SECTION 16010
BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. Requirements specified within this section apply to all sections in Division 16, Electrical. Work specified herein shall be performed as if specified in the individual sections.

1.02 SUMMARY

A. Comply with Division 1, General Requirements

1. The NEWPCC facility is a major wastewater treatment plant with limitations and restrictions to access and service disruptions. Work within this Division must be planned and coordinated as further described in Division 1, Section 01040.

B. Electrical Drawings indicate general location and route to be followed by conduits and cables and electrical equipment arrangements. They do not show all structural, architectural and mechanical details. In some cases, conduit or wiring is only shown diagrammatically on Drawings and may not detail exact or complete wiring or raceway requirements.

C. To provide sufficient detail and maximum degree of clarity on Drawings, symbols used for various electrical devices, particularly wall mounted devices, take up more space on Drawings than devices physically do. Locate devices with primary regard for convenience of operation and space utilization, rather than stringing devices out so as to comply with scaled locations of electrical symbols.

1.03 REFERENCES

A. CSA C22.2 No. 0 General Requirements - Canadian Electrical Code - Part 2

B. CAN3-C235 Preferred Voltage Levels for AC Systems, 0-50,000 V

C. Electrical and Electronic Manufacturers Association of Canada (EEMAC)

D. National Electrical Manufacturers Association (NEMA)

E. Institute of the Electrical and Electronic Engineers (IEEE)

F. Insulated Cable Engineers Association (ICEA)

G. Canadian Standards Association (CSA)

H. Canadian Gas Association (CGA)

I. Underwriters Laboratories Canada (ULC)

J. American National Standards Institute (ANSI)

K. National Fire Protection Agency (NFPA)

1.04 DEFINITIONS

A. The following are definitions used in Division 16. Refer also to Division 1.

1. Inspection Authority means agent of any authority having jurisdiction over construction and safety standards associated with any part of electrical site work.
2. Electrical Code or Code means Provincial Electrical Code in force at project location.
3. CEC means latest edition of the Canadian Electrical Code.

1.05 DESIGN REQUIREMENTS

A. Operating voltages to be within those defined in CAN3-C235.

B. Verify before energization that equipment supplied under this contract or by Owner is compatible with related electrical power supply system.

1.06 SUBMITTALS

A. Action Submittals: Permits, Inspections, Test Reports, Certificates and Fees

1. Submit to Engineer necessary interim and final certificates of inspection and approval required by Inspection Authorities having jurisdiction over work, as evidence that work installed complies with laws and regulations of governing authorities.
2. Submit copies of plans and specifications required by Inspection and Supply Authorities.
3. Notify Inspection Authorities in sufficient time to inspect work.
4. Submit Inspection Authorities approval certificates.
5. Submit installation and energization certificates from manufacturers of motor control centres.
6. Submit electrical equipment or system warranty certificates.
7. Pay associated fees and costs.

PART 2 PRODUCTS

2.01 ACCEPTED MATERIALS

A. Materials: Approved by CSA or independent agency accepted by Inspection Authorities for use as installed. Where equipment or material is not approved or certified as indicated, obtain and pay for special acceptance from Inspection Authorities or independent agency accepted by Inspection Authorities.

B. Standards: Unless otherwise indicated, manufacture to standards of North American Standards Agencies.

2.02 EQUIPMENT FINISH:

A. Unless otherwise indicated, prepare, shop prime and factory finish electrical equipment, colour ANSI/ASA 61 grey. All shall be epoxy printed for maximum corrosion resistance.

PART 3 EXECUTION

3.01 PREPARATION AND PROTECTION

A. Schedule expediting of materials and execution of work in conjunction with associated work of other trades.

B. Post engraved warning signs to meet requirements of Inspection Authorities and Engineer.

C. Protect those working on or in vicinity of exposed electrically energized equipment from physical danger. Shield and mark live parts "LIVE - ___ VOLTS". Indicate the appropriate voltage.

D. Arrange for installation of temporary doors, barriers and similar items for access to rooms and areas containing electrical equipment. Keep these doors locked at all times, except when under direct supervision.

E. Permanently identify equipment energized from multiple power sources, noting voltages, power source locations, supply disconnect designations and grounding electrode location.

3.02 TESTS

A. Test and check electrical systems for correct operation and compliance with statutory and regulatory authority requirements.

B. Perform tests in presence of Engineer. Log, tabulate, sign and include test results in Maintenance Data and Operating Instructions.

C. Test the following systems:

1. 600 V distribution systems, including cabling for correct phasing, voltage, grounding and load balancing.
2. Circuits originating from branch distribution panels.
3. Lighting and associated control.
4. Motors, heaters and associated control equipment including sequenced operation of systems where applicable.

D. Refer to appropriate Sections for specific system or equipment tests.

E. Supply instruments, meters, consumable parts (such as fuses) and equipment. Arrange for qualified personnel to conduct tests.

F. In cooperation with mechanical trades, take clamp-on ammeter readings with motors operating at full load. Log, tabulate and include readings in Maintenance Data and Operating Instructions.

G. Check electrical system voltages after facility has been in operation for sixty days. Adjust transformer tap settings as required. Tabulate, make adjustments and record data in Maintenance and Operating Instruction Manuals.

3.03 CHECKOUT AND STARTUP

A. Voltage Field Test:

1. Check voltage amplitude and balance between phases for loaded and unloaded conditions.

B. Equipment Line Current Tests:

1. Check line current in each phase for each piece of equipment.
2. If any phase current for any piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

C. Grounding and Bonding:

1. Check grounding and bonding to conform to Code requirements.

3.04 TOUCH-UP PAINTING

A. Field touch-up shop painted electrical equipment.

B. Obtain necessary touch-up paint of original type and quality from equipment manufacturer.

C. Clean surfaces to be painted. Feather out edges of scratch marks. Make patch inconspicuous.

D. Apply one or more coats until damaged surface has been restored to original finish condition.

E. Do not paint nameplates, tags, warning plates and operating instructions. Observe field painting of electrical equipment or raceways.

