



Quinte Health

Making our communities healthier. Together.

BELLEVILLE GENERAL HOSPITAL

**Phase 2 Work Required for Generator &
Fuel System Replacement Project**

Contract No. CAP24-037-RFP02

APPENDIX C

IFT Electrical Package

ABBREVIATIONS	
ATS	AUTOMATIC TRANSFER SWITCH
BMS	BUILDING MANAGEMENT SYSTEM
C	CONDUIT
C/W	COMES WITH OR COMPLETE WITH
CCT	CIRCUIT
E	EXISTING TO REMAIN
EC	EMPTY CONDUIT
EMERG.	EMERGENCY
EQUIP.	EQUIPMENT
F	FUTURE
GF	GROUND FAULT
GFCI	GROUND FAULT CIRCUIT INTERRUPTER
HK	HOUSEKEEPING
HT	HEAT TRACING
MCC	MOTOR CONTROL CENTRE
NC	NORMALLY CLOSED
NIC	NOT IN CONTRACT
NO	NORMALLY OPEN
R	REMOVE
RE	REMOVE FOR THE PURPOSE OF RELOCATION
RL	ITEM IN ITS RELOCATED POSITION
RR	REMOVE AND REINSTALL IN SAME LOCATION
RTU	ROOFTOP UNIT
SWB	SWITCHBOARD
SWG	SWITCHGEAR
TPP	TRAP SEAL PRIMER PANEL
TR	TAMPER RESISTANT
TYP	TYPICAL
UPS	UNINTERRUPTIBLE POWER SUPPLY
VR	VANDAL RESISTANT
WP	WEATHERPROOF

	OR		FIRE ALARM MANUAL PULL STATION.
	OR		FIRE ALARM SMOKE DETECTOR. WALL MOUNTED SHOWN ON LEFT. CEILING MOUNTED SHOWN ON RIGHT. 'X' = '1P' DENOTES DUAL CONTACT. 'X' = 'CO' DENOTES CARBON MONOXIDE DETECTOR 'X' = 'A' DENOTES SMOKE ALARM. 'X' = 'S' DENOTES C/W STROBE.
	OR		FIRE ALARM HEAT DETECTOR. WALL MOUNTED SHOWN ON LEFT. CEILING MOUNTED SHOWN ON RIGHT.
	OR		HIGH TEMPERATURE FIRE ALARM HEAT DETECTOR. WALL MOUNTED SHOWN ON LEFT. CEILING MOUNTED SHOWN ON RIGHT.
			FIRE ALARM DUCT MOUNTED SMOKE DETECTOR.
			REMOTE ALARM FOR DUCT MOUNTED SMOKE DETECTOR.
			WALL MOUNTED FIRE ALARM BEAM DETECTOR AND RECEIVER.
	OR		FIRE ALARM EVAC SPEAKER. WALL MOUNTED SHOWN ON LEFT. CEILING MOUNTED SHOWN ON RIGHT.
	OR		FIRE ALARM EVAC SPEAKER WITH STROBE. WALL MOUNTED SHOWN ON LEFT. CEILING MOUNTED SHOWN ON RIGHT.
	OR		FIRE ALARM STROBE LIGHT. WALL MOUNTED SHOWN ON LEFT. CEILING MOUNTED SHOWN ON RIGHT.
			FIRE ALARM HORN.
			FIRE ALARM HORN WITH STROBE.
			FIRE ALARM BELL.
			SPRINKLER/STANDPIPE SYSTEM SUPERVISED VALVE.
			SPRINKLER/STANDPIPE SYSTEM FLOW SWITCH.
			SPRINKLER/STANDPIPE SYSTEM PRESSURE SWITCH.
			FIRE ALARM MONITORING MODULE.
			FIRE ALARM CONTROL MODULE.
			FIRE ALARM END OF LINE RESISTOR.
			FIRE ALARM FIRE FIGHTERS HANDSET.
			FIRE ALARM ZONE BOUNDARY.
	OR		FIRE ALARM PANEL. FLUSH MOUNTED SHOWN ON LEFT. SURFACE MOUNTED SHOWN ON RIGHT. 'XXX' = 'FATP' DENOTES FIRE ALARM RESPONDER PANEL. 'XXX' = 'FAK' DENOTES ANNUNCIATOR 'XXX' = 'PA' DENOTES PRE-ACTION PANEL.
			WALL MOUNTED FIRE DO NOT ENTER SIGN.
			CEILING MOUNTED FIRE DO NOT ENTER SIGN.
			FIRE ALARM ASPIRATION SYSTEM PANEL.
			PIPE FOR FIRE ALARM ASPIRATION SYSTEM.
			LINEAR FIRE ALARM HEAT DETECTOR.

ELECTRICAL SINGLE LINE DRAWING LEGEND	
	FUSE. 'XA' DENOTES SIZE.
	SWITCH. 'XA' DENOTES SIZE.
	LOAD BREAK SWITCH. 'XA' DENOTES SIZE.
	LOW VOLTAGE MOULDED CASE CIRCUIT BREAKER. 'XA' DENOTES BREAKER SIZE. 'YYY' DENOTES OPTIONAL SUPPLEMENTARY INFORMATION.
	LOW VOLTAGE DRAW-OUT POWER CIRCUIT BREAKER. 'XA' DENOTES BREAKER SIZE. 'YYY' DENOTES OPTIONAL SUPPLEMENTARY INFORMATION.
	MEDIUM VOLTAGE DRAW-OUT POWER CIRCUIT BREAKER. 'XA' DENOTES BREAKER SIZE.
	SWITCH AND FUSE. 'XA' DENOTES SWITCH SIZE. 'Y' DENOTES FUSE SIZE.
	TRANSFER SWITCH. 'XXX' DENOTES TRANSFER SWITCH REFERENCE. 'YYY' DENOTES SUPPLEMENTARY INFORMATION.
	DISTRIBUTION TRANSFORMER. 'XXX' = 'HMT' TO DENOTE HARMONIC MITIGATION / CANCELLATION. 'XXX' = 'K' TO DENOTE K-RATED.
	POTENTIAL TRANSFORMER.
	CURRENT TRANSFORMER.
	DELTA.
	WYE.
	ZIG-ZAG.
	MOTOR LOAD. 'X' = 'G' TO DENOTE GENERATOR. 'X' = 'FP' TO DENOTE FIRE PUMP.
	GROUND CONNECTION.
	SOLID GROUNDING.
	NEUTRAL RESISTANCE GROUNDING. 'XA' DENOTES AMPERAGE.
	KEY INTERLOCK
	LIGHTNING ARRESTOR
	SURGE PROTECTION DEVICE
	METER
	BATTERY
	LIGHTING INVERTER
	INVERTER/RECTIFIER. AC SIDE IS DENOTED BY "~", DC SIDE IS DENOTED BY "+".
	STATIC BYPASS SWITCH
	DRAW-OUT DEVICE. THE SHADED BOX WILL BE THE SYMBOL DENOTING WHICH DEVICE.

	120V, 1Ø DIRECT CONNECTION FOR EQUIPMENT AS NOTED.
	208V, 1Ø DIRECT CONNECTION FOR EQUIPMENT AS NOTED.
	208V, 3Ø DIRECT CONNECTION FOR EQUIPMENT AS NOTED.
	416V OR 480V, 3Ø DIRECT CONNECTION FOR EQUIPMENT AS NOTED.
	600V, 3Ø DIRECT CONNECTION FOR EQUIPMENT AS NOTED.
	FLOOR MOUNTED POWER MONUMENT. 'X' DENOTES TYPE.
	FLOOR MOUNTED COMBINATION POWER AND DATA MONUMENT. 'X' DENOTES TYPE.
	FLOOR MOUNTED POWER AND/OR SYSTEMS FURNITURE. 'X' DENOTES TYPE.
	WALL MOUNTED POWER & DATA INPUT FOR SYSTEMS FURNITURE. 'X' DENOTES TYPE.
	HEADWALL/SERVICE COLUMN. 'X' DENOTES TYPE.
	SERVICE POLE.
	SURFACE MOUNTED RACEWAY. TYPE AS SPECIFIED C/W TYPE AND QUANTITY OF DEVICES INDICATED.
	UN-FUSED DISCONNECT SWITCH. 'X' DENOTES DISCONNECT RATING.
	FUSED DISCONNECT SWITCH 'X' DENOTES DISCONNECT RATING. 'Y' DENOTES FUSE SIZE.
	JUNCTION BOX C/W BLANK COVER PLATE. SIZED FOR THE SERVICE/CONNECTION NOTED.
	PULL BOX C/W BLANK COVER PLATE. SIZED FOR THE SERVICE/CONNECTION AS NOTED.
	MOTOR CONTROLLER. 'XA' DENOTES TYPE.
	VARIABLE FREQUENCY DRIVE. 'XA' DENOTES TYPE.
	TRANSFORMER.
	HARMONIC FILTERS.
	ELECTRICAL PANEL. FLUSH MOUNTED SHOWN ON LEFT. SURFACE MOUNTED SHOWN ON RIGHT.
	POWER PANEL. FLUSH MOUNTED SHOWN ON LEFT. SURFACE MOUNTED SHOWN ON RIGHT.
	SPLITTER
	COPPER GROUND BAR
	GROUND ROD
	GROUND ROD C/W GROUND PLATE
	LIGHTNING PROTECTION DOWNLEAD
	LIGHTNING PROTECTION WALL MOUNTED AIR TERMINAL
	LIGHTNING PROTECTION FLOOR MOUNTED AIR TERMINAL
	BUS DUCT OR CABLE BUS AS NOTED
	BUS DUCT OR CABLE BUS ELBOW
	BUS DUCT OR CABLE BUS UP
	BUS DUCT OR CABLE BUS DOWN
	CABLE TRAY
	CABLE TRAY ELBOW
	CABLE TRAY TEE
	CABLE TRAY CROSSED TEE
	CABLE TRAY UP
	CABLE TRAY DOWN

ELECTRICAL RECEPTACLE LEGEND				
CEILING MOUNTED	WALL MOUNTED	EQUIPMENT / HEADWALL MOUNTED	MOUNTED ABOVE COUNTER HEIGHT	DESCRIPTION
				120V, 15A DUPLEX RECEPTACLE.
				120V, 15A SPLIT DUPLEX RECEPTACLE.
				120V, 15A GFCI DUPLEX RECEPTACLE
				120V, 15/20A T-SLOT DUPLEX RECEPTACLE. 'HK' DENOTES HOUSEKEEPING RECEPTACLE.
				120V, 15/20A T-SLOT GFCI DUPLEX RECEPTACLE. 'HK' DENOTES HOUSEKEEPING RECEPTACLE.
				120V, 15A DOUBLE DUPLEX RECEPTACLE.
				120V, 15A EMERGENCY POWER DUPLEX RECEPTACLE.
				120V, 15/20A T-SLOT EMERGENCY POWER DUPLEX RECEPTACLE.
				SPECIAL RECEPTACLE REFER TO SPECIAL RECEPTACLE DESIGNATION TABLE.

