circuit.

Part 3 EXECUTION

1.8 INSTALLATION

- .1 Locate panelboards as indicated and mount securely, plumb, and true and square, to adjoining surfaces.

- .2 Install surface mounted panelboards on plywood backboards in accordance with Section 06 10 00 - Rough Carpentry. Where practical, group panelboards on a common backboard.
- .3 Mount panelboards to height specified in Section 26 05 00 - Common Work Results – For Electrical or as indicated.
- .4 Connect loads to circuits. Three phase panelboards to have loads balanced to maintain maximum worst-case variation of 3% between phases. Orient branch breakers as required and record deviations on plans of record.
- .5 Connect neutral conductors to common neutral bus with respective neutral identified.

END OF SECTION

Part 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 26 05 00 - Common Work Results – For Electrical.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CAN/CSA C22.2 No.4-04, Enclosed and Dead Front Switches.

1.4 SUBMITTALS

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

Part 2 PRODUCTS

2.1 DISCONNECT SWITCHES

- .1 Fusible and non-fusible, horsepower rated disconnect switch in CSA, to CAN/CSA C22.2 No.4 size as indicated.
- .2 Enclosures, with hinged door, shall be EEMAC Type 1 indoor with sprinkler hood and EEMAC Type 4 outdoors except as otherwise indicated or as required by codes. Door to incorporate a viewing window to verify contact position prior to opening door.
- .3 Provision for padlocking in on-off switch position by three locks.
- .4 The operating handle shall be right side mounted and incorporate a mechanically interlocked to prevent opening when handle in ON position; complete with defeat mechanism.
- .5 Fuses: size as indicated.
- .6 Fuseholders: suitable, without adaptors, for type and size of fuse indicated.
- .7 Quick-make, quick-break action spring assisted operating mechanisms.
- .8 ON-OFF switch position indication on switch enclosure cover.
- .9 Switches to be approved equal to Federal Pioneer Switchmatic heavy duty and equal products of Cutler Hammer, Square D or Siemens.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results – For Electrical.
- .2 Indicate name of load controlled on size 4 nameplate.

Part 3 EXECUTION

3.1 INSTALLATION

- .1 Install disconnect switches complete with fuses if applicable.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 00 – Common Work Results – For Electrical.
- .2 Section 26 29 03 – Control Devices.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No.14-05, Industrial Control Equipment.
- .2 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA ICS 1-2001, Industrial Control and Systems: General Requirements.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate:
 - .1 Mounting method and dimensions.
 - .2 Starter size and type.
 - .3 Layout of identified internal and front panel components.
 - .4 Enclosure types.
 - .5 Wiring diagram for each type of starter.
 - .6 Interconnection diagrams.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 01 78 20 – Operation and Maintenance manuals.
- .2 Include operation and maintenance data for each type and style of starter.

1.5 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 77 00 - Closeout Procedures.
- .2 Provide listed spare parts for each different size and type of starter:
 - .1 3 contacts, stationary.
 - .2 3 contacts, movable.
 - .3 1 contact, auxiliary.
 - .4 1 control transformer.
 - .5 1 operating coil.
 - .6 2 fuses.
 - .7 10% indicating lamp bulbs used.

Part 2 Products

2.1 MATERIALS

- .1 Starters: EEMAC standard, NEMA rated.

2.2 MANUAL MOTOR STARTERS

- .1 Single or Three phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:
 - .1 Switching mechanism, quick make and break.
 - .2 Overload heater(s), manual reset, and trip indicating handle.
- .2 Accessories:
 - .1 Toggle switch: heavy duty, labelled as indicated.
 - .2 Indicating light: standard type and red colour.
 - .3 Locking tab to permit padlocking in "ON" or "OFF" position.
- .3 Manual motor starters to be approved equal to Allen Bradley Type 600T, Cutler Hammer MST Series, Square D - Class 2510 or Siemens SMF Series.