3.05 SUPPORTS AND HANGERS

A. Provide supports, hangers, plates and hardware required for electrical and instrumentation equipment.

B. Hot dip galvanize prefabricated steel supports, such as channels, struts, brackets, hangers, slotted angles and similar items. Bolt or clamp these supports. Do not field weld. Repaint cut sections with zinc rich galvanizing primer.

C. Bond metallic supports to grounding electrode. Do not use metallic supports as ground conductors for electrical equipment.

D. Provide non-corroding, 6 mm minimum, nylon or lead spacers for fastening enclosures to masonry walls.

E. Provide expansion anchors, type HKD by Hilti (Canada) Ltd. or Redhead Multi-Set II by Phillips and machine screws or threaded rods and nuts for supporting hangers or straps.

F. Provide UCAN or TAPCON fasteners, or KWIK-CON II anchors by Hilti (Canada) Ltd. for attaching conduit straps, conduit fittings, boxes, control stations, and similar items to concrete.

G. Do not use power-actuated tools.

3.06 CUTTING AND PATCHING

A. Bear costs for cutting and patching.

3.07 CLEANING

A. Clean construction debris and materials from enclosures, before final electrical tests.

B. Clean luminaire reflectors, lenses and other surfaces exposed to construction dust and dirt.

3.08 CORING AND CUTTING

A. Verify by xray any areas where coring to ensure no contact in electrical and/or piping supplies.

END OF SECTION

SECTION 16050
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 REFERENCES

A. CSA C22.2 No. 0 General Requirements – Canadian Electrical Code – Part 2.

B. CAN3-C235 Preferred Voltage Levels for AC Systems, 0-50,000 V.

C. Electrical and Electronic Manufacturers Association of Canada (EEMAC).

D. National Electrical Manufacturers Association (NEMA).

E. Institute of the Electrical and Electronic Engineers (IEEE).

F. Insulated Cable Engineers Association (ICEA).

G. Canadian Standards Association (CSA).

H. Canadian Gas Association (CGA).

I. Underwriters Laboratories Canada (ULC).

J. American National Standards Institute (ANSI).

K. National Fire Protection Agency (NFPA).

L. Comply with the latest editions of CSA C22.1 Canadian Electrical Code – Part 1, Provincial Electrical Authority Safety Codes and Bulletins, and local codes and requirements which govern the installation. Where these regulations conflict, comply with the most stringent condition.

M. Comply with latest editions of the CSA Certification Standards and Bulletins.

1.02 DEFINITIONS

A. The following are definitions used in Division 16.

1. Inspection Authority means agent of any authority having jurisdiction over construction and safety standards associated with any part of electrical site work.
2. Electrical Code or Code means Provincial Electrical Code in force at project location.
3. CEC means latest edition of the Canadian Electrical Code.

1.03 DESIGN REQUIREMENTS

A. Operating voltages to be within those defined in CAN3-C235.

B. Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz, within normal operating limits established by CAN3-C235. Equipment must be able to operate in extreme operating conditions established by CAN3-C235, without damage.

C. Verify before energization that equipment supplied under this contract is compatible with related electrical power supply system.

1.04 SUBMITTALS

A. Shop Drawings:

1. Device boxes for use in hazardous areas.
2. Junction and pull boxes used at or belowgrade.
3. Wiring devices.
4. Transformers.

B. Information Submittals: Test Report: Sound test certification for dry type power transformers (0 to 600-volt, primary).

1.05 QUALITY ASSURANCE

A. CSA Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to CSA Standards and have an applied CSA.

B. Hazardous Areas: Materials and devices shall be specifically approved for hazardous areas of the class, division, and group shown and of a construction that will ensure safe performance when properly used and maintained.

PART 2 PRODUCTS

2.01 NONFUSED SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

B. Enclosure: NEMA 250, Type as indicated in Part 3 of this Specification unless otherwise shown.

C. Interlock: Enclosure and switch to prevent opening cover with switch in the ON position.

D. Auxiliary contact (opens before main blades open, and closes sfter main blades closed) for remote interlocks.

2.02 DRY TYPE TRANSFORMER (0- TO 600-VOLT PRIMARY)

A. Windings: Copper, delta connected primary, wye connected secondary with neutral grounding provision.

B. Insulation Class and Temperature Rise: 185°C minimum with maximum 80°C temperature rise in 40 degrees C ambient.

C. Core and Coil:

1. Encapsulated for single-phase units 1/2 to 25 kVA and for three-phase units 3 to 15 kVA.
2. Thermosetting varnish impregnated for single-phase units 37.5 kVA and above, and for three-phase units 30 kVA and above.

D. Units larger than 5 kVA suitable for use with 75 degrees C wire at full 75 degrees C ampacity.

E. Enclosure:

1. Single-Phase, 3 to 25 kVA: EEMAC/NEMA 250, Type 3R, nonventilated.
2. Single-Phase, 37-1/2 kVA and Above: EEMAC/NEMA 250, Type 2, ventilated.
3. Three-Phase, 3 to 15 kVA: EEMAC/NEMA 250, Type 3R, nonventilated.
4. Three-Phase, 30 kVA and Above: EEMAC/NEMA 250, Type 2, ventilated.
5. Outdoor Transformers: EEMAC/NEMA 250, Type 3R.

F. Wall Bracket: For single-phase units, 15 to 37-1/2 kVA, and for three-phase units, 15 to 30 kVA.

G. Voltage Taps:

1. Single-Phase, 3 to 10 kVA: Two 5 percent, full capacity, below normal voltage rating.
2. Single-Phase, 15 kVA and Above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
3. Three-Phase, 3 to 15 kVA: Two 5 percent, full capacity, below normal voltage rating.
4. Three-Phase, 30 kVA and Above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.

H. Impedance: 4.5 percent minimum on units 75 kVA and larger.

I. Maximum Sound Level::

1. 40 decibels for 0 to 9 kVA.
2. 45 decibels for 10 to 50 kVA.
3. 50 decibels for 51 to 150 kVA.
4. 55 decibels for 151 to 300 kVA.
5. 60 decibels for 301 to 500 kVA.