GENERAL NOTES

(NOTES AND NUMBERING BELOW PERTAINS TO ALL E-SERIES DRAWINGS.)

1. COORDINATE WITH OWNER FOR SYSTEM ISOLATION ACTIVITIES INCLUDING STAGES OF REMOVAL OF EXISTING EQUIPMENT AND INSTALLATION OF NEW EQUIPMENT.
2. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL DAMAGES TO SURFACES, FINISHES AND MATERIALS DUE TO WORK UNDER THIS CONTRACT AND SHALL INCUR ALL COSTS TO RECTIFY, REPAIR AND REPLACE SAME TO CONSULTANT'S SATISFACTION.
3. BE RESPONSIBLE FOR CUTTING, PAINTING AND PATCHING, AS REQUIRED, TO FACILITATE THE INSTALLATION OF NEW SERVICES. FURNISH AND CLOSE OFF ALL OPENINGS IN WALLS OR CEILINGS THAT OCCUR DUE TO THE REMOVAL OF EXISTING SERVICES OR DUE TO INSTALLATION OF NEW SERVICES. FINISH TO MATCH EXISTING.
4. THE CONSULTANT DOES NOT WARRANT THE ACCURACY OF EXISTING BUILDING CONDITIONS, DIMENSIONS, OR MATERIALS REPRESENTED ON THE DRAWINGS. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO VISIT THE PLACE OF THE WORK AND SURROUNDINGS PRIOR TO SUBMITTING THE BID, TO FAMILIARIZE THEMSELVES WITH THE EXISTING CONDITIONS THAT WILL AFFECT THE WORK.
5. COORDINATE WORK WITH OTHER TRADES PRIOR TO THE ROUGH-IN OF ANY POWER INCLUDING COORDINATION WITH EQUIPMENT SUPPLIER.
6. ALL POWER AND SYSTEMS SHUTDOWNS TO BE OFF HOURS OR ON WEEKENDS. COORDINATE WITH OWNER FOR CABLE TIMING AND PROVIDE 7 DAYS WRITTEN NOTICE.
7. GENERATOR ENCLOSURES HAVE BEEN PRE-PURCHASED BY OWNER AND ARE STORED ON SITE, ADJACENT TO THE CONSTRUCTION AREA. CONTRACTOR IS RESPONSIBLE FOR RELOCATING GENERATORS TO EXISTING CONCRETE PAD.

[illegible]

CONDUCTOR LABELS

The diagram shows a conductor label: **2x [4 #250 CU + G - 78mm C]**. Callouts point to various parts of the label:

- QUANTITY (IF MORE THAN 1)**: Points to the **2x** at the beginning of the label.
- SIZE OF MAIN CONDUCTORS**: Points to the **4** inside the brackets.
- SIZE OF MAIN CONDUCTORS**: Points to the **#250** inside the brackets.
- AL = ALUMINUM CONDUCTORS**
CU = COPPER CONDUCTORS: Points to the **CU** inside the brackets.
- GROUND**: Points to the **+** and **G** inside the brackets.
- CONDUIT SIZE**: Points to the **- 78mm** inside the brackets.
- SIZE OF MAIN CONDUCTORS**: Points to the **C** at the end of the label.

NOMINAL CONDUIT SIZES										
mm	16	21	27	35	41	53	63	78	91	103
inch	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4

ELECTRICAL GENERAL LEGEND

 OR 	ELECTRICAL EQUIPMENT LABEL. "XXX" DENOTES ITEM CATEGORY "YY" DENOTES ITEM REFERENCE
	EXISTING ELECTRICAL EQUIPMENT OR SERVICE TO REMAIN.
	EXISTING ELECTRICAL EQUIPMENT OR SERVICE TO BE REMOVED.
 RE	EXISTING ELECTRICAL EQUIPMENT OR SERVICE TO BE RELOCATED.
 RL	NEW LOCATION OF RELOCATED ELECTRICAL EQUIPMENT OR SERVICE.
	DEMARCATOR POINT. ITEMS TO THE LEFT OF THE POINT IS BY DIVISION "XX" ITEMS TO THE RIGHT OF THE POINT IS BY DIVISION "YY"



HHAngus

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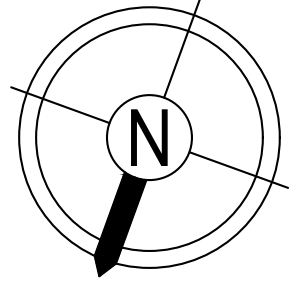
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NO.	DATE (YYYY-MM-DD)	DESCRIPTION
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07	2026-02-23	ISSUED FOR PHASE 1 CONSTRUCTION
06	2026-02-23	RE-ISSUED FOR BUILDING PERMIT
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04	2025-10-14	ISSUED FOR PHASE 1 TENDER
03	2025-09-26	ISSUED FOR FINAL REVIEW
02	2025-07-09	ISSUED FOR ESA PLAN REVIEW
01	2025-06-18	ISSUED FOR OWNER'S REVIEW
NO	DATE (YYYY-MM-DD)	DESCRIPTION
DRAWING ISSUE		
KEYPLAN:		

KEYPLAN

NORTH:



SEAL:



PROJECT:
QUINTE HEALTH BELLEVILLE
GENERAL HOSPITAL GENERATOR
REPLACEMENT - PHASE 2

HHA PROJECT NUMBER: 2230693

DRAWING TITLE:
ELECTRICAL LEGEND AND
DRAWING LIST

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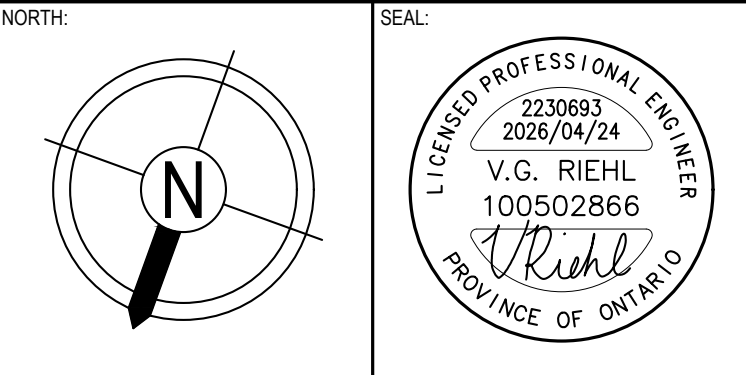
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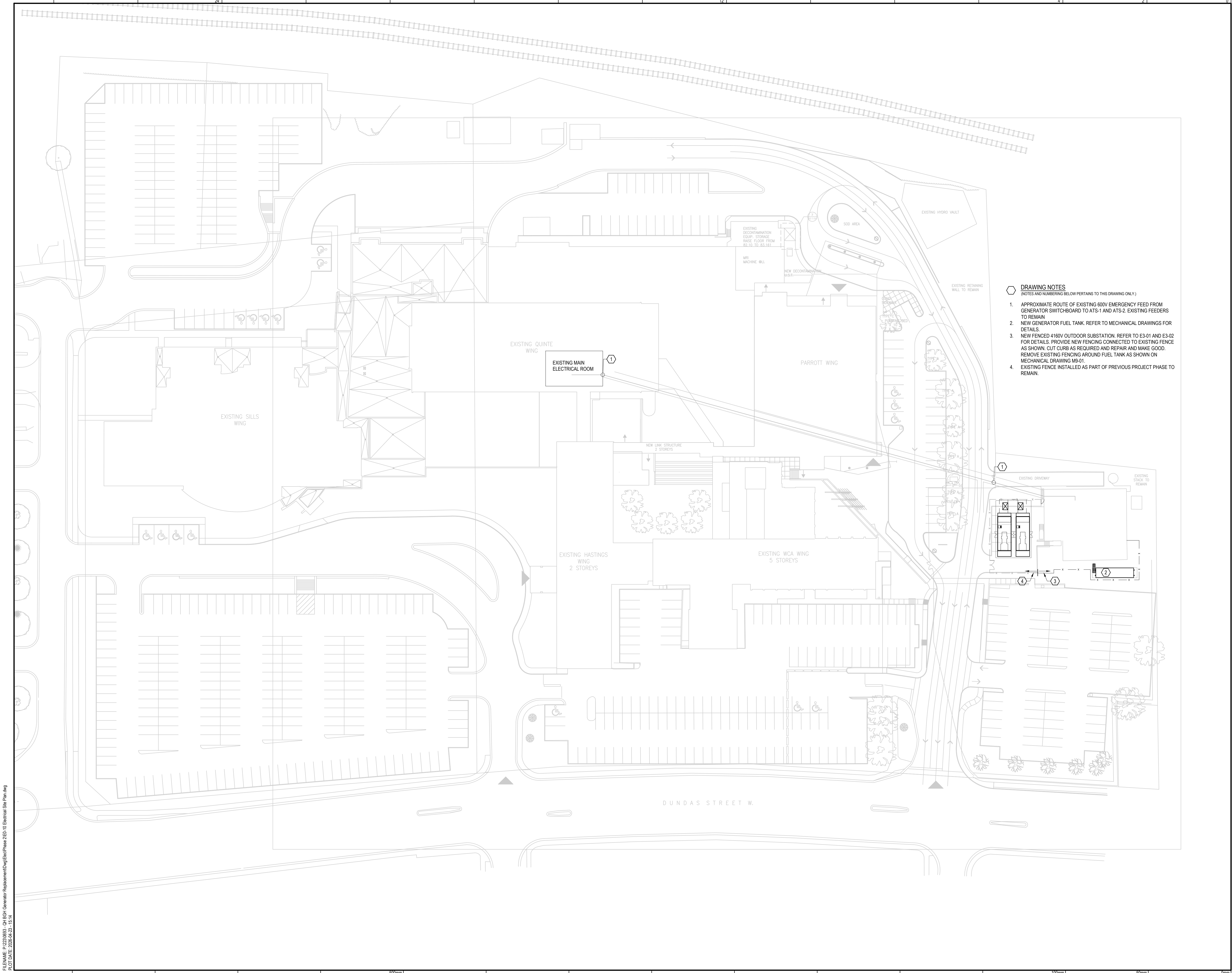