2.3 FULL VOLTAGE MAGNETIC STARTERS

- .1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Electrically maintained contactor, rapid action type.
 - .2 Solid state overload protective device in each phase, self powered type, compensated for air temperature variations, with phase loss protection to provide tripping within three seconds with two poles energized at 115% of motor FLA, manually resettable from outside of enclosure and provisions for remote reset which can be added in future.
 - .3 Power and control terminal blocks with 10% spare (minimum of 2 spare terminals)
 - .4 Wiring and schematic diagram inside starter enclosure in visible location.
 - .5 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- .2 Combination type starters to include motor circuit interrupter with operating lever on outside of enclosure to control motor circuit interrupter, and provision for:
 - .1 Locking in "OFF" position with up to 3 padlocks.
 - .2 Independent locking of enclosure door.
 - .3 Provision for preventing switching to "ON" position while enclosure door open.
- .3 Accessories:
 - .1 Pushbuttons and Selector switches: heavy duty, oil tight labelled as indicated.
 - .2 Indicating lights: heavy duty, oil tight, push-to-test LED type and color as indicated.

- .3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated. Auxiliary isolated contactor and overload contacts as indicated.
- .4 Full voltage magnetic motor starters to be approved equal to Allen Bradley Bulletin 513, Cutler Hammer EC0N22 Series, Square D Class 8539 or Siemens Type Class 25.

2.4 CONTROL TRANSFORMER

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

2.5 FINISHES

- .1 Apply finishes to enclosure in accordance with Section 26 05 00 - Common Work Results – For Electrical.

2.6 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results – For Electrical.
- .2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.
- .3 Magnetic starter designation label, white plate, black letters, size 1, engraved as indicated.

Part 3 Execution

3.1 INSTALLATION

- .1 Install starters, connect power and control as indicated.
- .2 Ensure correct fuses and overload devices elements installed.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results – For Electrical and manufacturer's instructions.
- .2 Operate switches, contactors to verify correct functioning.

- .3 Perform starting and stopping sequences of contactors and relays.
- .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 00 – Common Work Results – For Electrical.
- .2 Section 26 29 03 – Control Devices.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No.14-05, Industrial Control Equipment.
- .2 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA ICS 1-2001, Industrial Control and Systems: General Requirements.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate:
 - .1 Mounting method and dimensions.
 - .2 Starter size and type.
 - .3 Layout of identified internal and front panel components.
 - .4 Enclosure types.
 - .5 Wiring diagram for each type of VFD.
 - .6 Interconnection diagrams.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 01 78 20 – Operation and Maintenance manuals.
- .2 Include operation and maintenance data for each type and style of starter.

1.5 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 77 00 - Closeout Procedures.
- .2 Provide listed spare parts for each different size and type of starter:
 - .1 3 contacts, stationary.
 - .2 3 contacts, movable.
 - .3 1 contact, auxiliary.
 - .4 1 control transformer.
 - .5 1 operating coil.
 - .6 2 fuses.
 - .7 10% indicating lamp bulbs used.

Part 2 Products

2.1 MATERIALS

- .1 Starters: EEMAC standard, NEMA rated.

2.2 VARIABLE FREQUENCY DRIVE (VFD)

- .1 The VFD shall consist of the following major components, shop assembled and pre-wired:
 - .1 Pushbuttons and Selector switches: heavy duty, oil tight labelled as indicated.
 - .2 Input power disconnect, supplied and installed with a lock-off disconnecting device which is capable of being secured by padlock.
 - .3 Control power transformer, as indicated with fused primary and secondary.
 - .4 Input power fuses, as indicated.
 - .5 Input and output line reactors, as indicated.
 - .6 Phase-to-phase and phase-to-ground MOV protection.
 - .7 Forced air ventilation, for cooling of the VFD components.
 - .8 Input rectifier section to supply fixed DC bus voltage.
 - .9 DC bus capacitors.
 - .10 Sine weighted PWM generating inverter section.
 - .11 Microprocessor to control PWM pulse generation, microprocessor specifically dedicated to PWM pulse generation.
 - .12 Fully digital human-machine interface which will display programming, operation, and fault code diagnostic information. This display to be visible through the enclosure door.
 - .13 Control and interface elements, as indicated.
- .2 Terminals
 - .1 The power terminal blocks shall be located and configured to provide for the field installation of power feeders, as indicated. Suitable termination space shall be provided to properly terminate Teck90 power cables for the supply and load feeders, as indicated. The VFD power terminal blocks to be physically separated from control signal terminal blocks.
- .3 Construction
 - .1 The VFD shall be modularity constructed. Provide printed circuit boards with plug-in connections and easily removable from the drive. Provide power components readily accessible with "fast-on" or screw terminal connections for easy removal. The control printed circuit board to be interchangeable for all comparable HP ranges of VFD.
 - .2 Enclosures to be EEMAC 1 metal enclosed with hinged gasketed door.
- .4 Drive Load
 - .1 The VFD output kW (HP) rating is to be suitable for the load(s) as indicated.