J. Vibration Isolators:

1. Rated for transformer's weight.
2. Isolation Efficiency: 99 percent, at fundamental frequency of sound emitted by transformer.
3. Less Than 30 kVA: Isolate entire unit from structure with external vibration isolators.
4. 30 kVA and Above: Isolate core and coil assembly from transformer enclosure with integral vibration isolator.

K. Manufacturers:

1. Hammond Manufacturing Co. Ltd.
2. ABB Canada.
3. MagneTek Polygon Transformer Co.
4. Square 'D' Canada.
5. Marcus Transformer of Canada Ltd.
6. Rex Manufacturing.
7. Delta Transformer of Canada Ltd.

2.03 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment Screws: Stainless steel.

C. Color: Black, engraved to a white core.

PART 3 EXECUTION

3.01 GENERAL

A. Install equipment in accordance with manufacturer's recommendations.

B. Use appropriate conduit and conductor entry fittings with enclosures to maintain the specified enclosure environmental capability after installation.

C. All conduit and raceway system components to be exposed, surface mounted.

3.02 NONFUSED SWITCH ENCLOSURES

A. Location/Type:

1. Hazardous Gas: EEMAC/NEMA 250, Type 7.
2. Hazardous Dust: EEMAC/NEMA 250, Type 9.
3. Wet: EEMAC/NEMA 250, Type 4.
4. Corrosive: EEMAC/NEMA 250, Type 4X.
5. Wet/Corrosive: EEMAC/NEMA 250, Type 4X.
6. Industrial Use: EEMAC/NEMA 250, Type 12.
7. General Purpose: EEMAC/NEMA 250, Type 1.
8. Where Denoted WP: EEMAC/NEMA 250, Type 3R.

3.03 DRY TYPE TRANSFORMER (0- TO 600-VOLT PRIMARY)

A. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.

B. Provide moisture-proof, flexible conduit for electrical connections.

C. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.

D. Provide wall brackets for single-phase units, 15 to 167-1/2 kVA, and three-phase units, 15 to 112 kVA.

E. Isolation Transformer: Ground isolation shields to unit enclosure with conductor of same material, and same size minimum, as shield ground lead provided with unit.

a. channel, except where mounted on aluminum handrail, then use aluminum framing channel.
b. Aluminum Raceway and Other Systems Not Covered: Aluminum framing channel.

END OF SECTION

SECTION 16321
DRY TYPE POWER TRANSFORMER

PART 1 GENERAL

1.01 SUMMARY

A. Comply with Division 1 - General Requirements and Section 16010 - Basic Electrical Requirements.

1.02 REFERENCES

A. CSA C9 Dry Type Transformers.

B. CSA C9.1 Guide for Loading Dry Type Distribution and Power Transformers.

C. CSA C22.2 No. 47 Air Cooled Transformers (Dry-Type).

D. ANSI Standard C89.2 Dry Type Transformers for General Applications.

E. Applicable sections of ANSI Standard C57.

1.03 SUBMITTALS

A. Submit completed Vendor's Data Sheet with Bid (Tender).

B. Submit the following shop drawings and data for each transformer:

1. Data sheet.
2. Base plan, outline and assembly arrangement drawings.
3. Lifting, jacking, hauling, rolling and skidding data.
4. Required services and connection points.
5. Core and coil assembly drawings.
6. Schematic and wiring diagrams.
7. Nameplate, connection and voltage phasor diagrams.
8. Centres of gravity.
9. Details of ancillary devices.

C. Prior to delivery, submit Operating and Maintenance Manuals, including, but not limited to the following:

1. Installation, operation and maintenance instructions.
2. Parts list with details of local service and supply organizations.
3. Certified final test results.
4. Final record drawings.
5. Final data sheets.

1.04 QUALITY ASSURANCE

A. Subject transformer to production tests as specified by CSA C9. Perform additional tests as indicated on data sheets.

B. Prior to shipment, submit four copies of certified test results.

C. Submit results of type tests as specified by CSA C9 where available. If unavailable, subject the transformer to type tests required by CSA C9.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

1. Cutler Hammer
2. Hammond Manufacturing
3. ABB
4. Delta/Polygon
5. Schneider Electric

2.02 MANUFACTURED UNITS

A. Transformer Characteristics

1. Refer to Dry Type Transformer Performance Data Sheets for details.
2. Comply with standards listed under 1.2, Reference.
3. Provide “low loss design” (loss evaluation).

B. Enclosures

1. Enclosure: 2.7 mm minimum steel sheet, rigid, vibration free housing.
2. Access: Bolted removable panels for access to tap connections, enclosed terminals for power and control circuits, ground bus, fans, controls, lightning arresters and other accessories.
3. Mounting: Floor mounting, with floor channels and fixing hardware.
4. Exposed metal parts: Temperature rise 65°C maximum.
5. Lifting means: On enclosure and on transformer core/coil assembly.
6. Ground bus: Tin plated copper running full length of enclosure, with connection pads on both ends and ground strap for grounding transformer core.

C. Windings

1. Power connections and taps: Locate at front of core and coil assembly.
2. Winding material: Copper, uniformly insulated.
3. Tap changer: Lockable, with visible position indicator.

D. Termination Facilities

1. Primary and secondary termination fittings: To carry maximum full load current, including allowance for future fan cooled ratings and overload capabilities.
2. Termination hardware: Bolts, plates, flexible straps, lugs, bus and other material necessary for termination.
3. Cable connections: Sufficient space for cable entry and installation of stress relief cones and termination fittings.
4. Cable supports: Suitably sized.
5. Transformer close-coupled to the low voltage motor control center via bus transition section. Transition section to be complete with bus bars. Co-ordinate with low voltage motor control center manufacturer/supplier.

E. Current Transformers

1. Phase current transformers: Accuracy class and capacity adequate for application and connected burden.
2. Neutral bus current transformer: Multi-ratio, for ground over-current relaying, relaying accuracy for burden of relays indicated.