PROJECT:
QUINTE HEALTH BELLEVILLE
GENERAL HOSPITAL GENERATOR
REPLACEMENT - PHASE 2

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SITE PLAN

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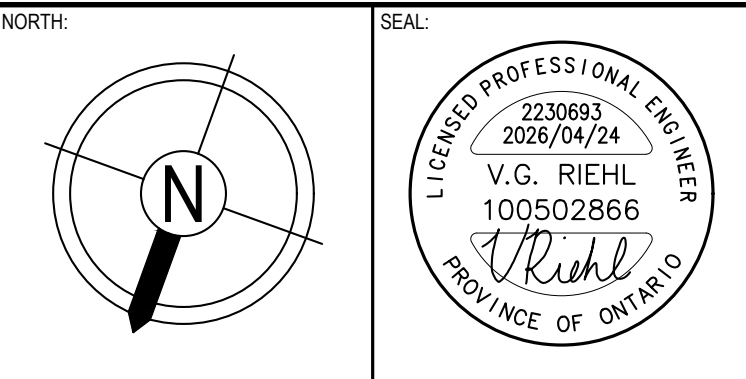


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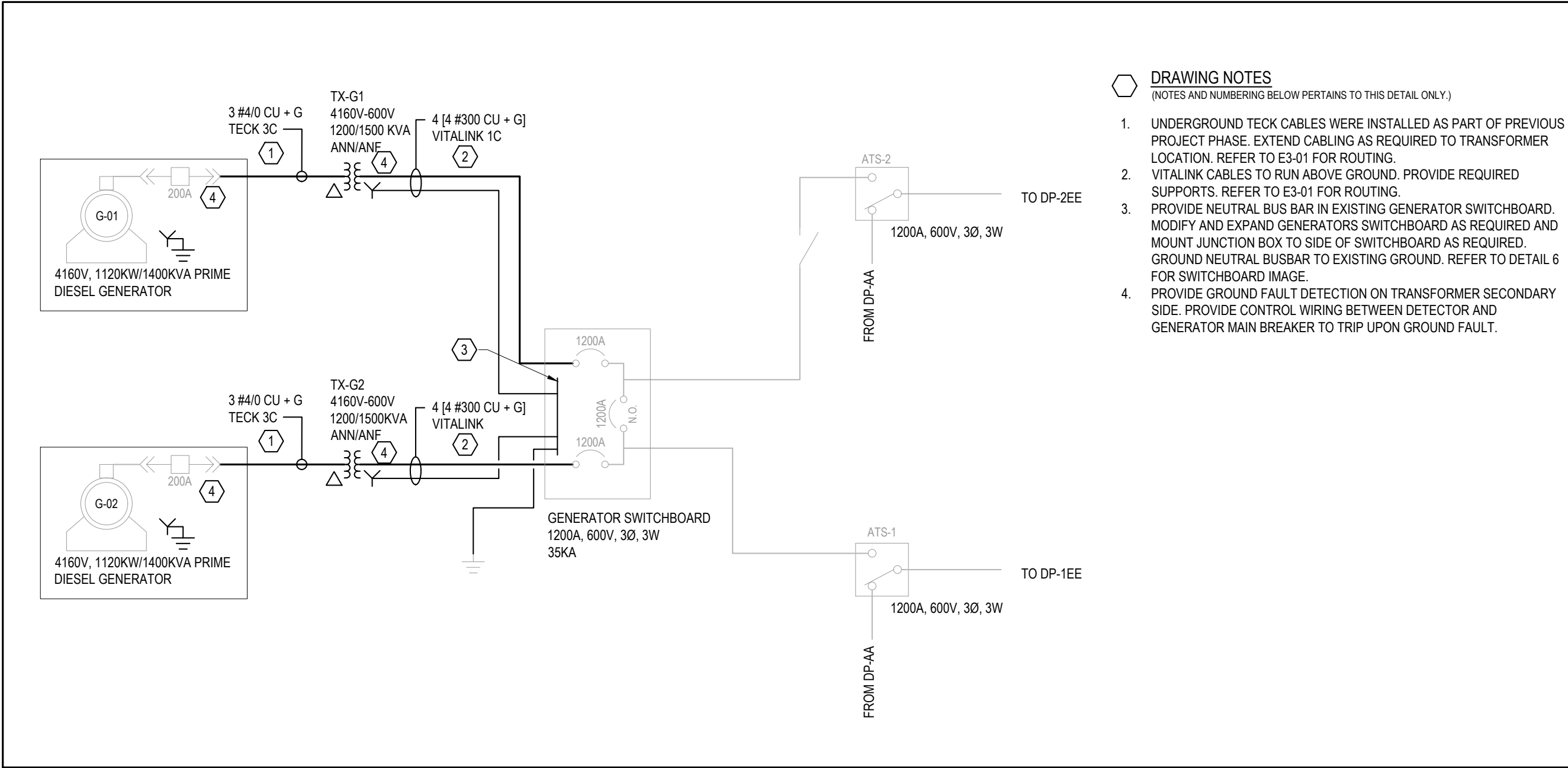
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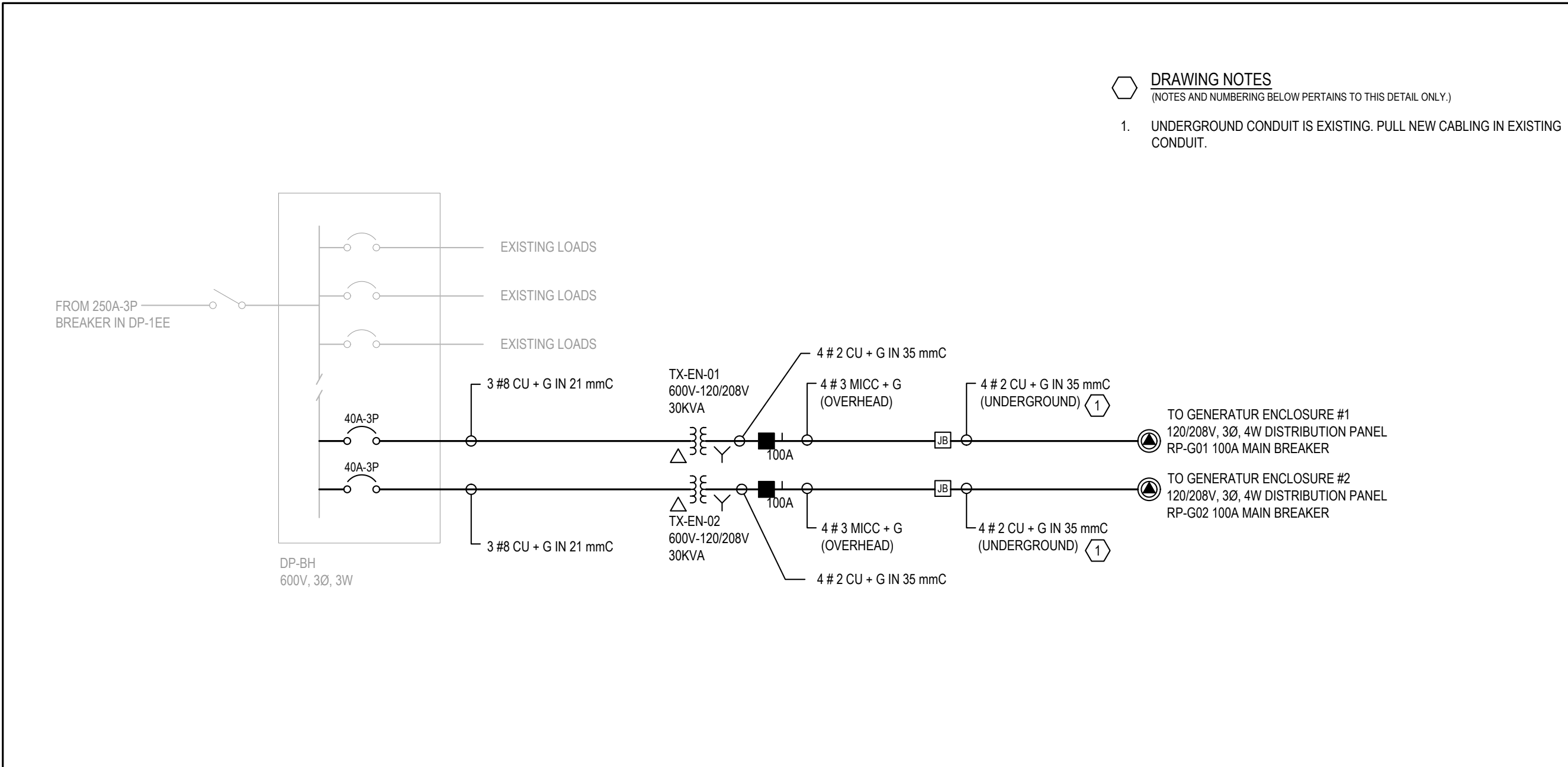
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GENERAL HOSPITAL GENERATOR
REPLACEMENT - PHASE 2
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SINGLE LINE DIAGRAMS