- .2 Unless otherwise noted EEMAC Type B High Efficiency inverter rated AC induction motors will be used to operate variable or constant torque loads over a 40 to 110% speed range reaching rated nameplate horsepower (hp) at 60Hz.
- .5 Input Power
 - .1 VFD to accept nominal supply voltage $\pm 10\%$ 3-phase 60 Hz, grounded power supply and permit variations of up to ± 2 Hz of line frequency without the VFD shutting down on a fault.
 - .2 The VFD is not to exceed the notch depth of 20%, the total harmonic distortion factor (THD) of 5%, total demand distortion of 10%.
 - .3 The VFD shall present a displacement power factor of 0.98 or better to the AC line at any speed or load. Full load power factor shall be 90% or better.
 - .4 Efficiency of VFD controller shall be not less than 97% at 60 hertz output when driving the specified maximum load.
 - .5 The variable frequency controller shall operate satisfactorily when connected to a bus supplying other solid state power conversion equipment which may be causing up to 5% total harmonic voltage distortion.
 - .6 The VFD shall not require input or output isolation transformers.
 - .7 The VFD shall not be sensitive to incoming phase sequence or referenced to earth ground (Wye).
 - .8 The VFD to include transient voltage suppression to allow reliable operation encountered in an industrial/commercial power distribution system for transients up to 3000V, 50 JOULES.
- .6 Output Power
 - .1 The VFD to produce a three phase output for the load.
 - .2 The VFD to be of the Pulse-Width Modulated type and to consist of a full wave diode bridge converter to convert incoming fixed voltage/frequency to a fixed DC voltage. The Pulse Width Modulation strategy shall incorporate a microprocessor to handle all logic functions as well as the complex, sine-coded PWM generating algorithms.
 - .3 Generate the inverter output by IGBT power transistors only.
 - .4 VFD output frequency to be adjustable from 5 to 66 Hz.
 - .5 VFD output voltage to be adjustable from 0 to full voltage reaching full voltage at 60 Hz.
 - .6 VFD to produce a constant volts-per-hertz (V/Hz) ratio in the 60 Hz range and below.
 - .7 VFD to supply a constant full voltage output when operating above 60 Hz.
 - .8 Provide selectable constant V/Hz ratio or configurable V/Hz ratio. Specific V/Hz patterns to be available for both constant torque and variable torque applications.
 - .9 The VFD to have a programmable PWM carrier frequency.
 - .10 The VFD to be capable of operating with output open circuited with no fault or damage for startup and testing purposes.
- .7 Electrical Noise and Generated Heat

- .1 Manufacturer to indicate, at time of tender, the anticipated levels of electrical audible noise and heat generated. These levels to be warranted and supported by actual test data.
- .2 Audible noise levels to be less than 85 dbA at 1 m out from any point on the VFD cabinet under normal operating condition.
- .3 Electrical noise, (radio interference and AC line harmonics) limited to levels specified in the latest edition of IEEE 519 and per Class A of the Radiocommunication Act of Canada. Equipment to be so designed that use of radio communication equipment adjacent to VFD units is possible. In addition, the adjustable speed equipment not to be susceptible to interference from radio equipment operated adjacent to it. Harmonics generated by the adjustable speed equipment are to be indicated by the manufacturer at the time of tender and shall be guaranteed not to exceed the levels of distortion for voltage and current based on IEEE 519 latest edition.
- .4 The short circuit current at point of common coupling under utility operation is shown on the single-line diagram drawings. A preliminary harmonic analysis must be submitted by the manufacturer at time of tender in accordance with IEEE 519, latest edition. Compliance to be verified by the VFD manufacturer with field measurements of the harmonic distortion difference at the point of common coupling with and without VFD's operating.
- .8 VFD Protective Features
 - .1 The VFD to shut down and annunciate all faults including:
 - .2 Over current, short circuit or ground fault
 - .3 Over and under voltage
 - .4 Controller high temperature
 - .5 External function loss
 - .6 Electronic thermal overload
- .9 Drive Setup and Control Structure
 - .1 All VFD set-up operations and adjustments to be digital and stored in a nonvolatile memory (EEPROM). No analog or potentiometer adjustments to be allowed.
 - .2 VFD operation to be fully digital with microprocessor control of frequency, voltage and current.
 - .3 Provide a local digital interface to upload, download and read drive parameter settings through the use of a personal computer or a similar portable device.
NOTE: Provide software and interconnection cable for personal computer use to upload and download parameters.
 - .4 The VFD to be capable of communicating with a communication adapter module over a serial link, multi-drop, Modbus Plus protocol providing a means to:
 - .5 Access all drive programmable configuration and control parameters
 - .6 Access all drive motor meter readings, alarm and trip values, set points, and reset, etc.
 - .7 Access all protection and diagnostic fault annunciation