F. Cooling and Temperature Monitoring

1. Air natural self-contained cooling system.
2. Temperature detection: Winding temperature detectors in each windings.
3. Visible indicators, face mounted on control panel:
    a. Power On - green
    b. High temperature alarm - red
    c. Button to cancel alarm signals except high temperature indicator which will remain on until winding temperature returns to normal.
    d. Digital readout indicator.
    e. Scan button to read individual winding temperatures.
4. Interconnecting wiring: From control cabinet to the temperature detectors.
5. Remote annunciation : 2 Form C, 120 V AC, 10 A contacts minimum; temperature switch operating on high temperature, with dial-type indicator

G. Control Panel

1. Control panel: Locate in front face of transformer enclosure.
2. Wiring: 600 volt, 14 AWG minimum, stranded, copper with heat, moisture and flame resistant cross-linked polyethylene insulation. CT wiring: #10AWG minimum.
3. Identification: Wieland Type Z wire markers at both ends of wire and terminal blocks marked with associated wiring designations.

4. Terminal blocks: Modular, rated 25 A minimum, 600 V, with barriers separating voltage levels.
5. Current transformer terminal blocks: Distinctly coloured, separate, with automatic shorting provisions.
6. Control panel door: Hinged, provision for padlocking.
7. Ancillary power supply: As indicated on the data sheets. Derive all other voltages from transformers with fused primary and secondary windings.
8. Circuit Protection: Individual, with suitably rated moulded case circuit breaker.
9. Ground bus: Tin plated copper, 6.35 mm by 50 mm (minimum).
10. Cutler Hammer type MVS or equal..

H. Surface Preparation and Coatings

1. Finish: Prime and finish paint transformer and appurtenances to manufacturer's standard specifications, suitable for service indicated.
2. Enclosure interior surface finish: One prime and one finish coat minimum, matte white paint.
3. Exterior surface finish: One coat prime and two coats minimum of finish enamel.
4. Touch-up paint: One litre of original paint material from transformer manufacturer.

I. Nameplates and Warning Signs

1. Warning signs: Engraved lamacoid with 13 mm white letters on red background for fixing to high voltage and low voltage access panels. Indicate switching device to be opened to de-energize transformer.
2. Nameplate: Non-corroding, with details as specified by CSA C9.
3. Fixing hardware: Non-corroding screws or rivets.

J. Noise Suppression

1. Anti-vibration pads: Factory installed, neoprene, mounted between core/coil assembly and bottom support members in enclosure to eliminate 95% minimum sound transmission.
2. Stiffening members: On enclosure panels to eliminate diaphragm noise amplification.
3. Sound level: To CSA C9 standards minimum.

K. Two-Position Air Interrupter Primary Switch.

1. Open/close, three-pole, quick-make, quick-break, gang operated. In accordance with ANSI C37.20.3
2. Operating handle: External, with locking provisions and position indicator.

3. Load break, non-fused, rated for 5 kV, 600 amperes continuous, 600 ampere interrupting 60 kV BIL.
4. Momentary and fault close rating of 40,000 amperes.
5. Mechanically interlocked to prevent opening access door while switch is closed.
6. Full height, freestanding, with visual inspection window and flanges for close coupling to transformer.
7. Ground Bus:
8. Tin-plated copper,

PART 3 EXECUTION

3.01 INSTALLATION

A. Set and secure enclosure and transformer in place, rigid, plumb and square.

B. Make connections as indicated.

C. Connect transformer ground bus to system ground.

D. Make external wiring connections (power, control, alarm, instrumentation) to plant systems as required.

3.02 INSPECTION AND TESTING

A. Check factory made connections for mechanical security and electrical continuity.

B. Energize transformer and measure no load voltage.

C. Adjust primary taps as necessary to produce rated secondary voltage at no load.

D. When transformers are connected in parallel or to tie circuit buses, check phase and polarity relationships before energization.

E. Verify operation of indicating, operator and protective devices in accordance with manufacturer's recommendations.

F. Check operating temperature and adjust cooling fan controls.

PART 4 DATA SHEETS

4.01 SHEET #1

EQUIPMENT NUMBER(S) T6, T7		**SERVICE DESCRIPTION:**	
DESCRIPTION	**REQ'D**	**DESCRIPTION**	**REQ'D**
SITE CONDITIONS		COOLING	
Location: [**I**ndoor/**O**utdoor]	**I**	Cooling Type Designation [ANN, ANF, FFA]	**ANN**
Ambient Design Temperature: (maximum)	**40°C**	Cooling Fan Controls	**No**
Elevation: above sea-level		Temperature Rise, average at rated kVA,	**80°C**
Special Conditions:			**C**
DESIGN CONDITIONS		WINDINGS	
Rating	**300 KVA**	Winding Type: [**O**pen, **V**PI Epoxy, **E**ncapsulated, **C**ast]	**C**
No. of Phases	**3**	Winding Temperature Class: [**150/185/220**]	**150°C**
Frequency:	**60 Hz**		
Primary Configuration [**D**elta, **W**ye]	**D**		
Secondary Configuration [**D**elta, **W**ye]	**W**		
Primary BIL	**30 KV**	PRIMARY CONNECTIONS	
		Entry: [**T**op/**B**ottom]	**T**
Neutral Grounding Method [**S**olid, **L**ow Res., **H**igh Res.]	**S**	Type: [**C**over mounted bushings/**T**hroat and **T**ransition **S**ection/**B**us **D**uct/**C**able **D**uct/**T**erminal **B**ox]]	**TTS**
Impendance, % of Base kVA	**5.5 %**		
		Close coupled to switchgear [for Unit Sub] [**Y**es/**N**o]	**Y**
		Primary Disconnect Switch [**Y**es/**N**o]	**Y**
TAPS			
Type: [**On** Load/**Off** Load]	**OFF**		
Number, 2 1/2% FCAN	**2**		
Number, 2 1/2% FCBN	**2**		
REMARKS:			