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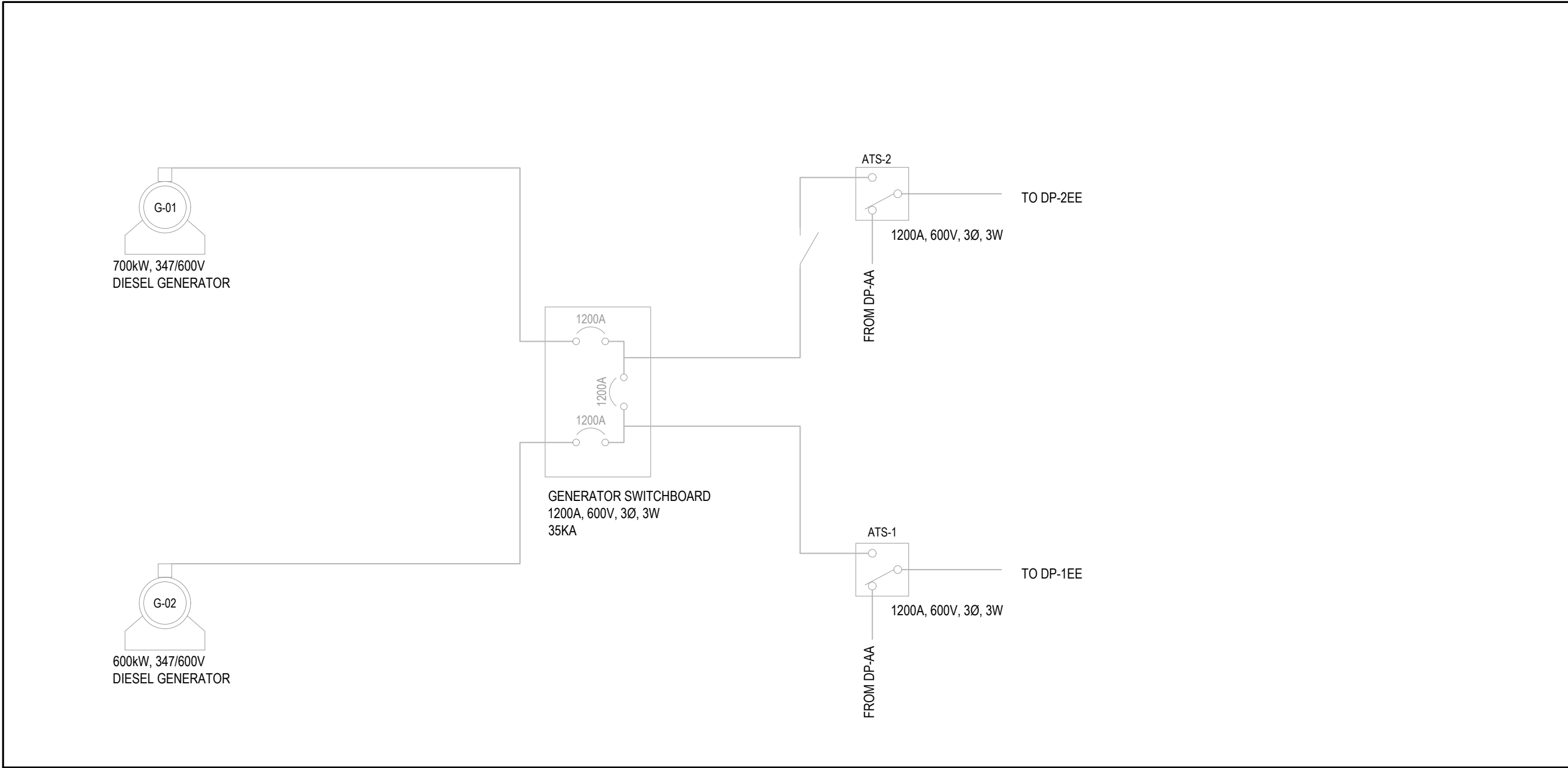
4 NEW PARTIAL SINGLE LINE DIAGRAM - GENERATOR POWER
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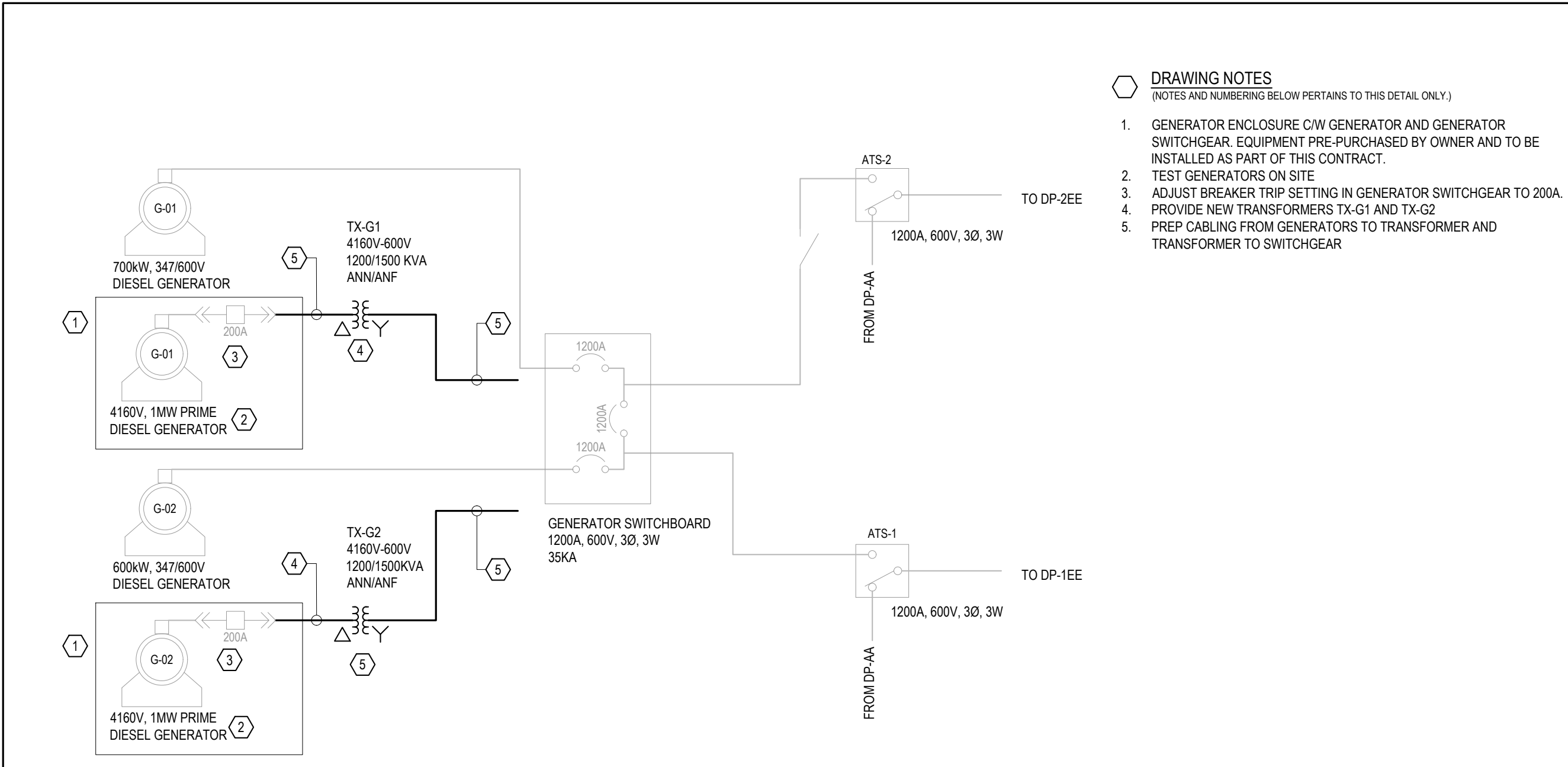
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E1-01 N.T.S.