- .8 Provide the following system configuring settings, field adjustable through the human-machine interface keypad/display unit or via the digital interface serial communication port.
- .9 Controller adjustments:
 - .1 Hz min, Hz max.
 - .2 V min, V max, V/Hz.
 - .3 Acceleration time.
 - .4 Deceleration time.
 - .5 Coast or ramp to stop
 - .6 Output current 50 - 150% of nominal current for constant torque. Output current 50 - 125% for variable torque application minimum.
- .10 Provide one (1) analog input for external speed reference which is capable of operating from 0-20 mA.
- .11 Provide one (1) analog output which can be programmed to be proportional to any of the following:
 - .1 Output frequency
 - .2 Output current
 - .3 Motor voltage
- .12 Provide 1 programmable discrete output contact to indicate:
 - .1 Run
 - .2 Ready
 - .3 Fault
- .13 Selectable stopping modes of coast or ramp to stop shall be available.
- .14 Provide minimum of two adjustable skip frequencies with programmable band width.
- .15 Provide remote automatic Reset/Restart after any individual trip condition.
- .16 Use twisted shielded pairs for control and signal wiring that connects external to the VFD. Separate signal and power wiring that may contain voltage and/or current harmonics inherent to inverter.
- .10 **Local Control** - Digital Human-Machine Interface (HMI) Operator Station
 - .1 The HMI shall provide the following control features as a minimum:
 - .1 START pushbutton for local control
 - .2 STOP pushbutton for local control
 - .3 Local speed adjustment.
 - .4 Digital frequency display.
 - .2 The digital operator station to be capable of being mounted on the drive and/or on the drive panel (i.e. MCC cubicle door) face.
 - .3 Manual/Off/Automatic or Local/Remote Selector switch or pushbuttons, as indicated.
- .11 **Remote Control** - via Programmable Logic Controller (PLC) or Digital Control System (DCS)

- .1 Provide control transformer, fuses with six (6) spare of each size and type., terminal blocks and control relay(s) interconnected in accordance with the project requirements.
- .2 The VFD to accept isolated discrete output signals from a PLC/DCS to stop and start the drive.
- .3 The VFD to accept isolated analog input speed 4-20 mA signals from a PLC/DCS to provide speed reference speed. The 4-20 mA analog input speed reference signal to be galvanically isolated. Calibration adjustments shall be provided within the speed ranges specified.
- .4 The drive to be configured to achieve the following functionality:
 - .1 Drive selected to "Manual" ("Local") enables motor to be started, stopped with speed adjusted via the front panel (HMI) pushbuttons.
 - .2 Drive selected to "Auto" ("Remote") enables motor to be started, stopped with speed adjusted via PLC/DCS analog output.
 - .3 (AND)
 - .4 Drive selected to "Auto" ("Remote") enables motor to be started, stopped with speed adjusted via communication adapter module over a serial link, Modbus Plus protocol.
- .5 The VFD to have capability to interface to control interlocks as indicated.
- .12 Motor Overload Protection
 - .1 Provide the VFD with a separate solid state motor overload protection as indicated.
 - .2 The overload protection to be adjustable from 80 to 115% of the full load current rating.
 - .3 The overload to provide the protection required by the CEC for motor overload protection and to be tested in accordance with CSA.
- .13 Input Line Reactor
 - .1 Input and output line reactors to be approved to UL506, rated 600 VAC, iron core, copper winding with epoxy resin, temperature rise of 115 deg. C, Class H insulation, a 5% impedance, and harmonic compensated to carry full rated fundamental current plus 50% additional harmonic current continuously.
- .14 Motor Filter
 - .1 Output line dV/dt filters to be provided, if necessary, so as to limit the peak voltage at the motor terminals to less than 900 Volts with a maximum voltage rise of less than 300 volts per micro-second. The selection of load side filtering is to be co-ordinated with selection of the pump motor.
- .15 APPROVED MANUFACTURER
 - .1 Adjustable speed drives to be approved equal to Allen Bradley 1336 Plus and equivalent products manufactured by ABB, Schneider, Toshiba, and Westinghouse-TECO.