EQUIPMENT NUMBER(S) T6, T7		**SERVICE DESCRIPTION:**	
DESCRIPTION	**REQ'D**	**DESCRIPTION**	**REQ'D**
		TESTS	
		Standard Production Tests	**Yes**
		Temperature Rise Test	**Yes**
		Sound Level Test	**Yes**
		Radio Influence Voltage Test	**Yes**
		BIL Test	**Yes**
		Partial Discharge Test	**Yes**
LIGHTNING ARRESTERS			
Voltage Class	**3 kV**		
Class Type: [Station/Intermediate/Distribution]	**D**	FINISH	
Location [**P**rimary, **S**econdary, **B**oth Windings]	**P**	Colour:	**ASA 61**
ACCESSORIES			
CSA C9 Standard Accessories			
Primary Bus Current Transformers			
Secondary Phase Bus Current Transformers			
Neutral Bus Current Transformers			
Winding Temperature Monitoring and Control	**Yes**		
Winding Temperature Detector: [**T**hermistors/**R**TD]	**R**		
ENCLOSURE			
Enclosure Type:	**1**		
Anti-Condensation Heaters c/w Thermostat Control			
120 V, 100 W Lamp			
Duplex 120 V, 15A, U Ground Receptacle			
Auxiliary Supply: Voltage	**V**		
Number of Phases			
Frequency	**Hz**		

REMARKS:

PART 5 VENDOR'S DATA SHEETS

5.01 SHEET #1

	DESCRIPTION OF DATA REQUIRED	UNIT	ITEM NO.:	ITEM NO.:
	PHYSICAL DATA			
	Overall height	mm		
	Overall length	mm		
	Overall width	mm		
	Core/Coil height	mm		
	Core/Coil length	mm		
	Core/Coil width	mm		
	Weight, Core and Coils	kg		
	Enclosure and Fittings	kg		
	Total	kg		
	Insulation Class	-		
	Voltage taps (No., % step, type)	-		
	Primary/secondary winding arrangement	-		
	Vibration isolator type	-		
	Insulation Type	-		
	TECHNICAL DATA			
	Cooling Designation (ANN, ANF, etc.)	-		
	Temperature rise at service condition	°C		
	Transformer impedance at base rating	%		
	Transformer ratings at service condition	kVA		
	No load loss	kW		
	Load Loss @ 25/50/75/100/110% of Full Load	kW		
	Basic impulse level - primary winding	kV		
	Basic impulse level - secondary winding	kV		
	Primary Voltage	kV		
	Secondary Voltage	kV		
	Regulation @1.0/0.8 PF	%		
	Efficiency @125/100/75/50/25 %	%		
	Sound level - base kVA/max. kVA	dBa		
	Windings Phase Displacement	-		
	Temperature Detector Type	-		

REMARKS:

5.02 SHEET #2

	DESCRIPTION OF DATA REQUIRED	UNIT	ITEM NO.:	ITEM NO.:
	CURRENT TRANSFORMERS			
	Manufacturer's Name	-		
	Primary Current Ratio(s)	-		
	Secondary Phase Current Ratio(s)	-		
	Neutral Current Ratio(s)	-		
	Accuracy			
	LIGHTNING ARRESTERS			
	Manufacturer's Name	-		
	Type	-		
	Voltage Class	kV		
	Impulse spark-overvoltage	kV		
	Front-of-wave spark-overvoltage	kV		
	GROUNDING RESISTOR			
	Current Rating/Duration	A/sec		
	Mounting (transformer/remote)	-		
	Element Type and Resistance	Ohm		
	SUPPLEMENTARY COOLING DATA			
	Number of Cooling Fans	-		
	Motor Rating	kW		
	Motor Supply	V/ph/H		
	Fans on at:	°C		

REMARKS:

END OF SECTION

SECTION 16440
LOW VOLTAGE MOTOR CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. Comply with Division 1, General Requirements and Section 16010, Basic Electrical Requirements.

1.02 REFERENCES

A. EEMAC/NEMA Standard ICS 2.

B. CAN/CSA C22.2 No. 14 Industrial Control Equipment

C. The following is a list of standards which may be referenced in this section:

1. American National Standard Institute (ANSI):
   a. C2, National Electrical Safety Code (NESC).
   b. C57.12.28, Switchgear and Transformers—Pad-Mounted Equipment—Enclosure Integrity.
2. National Electrical Manufacturers Association (NEMA):
   a. AB1, Moulded Case Circuit Breakers.
   b. ICS 1, General Standards for Industrial Control and Systems.
   c. ICS 2, Standards for Industrial Control Devices, Controllers, and Assemblies.
   d. ICS 2.3, Instructions for Handling, Installation, Operation, and Maintenance of Motor Control Centers
   e. 250, Enclosures for Electrical Equipment (1,000 volts maximum).
3. Uniform Building Code (UBC): Section 2312, Earthquake Requirements.

1.03 SUBMITTALS

A. Action Submittals: Shop Drawings:

1. Itemized bill of material.
2. Descriptive information.
3. Dimensional drawings.
4. Conduit entrance locations.
5. Bus data.
6. Protective Devices:.
7. Anchoring instructions and details.
8. Typed tabulation:
   a. Motor name; tag (equipment) numbers as shown on Drawings.
   b. Motor horsepower.
   c. Nameplate full load current.

d. Measured load current and voltage.
e. Heater catalog number as applicable.
f. Protective device trip settings.

9. Attach above typed, tabulated data to a copy of starter manufacturer's overload heater selection tables for the starters provided.
10. Control Diagrams:
    a. EEMAC/NEMA Type I. .
    b. Wiring Type B.
        1) In addition to standard EEMAC/NEMA control diagrams, provide the following:
        2) Remote control devices.
        3) Remote indication and/or pilot lights.
        4) Interconnections and interlocking circuits between starter and remote equipment.
        5) Remote sensors.
        6) Tag numbers associated with all control devices and equipment.
11. One-line diagrams.
12. Schematic (elementary) diagrams.
13. Outline diagrams.