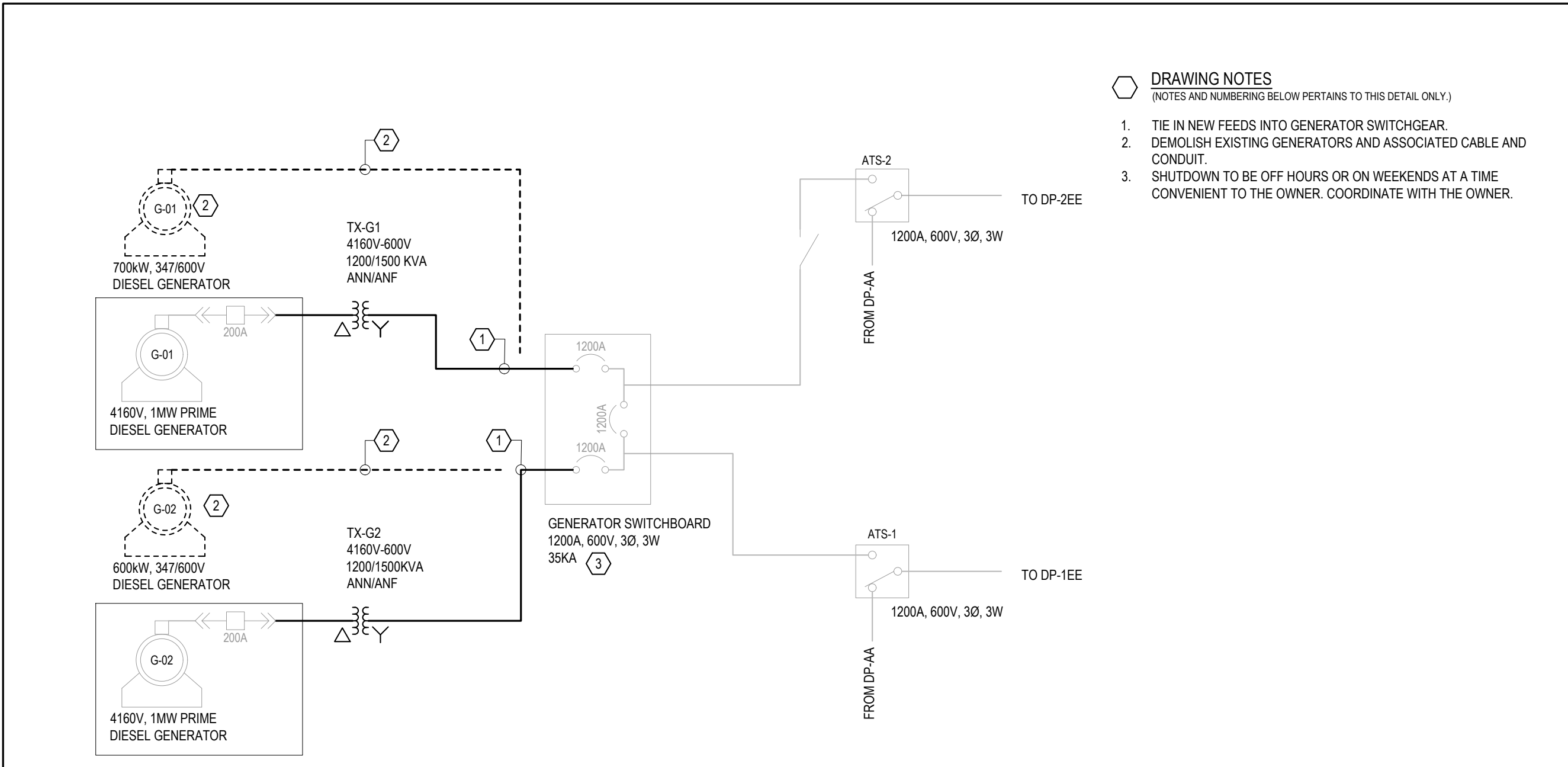
6 EXISTING GENERATOR SWITCHBOARD
E1-01 N.T.S.



1 EXISTING PARTIAL SINGLE LINE DIAGRAM - GENERATOR POWER
E1-01 N.T.S.



2 PARTIAL SINGLE LINE DIAGRAM - GENERATOR POWER - PHASE A
E1-01 N.T.S.



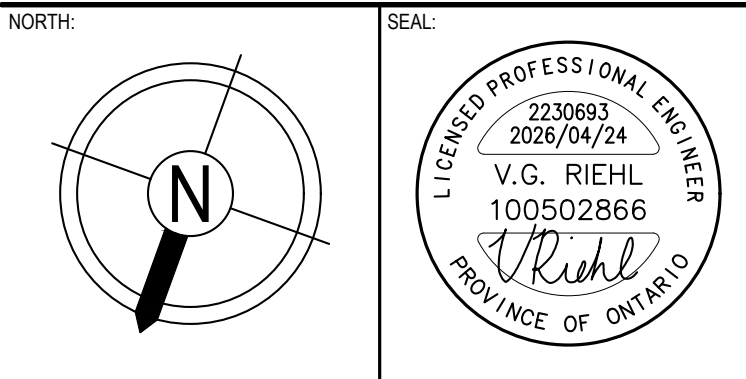
3 PARTIAL SINGLE LINE DIAGRAM - GENERATOR POWER - PHASE B
E1-01 N.T.S.

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KEYPLAN:



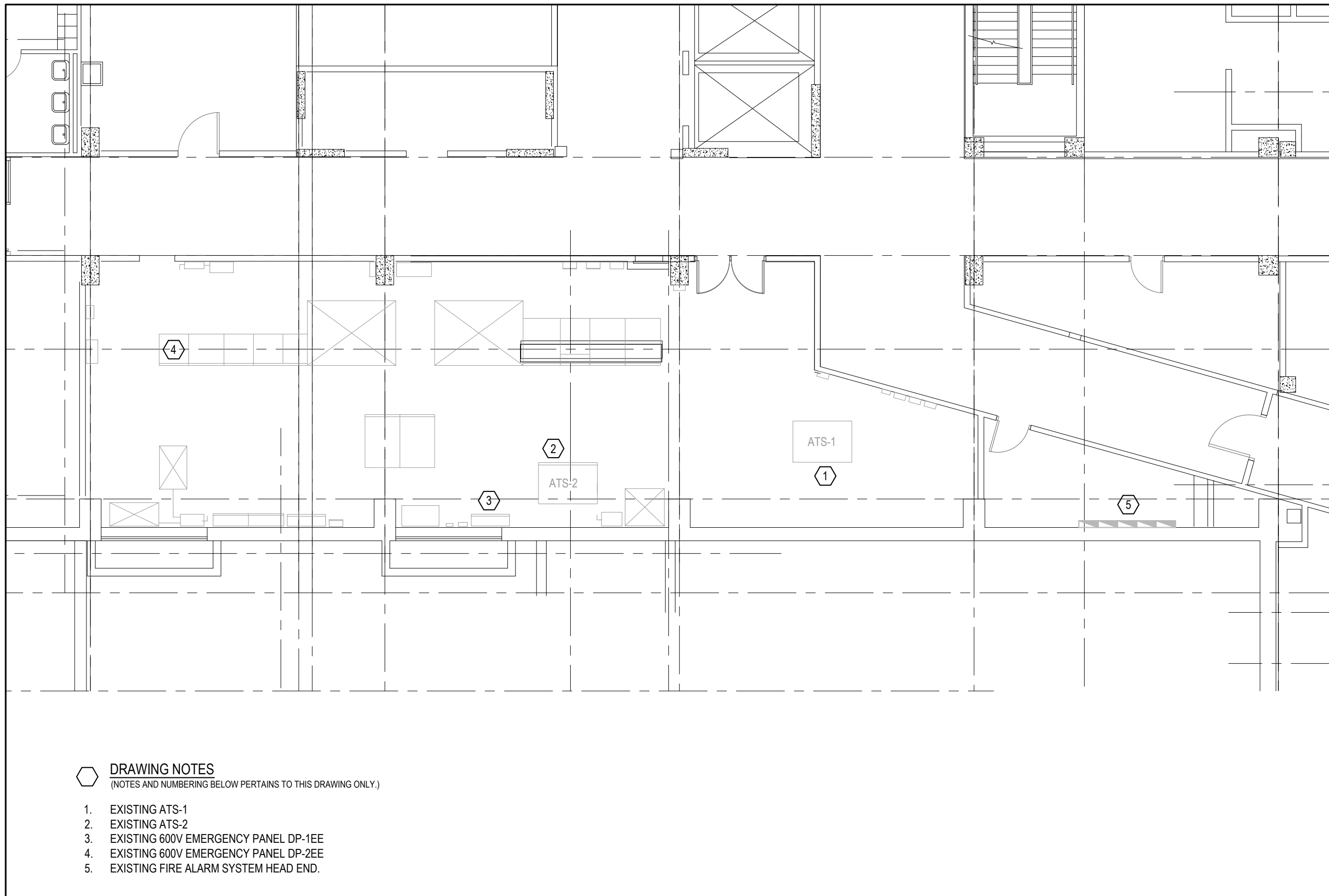
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REPLACEMENT - PHASE 2