2.3 LINE FILTERING

- .1 A line filter shall be supplied and installed to the line side of the adjustable frequency drives, as indicated and shall perform to one of the following:
 - .1 Filter characteristics shall be required to reduce the harmonic currents, as measured at the utility point of service, to below the limits established by SaskPower's condition of service regulations. The Contractor shall submit design calculations, with the equipment shop drawings, for review by the Consultant to verify the performance of the filter and adjustable frequency drive operating as a unit will be within SaskPower's limits.
 - .2 Filter characteristics shall be required to reduce the harmonic currents, as measured at the point of connection at the MCC, to below the limits established by IEEE 519. The normal source power supply is a single power transformer as indicated with impedance of 5%. Fault level on the primary of the transformer is approximately 150 MVA. The Contractor shall submit design calculations, with the equipment shop drawings, for review by the Consultant to verify the performance of the filter or reactors and adjustable frequency drives operating as a unit will be within IEEE 519 limits.
- .2 If required to be external, the filter enclosure shall be EEMAC 1 with sprinkler hoods.

2.4 CONTROL TRANSFORMER

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

2.5 FINISHES

- .1 Apply finishes to enclosure in accordance with Section 26 05 00 - Common Work Results – For Electrical.

2.6 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results – For Electrical.
- .2 Variable frequency drive label, white plate, black letters, size 1, engraved as indicated.

Part 3 Execution

3.1 INSTALLATION

- .1 Install VFDs, connect power and control as indicated.
- .2 Ensure correct fuses and protection devices elements installed.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results – For Electrical and manufacturer's instructions.
- .2 Operate switches, VFDs to verify correct functioning.
- .3 Perform starting and stopping sequences of contactors and relays.
- .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute (ANSI)
 - .1 ANSI C82.16-2015, American National Standard for Light-Emitting Diode Drivers—Methods of Measurement
- .2 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
 - .1 ANSI/IEEE C62.41-1991, Surge Voltages in Low-Voltage AC Power Circuits.
- .3 American Society for Testing and Materials (ASTM)
 - .1 ASTM F1137-88 (1993), Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
- .4 United States of America, Federal Communications Commission (FCC)
 - .1 FCC (CFR47) EM and RF Interference Suppression.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 45 00 - Quality Control.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by Engineer.
- .3 Photometric data to include: spacing criterion.

Part 2 Products

2.1 LAMPS

- .1 LED lamps shall be as scheduled or approved equal.

2.2 BALLASTS

- .1 LED ballast: Coordinate with luminaries & lamp supplier.
 - .1 Rating: Voltage as scheduled, 60 Hz, for use with LED lamp - wattage as indicated
 - .2 Totally encased and designed for 40 °C ambient temperature.
 - .3 Power factor: high.
 - .4 Type: electronic.
 - .5 Input voltage range: plus or minus 10% of nominal.
 - .6 Minimum starting temperature: minus 40 °C at 90% line voltage.

- .7 Mounting: integral with luminaires.
- .8 0 – 10 V dimming control where indicated.

2.3 LUMINAIRES

- .1 Refer to the luminaire schedule on Drawings for luminaire descriptions. Where two or more luminaires are specified similar except for voltage, wattage, configuration or other operating characteristics, they shall be the same manufacturer and model to maintain continuity of appearance.

Part 3 Execution

3.1 INSTALLATION

- .1 Locate and install luminaires as indicated.

3.2 WIRING

- .1 Connect luminaires to lighting circuits:

3.3 LUMINAIRE SUPPORTS

- .1 For suspended ceiling installations support luminaires from ceiling grid in accordance with local inspection requirements.

3.4 LUMINAIRE ALIGNMENT

- .1 Align luminaires mounted in continuous rows to form straight uninterrupted line.
- .2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

END OF SECTION