B. Submit bound and indexed copies of operating and maintenance manuals. Include the following:

1. Complete parts list.
2. Spare parts list.
3. Installation instructions.
4. Operating instructions.
5. Maintenance instructions.
6. Detailed troubleshooting procedures and fault correction schedules.
7. Final record drawings.
8. Certified test results.

C. Prior to shipping MCC, submit comprehensive starter wiring diagrams showing wiring between panel components and devices and panel terminal blocks and between panel terminal blocks and remote equipment.

D. Submit final record wiring diagrams at completion of project. Include changes made during field installation and start-up. Enclose one copy of wiring diagram in plastic envelope and leave in each starter compartment door pocket.

1.04 CSA COMPLIANCE

A. Products manufactured conform to CSA Standards and have an applied CSA or equivalent approved Listing Mark.

1.05 QUALITY ASSURANCE

A. Factory test individual components and complete MCC assembly in accordance with applicable standards.

B. Test MCC assembly in accordance with applicable Standards and include, but do not limit to, the following:

1. Interchangeability of removable elements.
2. Mechanical and electrical operation of circuit breakers, starters, drawout mechanism, interlocks, auxiliary switches, protective devices, manual devices.
3. Functional tests on components and circuits. Simulate control signals.
4. Continuity of power and control circuit wiring.

1.06 PACKING AND SHIPPING

A. Shipping Splits: to facilitate ingress of equipment to final installation location within the building.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Cutler-Hammer.

B. Square D.

C. General Electric.

D. Allen Bradley.

2.02 MOTOR CONTROL

A. General:

1. Like Items of Equipment: Same manufacturer as low voltage switchboard and panelboards for standardization.
2. Make adjustments as necessary to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate motors actually provided under this Contract.
3. Electronic Overload Protection
    a. Self-powered
    b. Ambient temperature compensated
    c. Wide adjustment range (min 3:1)
    d. Visible trip indication
    e. Manual reset
    f. Selectable Trip Class (10, 15, or 20)

g. Phase loss protection

4. Control Transformer:
   a. Two winding, 120-volt secondary, primary voltage to suit.
   b. Two current-limiting fuses for primary circuit.
   c. One fuse in secondary circuit.
   d. Mount within starter unit.
5. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
6. Lifting lugs on all equipment and devices weighing over 50 kg..
7. Anchor Bolts: Galvanized, sized by equipment manufacturer.
8. Operating Conditions:
   a. Ambient Temperature: Maximum 40 degrees C.
   b. Equipment to be fully rated without any derating for operating conditions listed above.
9. Enclosures: In accordance with EEMAC and ANSI C57.12.28.
10. Equipment Finish:
    a. Electrocoating process applied over rust-inhibiting phosphated base coating.
    b. Exterior Color: Provide factory standard gray finish unless otherwise noted.

B. Manually Operated Starter, Fractional Horsepower:

1. Rating: 16 amperes continuous at 277 volts maximum.
2. Single-phase, nonreversing, full voltage with overload protection.
3. Toggle operated, keyed where shown.
4. Enclosure: As shown.
5. Neon Light: Red.
6. Handle guard/lock-off attachment.

C. Manually Operated Starter, Integral Horsepower:

1. Rating: Hp rated to maximum of 10 hp at 600 volts with overload protection.
2. Single or three-phase, nonreversing, full voltage.
3. Control: Toggle or Pushbutton.
4. Undervoltage protection as shown.
5. Enclosure: EEMAC, Type 4X or as otherwise shown.
6. Red pilot light in series with an auxiliary contact.
7. Locking in OFF position.
8. Two spare auxiliary, field-convertible contacts.

D. Combination Full-Voltage, Magnetic Starter:

1. Rating: Hp rated at 600 volts, CSA labeled for 22,000 amperes with overload protection.
2. Three-phase, nonreversing, full voltage.
3. Control: As shown.

4. Disconnect Type: Motor circuit protector.
5. Enclosure**:** As shown.
6. Pilot Lights: Red—ON and Green—OFF**.**
7. Padlockable operating handle.

2.03 MOTOR CONTROL CENTERS

A. General:

1. In accordance with NEMA ICS 2, CSA C22.2 No. 14, and UL 845.
2. Voltage Rating: 600 volts.
3. Short Circuit Rating: 42,000 amperes rms symmetrical for entire motor control center as a complete assembly.
4. All controllers, main and branch circuit breakers, wire connections, and other devices to be front mounted and accessible unless otherwise noted.
5. NEMA ICS 2, Section 322.08.
   a. Class: I.
   b. Type: B.
   c. Provide blank spaces on interconnection diagrams to add control conductor code designations during installation of equipment.

B. Enclosure:

1. Modular, compartmented vertical sections, rigid, free-standing, dead-front, metal enclosed.
2. Type: EEMAC Type 1 gasketed.
3. Vertical Section Dimensions: 2286 mm high, 508 mm wide, 508 mm deep.
4. Unless otherwise indicated or specified, back-to-back arrangement of MCC where shown as 1016 mm deep are to be full sections back-to-back with separate horizontal and vertical buses. 508 mm back-back sections will not be accepted as these may produce high internal temperatures in a typical plant environment.
5. Construction:
   a. Sheet steel reinforced with channel or angle irons.
   b. Butt sections flush, end-to-end against similar section without bolts, nuts, or cover plates causing interference.
   c. Removable top cover plates.
   d. Removable plates on end panels for future bus extension.
6. Section Mounting: Removable formed-steel channel sills and lifting angles to meet specified seismic requirements.
7. Horizontal Wiring Compartments/Wireways: Accessible from front, full width, top and bottom.
8. Vertical Wiring Compartment: Full height, isolated from unit starters with removable hinged and latched cover, in each vertical section, minimum 100 mm wide, complete with cable tie clamps.