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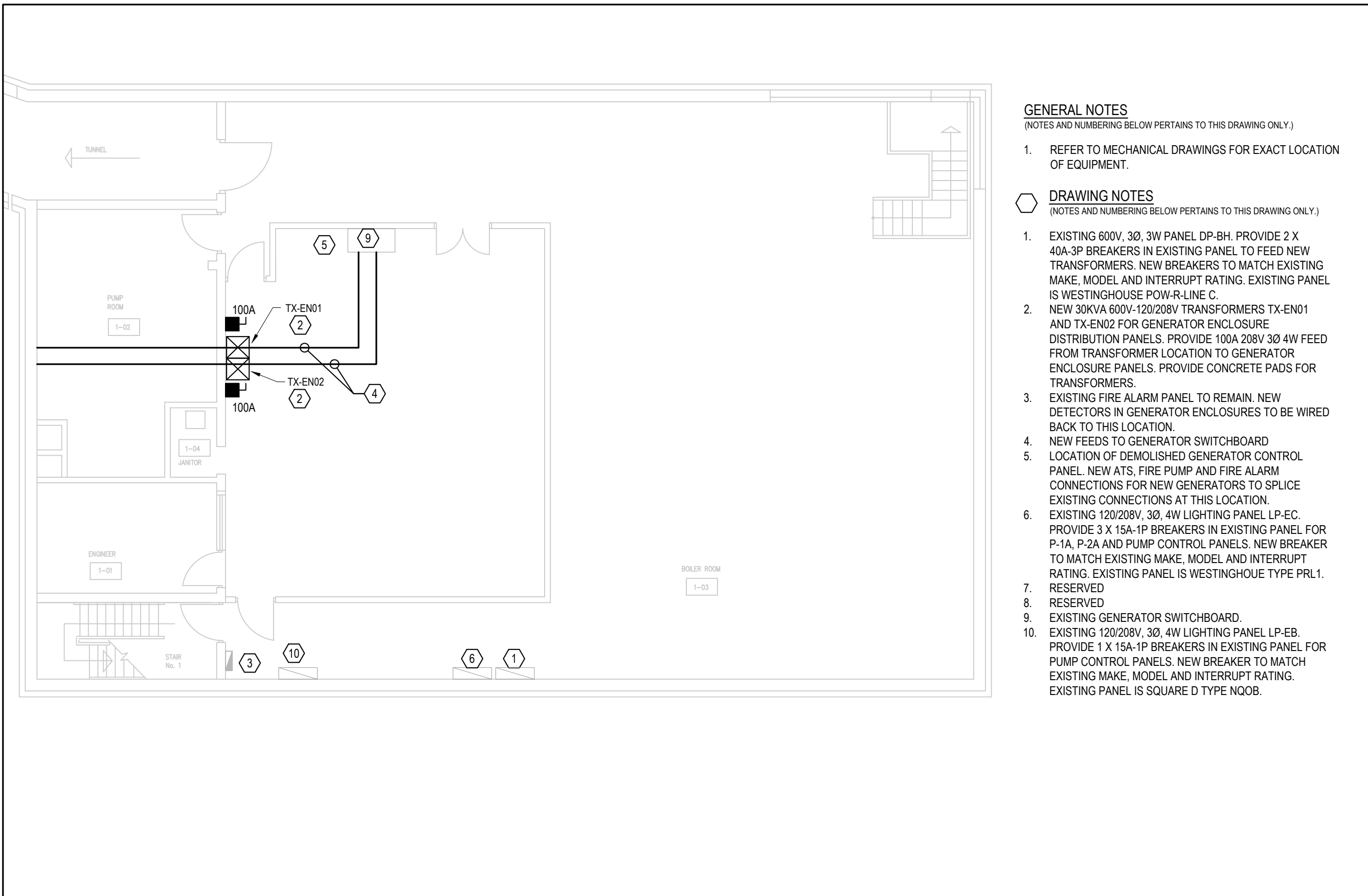
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SYSTEMS PLAN

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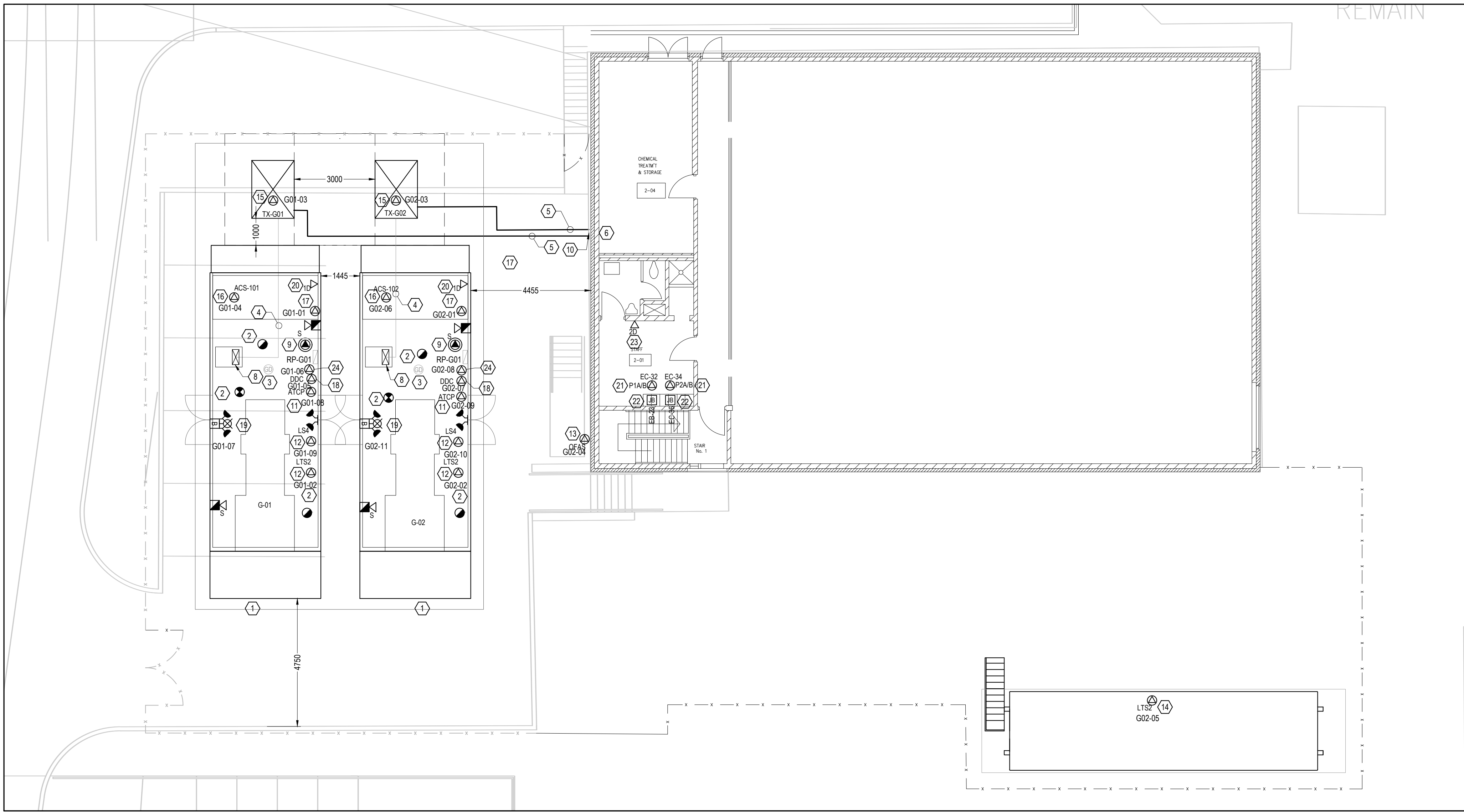
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3 EXISTING AND NEW WORK MAIN ELECTRICAL ROOM
E3-01 1:100



1 NEW LAYOUT - BOILER PLANT
E3-01 1:100



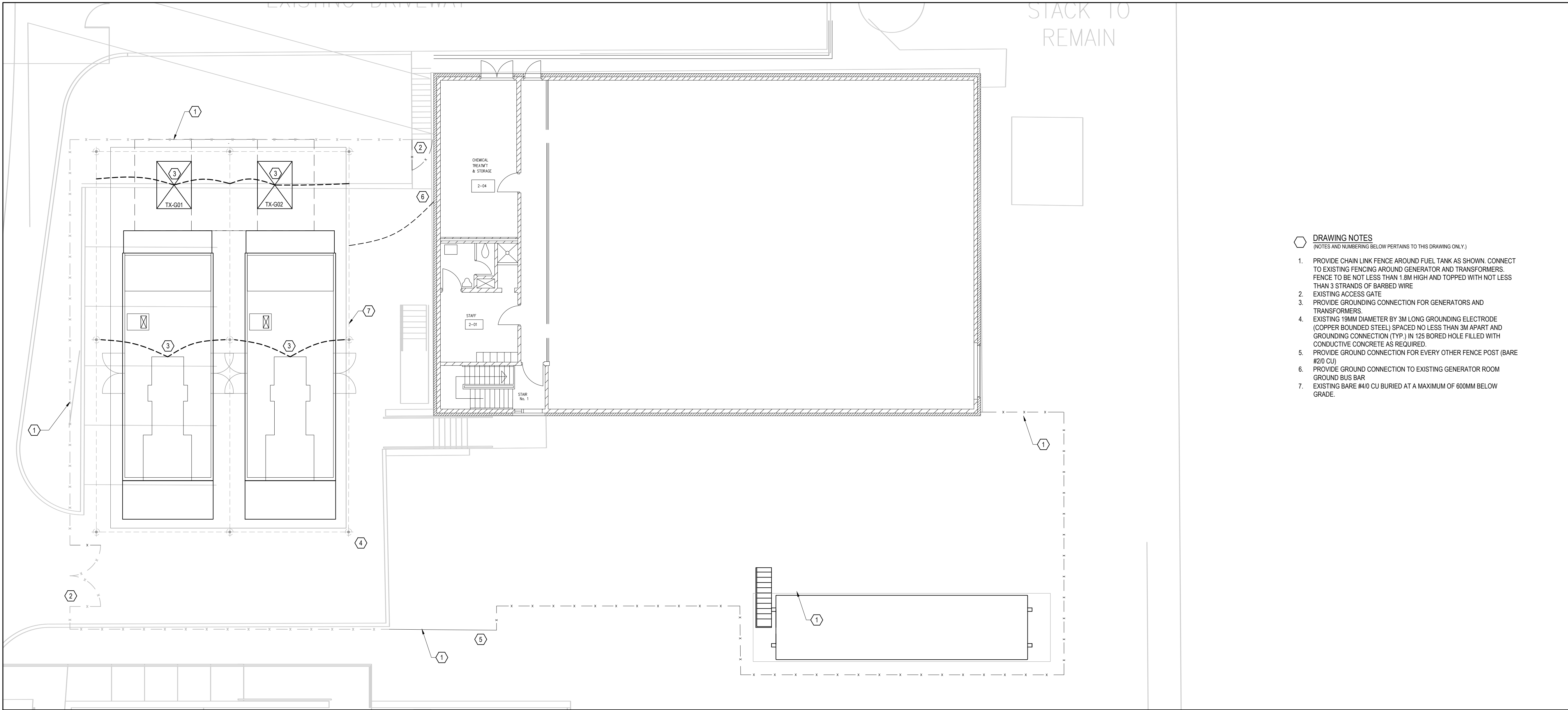
2 NEW LAYOUT - EXTERIOR
E3-01 1:100

GENERAL NOTES
(NOTES AND NUMBERING BELOW PERTAINS TO THIS DRAWING ONLY.)