9. Unit Compartment: Individual compartments separated by steel barriers for each starter, feeder, or other unit capable of being wired from front without unit removal.
10. Compartment Doors: Separate hinged doors for each starter, feeder, or other unit.
11. Door Interlocking: Interlock starter and feeder doors mechanically so doors cannot be opened with unit energized. Provide defeater mechanism to allow intentional access at any time.
12. External disconnect handles, padlockable in OFF position.
13. Cable Entrance: Main leads enter from bottom; control and feeder circuits enter from top and bottom.
14. Busway Entrance:
    a. Pull box with flanged connection for incoming busway, bus connection to motor control center main power bus and cable connection to ground bus.
    b. Match dimensions of incoming busway.
    c. Provide Belleville washers on bus connection bolts.

C. Bus:

1. Horizontal Power Bus:
    a. Three-phase tin-plated, copper, entire width of control center, rated amperes as indicated.
    b. Construct to allow future extension of additional sections.
    c. Pressure type solderless lugs for each incoming line cable.
    d. Isolated from top horizontal wireway.
    e. Provide Belleville washers on bus connection bolts.
2. Vertical Power Bus:
    a. Three-phase tin-plated, copper,full height of section, rated 300 amperes.
    b. Sandwich type bus insulation providing deadfront construction with starter units removed except for bus stab openings.
    c. Insulated and isolated barrier complete with shutters.
    d. Provide Belleville washers on bus connection bolts.
3. Neutral Bus: None.
4. Ground Bus:
    a. Copper, 33 percent minimum of phase bus ampacity, entire width of control center.
    b. Provide Belleville washers on bus connection bolts.
5. Bus Bracing: 42,000 amperes rms symmetrical.

D. Motor Controller Unit:

1. Provide indicated individual components and control devices including pushbuttons, selector switches, indicating lights, control relays, time delay relays, and elapsed time.
2. Construction:

a. Plug-in combination type with stab connections for starters NEMA ICS, Size 4 and smaller.
b. Bolt-on combination type with cable connection to riser for starters NEMA ICS, Size 5 and larger.
c. Readily interchangeable with starters of similar size.
d. Pull-apart unit control wiring terminal boards on all units.

3. Operator devices, and controls.
   a. Operator's devices: Heavy duty, industrial, oil tight, functions as indicated (pushbuttons, selector switches and indicating lights), rated 120 V AC and prewired to starter terminal blocks.
   b. Indicating lights: Integral transformer type, push-to-test, with clustered LED lamps replaceable from front without disconnecting power supply.
   c. Future field installation: Knockouts where no control devices indicated.
   d. Device colours: As indicated.
   e. General purpose relays: Heavy duty, industrial, enclosed, EEMAC rated, electrically held, 120 V coil, 60 Hz, 10 amp, 120 V AC convertible contacts, Type AR by Cutler-Hammer, Type P by Allen-Bradley Canada Ltd., Type X by Square D Canada,.
   f. Magnetic latching relays: Magnetically or mechanically held, electrically released, 120 V AC coil, enclosed, with 10 A, 120 V AC convertible contacts, number and type as indicated Type ARML by Cutler-Hammer, Type NM by Allen-Bradley Canada Ltd., Type XL by Square D Canada,.
   g. Timing relays: ON delay, OFF delay or Interval type as indicated, enclosed, 120 V AC coil, 10A, 120 V AC, convertible contacts, knob adjustable timing range as indicated, Type ARPT by Cutler-Hammer Type PT or NT by Allen-Bradley Canada Ltd., or Type X by Square D Canada.
   h. Double voltage relays: Enclosed, 10 A, 120 V AC convertible contacts, with metal barrier between coil and contact terminations, where indicated or required by Inspection Authorities.
   i. Elapsed time meters: Non-reset type, calibrated in tenths of an hour, range to 99999.9 hours where indicated.

4. Starters:
   a. None smaller than EEMAC, Size 1.
   b. Rating: Hp rated at 600 volt, CSA labeled for 22,000 amperes with overload protection.
   c. Three-phase, non-reversing.
   d. Disconnect Type: Motor circuit protector.
   e. Combination Full Voltage, Magnetic Starter:
      1) Control: As shown.
   f. Multi-Speed Motor Magnetic Starter:
      1) Control: As shown.
      2) Suitable for either two-speed, two winding or two-speed, single winding motors as shown on the drawings.

3) Pilot Lights: Green-OFF, Red-HIGH SPEED, Amber-LOW SPEED.

g. Padlockable operating handle when de-energized.

h. Unit door interlocked to prevent opening when disconnect is in closed position.

i. Mechanical interlocked to prevent placing disconnect in ON position when unit door is open.

j. Minimum Dimensions: 12 inches high by full section width, less vertical wireway.

5. Disconnecting Device:

a. As indicated.

b. Padlockable in OPEN position.

6. Circuit Breaker:

a. Moulded case with manufacturer's recommended trip setting for maximum motor protection.

b. Thermal-magnetic trip.

c. Tripping indicated by operating-handle position.

d. Interrupting capacity required for connection to system with short circuit capacity indicated.

7. Motor Overload Protection:

a. Electronic Overload Protection

1) Self-powered

2) Ambient temperature compensated

3) Wide adjustment range (min 3:1)

4) Visible trip indication

5) Manual reset

6) Selectable Trip Class (10, 15, or 20)

7) Phase loss protection

8. Motor Thermal Protector Interface: Manual-reset interposing relay for connection to motor-mounted thermal protector system. Type 3UN2100 by Siemens Electric Ltd., compatible with respective motor thermistor type where indicated.

9. Ground Fault Protection: Where indicated and as specified in paragraph Feeder Units and Main Protective Device, except provide instantaneous operation device.

E. Control Unit:

1. Disconnecting Device: Capable of de-energizing external source control circuits in unit.

2. Control Devices:

a. Operator's devices: Heavy duty, industrial, oil tight, functions as indicated (pushbuttons, selector switches and indicating lights), rated 120 V AC and prewired to starter terminal blocks.

b. Indicating lights: Integral transformer type, push-to-test, with long life incandescent or clustered LED lamps replaceable from front without disconnecting power supply.

c. Future field installation: Knockouts where no control devices indicated.
d. Device colours: As indicated.
e. General purpose relays: Heavy duty, industrial, enclosed, EEMAC rated, electrically held, 120 V coil, 60 Hz, 10 amp, 120 V AC convertible contacts, Type AR by Cutler-Hammer Type P by Allen-Bradley Canada Ltd., Type X by Square D Canada,.
f. Magnetic latching relays: Magnetically or mechanically held, electrically released, 120 V AC coil, enclosed, with 10 A, 120 V AC convertible contacts, number and type as indicated, Type ARML by Cutler-Hammer, Type NM by Allen-Bradley Canada Ltd., Type XL by Square D Canada..
g. Timing relays: ON delay, OFF delay or Interval type [as indicated], enclosed, 120 V AC coil, 10A, 120 V AC, convertible contacts, knob adjustable timing range as indicated, Type ARPT by Cutler-Hammer ,Type PT or NT by Allen-Bradley Canada Ltd. or Type X by Square D Canada.
h. Double voltage relays: Enclosed, 10 A, 120 V AC convertible contacts, with metal barrier between coil and contact terminations, where indicated or required by Inspection Authorities.
i. Elapsed time meters: Non-reset type, calibrated in tenths of an hour, range to 99999.9 hours where indicated.

3. Control Wiring:
a. Minimum wire size, 14 AWG copper.
b. Permanent sleeve type markers with wire numbers applied to each end of wires.
c. Terminate wires using insulated locking fork or ring type crimp terminals.
d. Terminate current transformer leads on shorting type terminal blocks.

F. Feeder Unit and Main Protective Device:

1. Incoming Service Feeder Cable **e**ntering section as shown.
2. Molded Case Circuit Breaker:
a. Feeder protective device, unless otherwise indicated.
b. Thermal-magnetic trip and interrupting capacity required for connection to system with short circuit capacity indicated.
c. Indicate tripping by operating-handle position.
d. Suitable for use with 75 degrees C wire.
3. Key Interlocking**:** Kirk keying system with lock cylinders and keys where indicated.

G. Instruments:

1. Digital instrumentation package:
a. Solid state, microprocessor based, true RMS, 3 phase monitoring, front face programmable, non volatile memory, minimum and

maximum measured parameter recording, 10 A Form C output contacts., Power Logic Series 4000 by Square D Canada with backlit LCD display.

b. Digital instrumentation package output signals and communication protocol: Compatible with facility control PLC system. Where required, supply necessary software drivers. Co-ordinate with control PLC system manufacturer.

c. Information monitored, calculated and displayed by digital instrumentation package:
   1) Phase voltages
   2) Phase currents
   3) Neutral or ground current
   4) Frequency
   5) Power factor
   6) kVA
   7) kVAR
   8) kW
   9) Kilowatt hours
   10) kVAR hours
   11) kW demand
   12) Current demand

2. Ground Detection Lights: Heavy-duty oiltight type, with operation explanation nameplate.

H. Key Interlocks:

1. Two Main and One Tie Breaker Arrangement:
   a. Two keys available for each group of three locks.
   b. Two out of three breakers closed at any time.

I. Pushbuttons, Indicating Lights, and Selector Switches: As specified in Section 16050, Basic Electrical Materials and Methods.

J. Elapsed Time Meters: As specified in Section 16050, Basic Electrical Materials and Methods.

K. Time Delay Relays: As specified in Section 16050, Basic Electrical Materials and Methods.

L. Control Relays: As specified in Section 16050, Basic Electrical Materials and Methods.

M. Reset Timers: As specified in Section 16050, Basic Electrical Materials and Methods.

N. Nameplates:

1. MCC identification: Lamacoid, with white letters on black background, centrally mounted on front and back (in back-to-back units.
2. Provide for each motor control center and each unit.
3. Warning sign: Lamacoid with 13 mm white letters on red background, on front of main supply compartment [compartments] to identify power source [sources].
4. Warning labels: Lamacoid with 3 mm white letters on red background, on front of compartments where multiple power sources are or maybe present.
5. Compartment identification: Lamacoid, with white letters on black background, identifying load by equipment number and function.
6. Provide for each motor control center and each unit.
7. Engrave with inscription shown on single-line diagram.
8. Provide blank nameplates on spaces for future units.
9. Attach with stainless steel pan head screws on face of control center. Grind back of screws flush so no sharp edges protrude.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with NEMA ICS 2.3, Submittal Drawings, and Manufacturer's Instructions and Recommendations.

B. Secure equipment to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.

C. Install equipment plumb and in longitudinal alignment with pad or wall.

D. Coordinate terminal connections with installation of secondary feeders.

E. Grout mounting channels into floor or mounting pads.

F. Check factory-made connections for mechanical security, electrical continuity and phasing.

G. Retighten current-carrying bolted connections and enclosure support framing and panels to manufacturer's recommendations.

H. Provide grounding connections between equipment ground buses and building grounding system.

I. Remove foreign material, including dust before energizing equipment.

J. Connect power, control and grounding wiring.

3.02 CIRCUIT BREAKERS

A. Field adjust trip settings of motor starter magnetic-trip-only circuit breakers.

B. Adjust to approximately 11 times motor rated current.

C. Determine motor rated current from motor nameplate following installation.

3.03 OVERLOAD RELAY

A. Select and install overload relay heaters after the actual nameplate full-load current rating of motor has been determined.

3.04 MOTOR DATA

A. Provide typed, self-adhesive label attached inside each motor starter enclosure door displaying the following information:

1. Motor served by tag number and equipment name.
2. Nameplate horsepower.
3. Motor code letter.
4. Full load amperes.
5. Service factor.
6. Installed overload relay heater catalog number.

3.05 FIELD QUALITY CONTROL

A. Prior to energization, confirm in writing that solid state devices have been activated, programmed, calibrated, and set.

B. Perform tests in accordance with Section 16010, Basic Electrical Requirements.

3.06 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative for the following services at jobsite or classroom as designated by Owner and/or Engineer, for minimum person-days listed below, travel time excluded:

1. 2 person-days for installation assistance, and inspection of installation.
2. 2 person-days for functional and: performance testing.
3. 2 person-days for plant startup.

END OF SECTION