- RP-G01 AND RP-G02 CIRCUITS ARE DIAGRAMMATIC ONLY. UTILIZE AVAILABLE CIRCUITS IN PANEL. PROVIDE ALL REQUIRED BREAKERS.
- EXISTING GENERATOR I/O BOARDS TO BE UPGRADED. CONTRACTOR TO COORDINATE WITH PRITCHARD FOR I/O BOARD UPGRADE. CONTRACTOR TO ALSO COORDINATE WITH PRITCHARD FOR RE-PROGRAMMING OF GENERATOR PROFILES FOR INDEPENDENT INDIVIDUAL OPERATION (NOT PARALLELED). PROVIDE ALL REQUIRED CABLE, CONDUIT AS REQUIRED BY PRITCHARD.
- ALL DIMENSIONS SHOWN ARE IN MM.
- ALLOW FOR AN ADDITIONAL 3 15A-1P BREAKERS IN EACH GENERATOR DISTRIBUTION PANEL INCLUDING WIRE, CONDUIT AND TERMINATION TO MISCELLANEOUS LOADS IN GENERATOR ENCLOSURES.

DRAWING NOTES
(NOTES AND NUMBERING BELOW PERTAINS TO THIS DRAWING ONLY.)

- RELOCATE GENERATOR ENCLOSURES FROM STORAGE LOCATION TO CONCRETE PAD. CONTRACTOR TO CARRY QUALIFIED PERSONNEL TO PERFORM WORK. PLACE GENERATOR ENCLOSURES ON CONCRETE PAD AND COORDINATE ENCLOSURE CABLE OPENING WITH EXISTING CABLE AND CONDUIT LOCATION. REFER TO E3-03 FOR EXISTING CONDUITS AND CABLES. CONTRACTOR TO SITE VERIFY EXACT LOCATION.
- REPLACE HEAT DETECTORS AND SMOKE DETECTORS THAT COME COMPLETE WITH GENERATOR ENCLOSURE WITH NEW DETECTORS TO MATCH HOSPITAL STANDARD. WIRE BACK TO FIRE ALARM PANEL IN BOILER PLANT. COORDINATE EXACT PLACEMENT OF FIRE ALARM DEVICES ON SITE.
- GAS DETECTOR TO COME WITH GENERATOR ENCLOSURE. PROVIDE CONNECTION BACK TO FIRE ALARM PANEL IN BOILER PLANT.
- EXISTING DIRECT BURIED 4160V CABLES. CABLES TO RUN MIN. 750MM BELOW CONCRETE.
- PROVIDE STRUCTURAL HANGER SUPPORTS MOUNTED TO CONCRETE FOR 600V FEEDS FROM TRANSFORMERS TO BOILER HOUSE AND ALL LOW VOLTAGE CONDUITS ASSOCIATED WITH GENERATOR.
- FEEDS TO DESCEND ONE LEVEL. COORDINATE EXACT CORING LOCATION ON SITE.
- RESERVED.
- OPENING IN GENERATOR ENCLOSURE BASE FOR MAIN POWER CONNECTION.
- PROVIDE 100A FEED FROM TX-EN01 AND TX-EN02 IN BOILER HOUSE TO 100A DISTRIBUTION PANELS RP-G01 AND RP-G02 IN GENERATOR ENCLOSURES. PANEL PROVIDED BY OTHERS. COORDINATE ON SITE FOR EXACT LOCATION OF PANELS.
- PROVIDE WATERPROOF CORES IN EXISTING BOILER HOUSE WALL FOR CABLE ENTRY INTO EXISTING BASEMENT GENERATOR ROOM.
- AUXILIARY SUPPLY TANK CONTROL PANEL. COORDINATE LOCATION WITH MECHANICAL. PROVIDE 15A-1P BREAKER IN RP-G01 AND RP-G02.
- LEVEL TRANSMITTER/SWITCH ON SUB BASE FUEL TANK. COORDINATE LOCATION WITH MECHANICAL. PROVIDE 15A-1P BREAKER IN RP-G01 AND RP-G02.
- OVERFILL LEVEL ALARM SYSTEM. PROVIDE 15A-1P BREAKER IN RP-G02.
- LEVEL TRANSMITTER/SWITCH ON MAIN SUPPLY TANK. PROVIDE 15A-1P BREAKER IN RP-G02.
- FOR TRANSFORMER HEATERS. PROVIDE 15A-1P BREAKER IN RP-G01 AND RP-G02.
- AIR COMPRESSOR ACS-101/ACS-102. PROVIDE 15A-1P BREAKER IN RP-G01 AND RP-G02.
- UREA CONTROL PANEL CP-100DS-100. PROVIDE 15A-1P BREAKER IN RP-G01 AND RP-G02.
- DDC SYSTEM UNIT. PROVIDE 15A-1P BREAKER IN RP-G01 AND RP-G02.
- EMERGENCY BATTERY UNIT. PROVIDE 15A-1P BREAKER IN RP-G01 AND RP-G02.
- PROVIDE DATA DROP FOR BAS CONNECTION. COORDINATE WITH MECHANICAL FOR EXACT LOCATION. ASSUME 75M TO NEAREST SWITCH.
- FOR DUPLEX PUMPS P1A/B AND P2A/B.
- FOR PUMP CONTROL PANELS DPCP-1 AND DPCP-2. PROVIDE SEPARATE FEED FROM EACH JUNCTION BOX TO EACH DPCP (TWO FEEDS PER DPCP).
- PROVIDE DATA DROPS FOR BAS CONNECTION. ASSUME 60M TO THE NEAREST SWITCH.
- LEVEL SENSOR LTS-RD. PROVIDE 15A-1P BREAKER IN RP-G01 AND RP-G02.



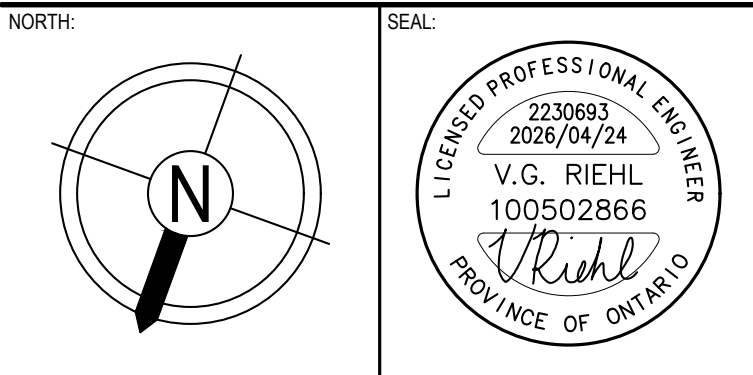
- DRAWING NOTES**
(NOTES AND NUMBERING BELOW PERTAINS TO THIS DRAWING ONLY.)
1. PROVIDE CHAIN LINK FENCE AROUND FUEL TANK AS SHOWN. CONNECT TO EXISTING FENCING AROUND GENERATOR AND TRANSFORMERS. FENCE TO BE NOT LESS THAN 1.8M HIGH AND TOPPED WITH NOT LESS THAN 3 STRANDS OF BARBED WIRE
 2. EXISTING ACCESS GATE
 3. PROVIDE GROUNDING CONNECTION FOR GENERATORS AND TRANSFORMERS.
 4. EXISTING 19MM DIAMETER BY 3M LONG GROUNDING ELECTRODE (COPPER BOUNDED STEEL) SPACED NO LESS THAN 3M APART AND GROUNDING CONNECTION (TYP.) IN 125 BORED HOLE FILLED WITH CONDUCTIVE CONCRETE AS REQUIRED.
 5. PROVIDE GROUND CONNECTION FOR EVERY OTHER FENCE POST (BARE #2/0 CU)
 6. PROVIDE GROUND CONNECTION TO EXISTING GENERATOR ROOM GROUND BUS BAR
 7. EXISTING BARE #4/0 CU BURIED AT A MAXIMUM OF 600MM BELOW GRADE.

DISCREPANCIES MUST BE REPORTED IMMEDIATELY TO THE CONSULTANT BEFORE PROCEEDING.
ONLY FIGURED DIMENSIONS ARE TO BE USED AND CONTRACTOR MUST CHECK ALL DIMENSIONS ON SITE.
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NO.	DATE (YYYY-MM-DD)	DESCRIPTION
DRAWING REVISIONS		

08	2026-04-24	ISSUED FOR TENDER - PHASE 2
07	2026-02-23	ISSUED FOR PHASE 1 CONSTRUCTION
06	2026-02-23	RE-ISSUED FOR BUILDING PERMIT
05	2025-11-07	ISSUED FOR PERMIT AND PHASE 1 TENDER
04	2025-10-14	ISSUED FOR PHASE 1 TENDER
03	2025-09-26	ISSUED FOR FINAL REVIEW
02	2025-07-09	ISSUED FOR ESA PLAN REVIEW
01	2025-06-18	ISSUED FOR OWNER'S REVIEW
NO.	DATE (YYYY-MM-DD)	DESCRIPTION
DRAWING ISSUE		

KEYPLAN:



PROJECT:
QUINTE HEALTH BELLEVILLE
GENERAL HOSPITAL GENERATOR
REPLACEMENT - PHASE 2

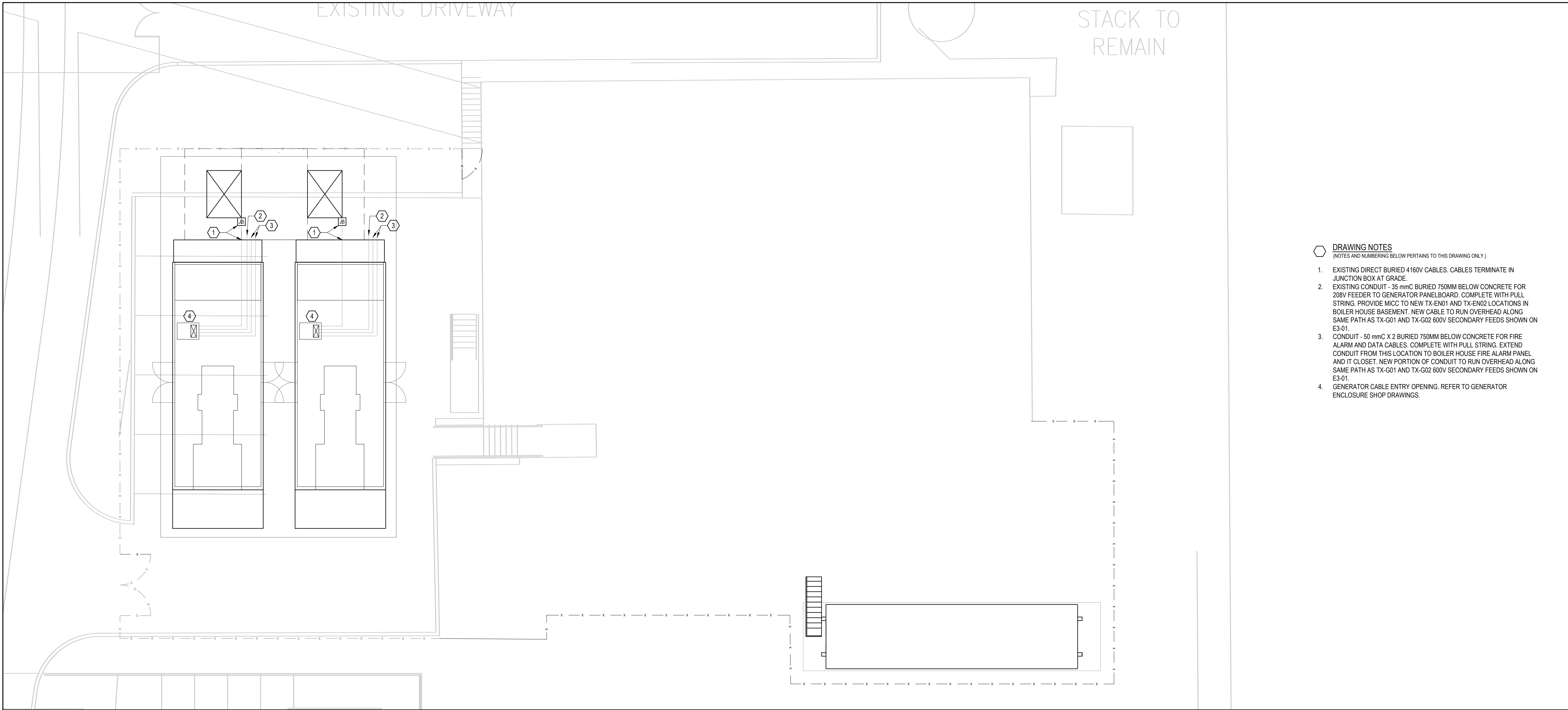
HHA PROJECT NUMBER: 2230693

DRAWING TITLE:
ELECTRICAL OUTDOOR
SUBSTATION DETAILS

PAGE SIZE:	ARCH D	DRAWN BY:
SCALE:	AS INDICATED	CHECKED BY:
DRAWING NUMBER:		

E3-02

FILE NAME: P:\2024\003 - QuinTE Generator Replacement\Eng\Elec\Phase 2\E3-01 Electrical Power and Systems Planning
PLOT DATE: 2026-04-23 11:14



1 4160V SUBSTATION DETAILS
E3-02 1:100



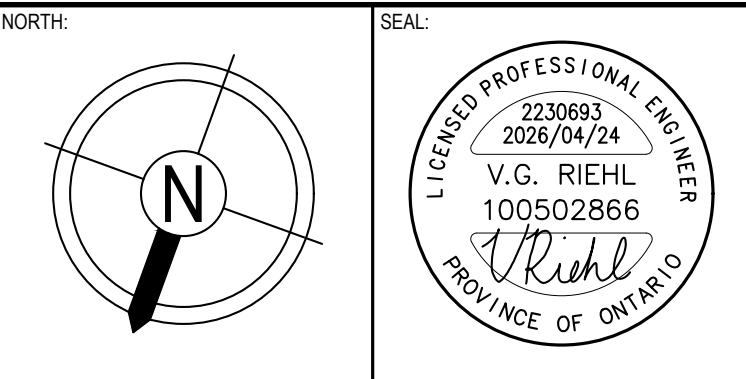
H.H. Angus & Associates Limited
Consulting Engineers
1176 Eglinton Avenue East, Suite 800, Toronto,
ON M3C 0S1 | hhangus.com | 416 443 8200

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DRAWING ISSUE		

KEY PLAN:

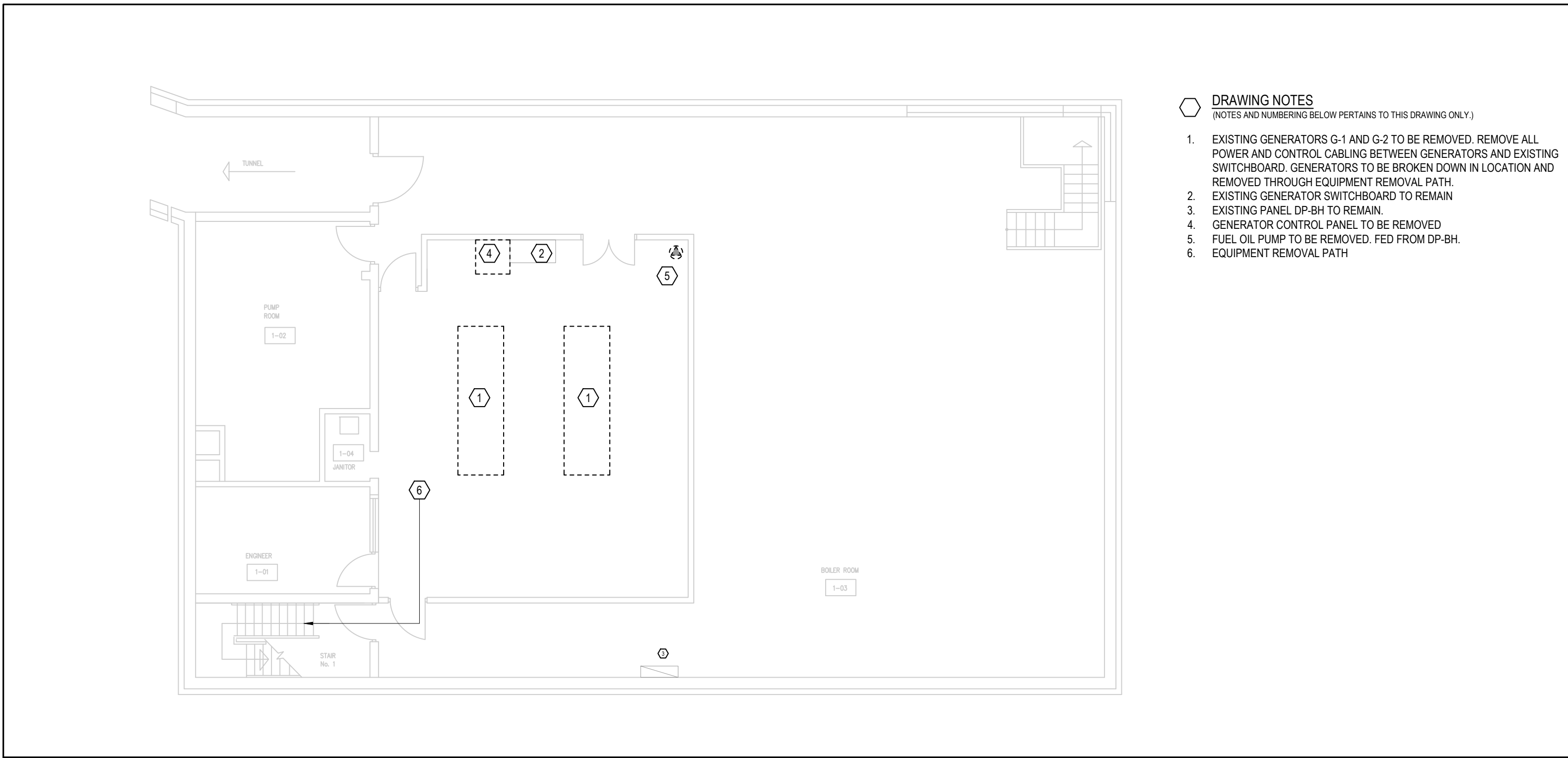


PROJECT:
**QUINTE HEALTH BELLEVILLE
GENERAL HOSPITAL GENERATOR
REPLACEMENT - PHASE 2**

HHA PROJECT NUMBER: 2230693
DRAWING TITLE:
**ELECTRICAL UNDERGROUND
FEEDER DETAILS**

PAGE SIZE:	ARCH D	DRAWN BY:
SCALE:	AS INDICATED	CHECKED BY:
DRAWING NUMBER:		

E3-03



1 EXISTING LAYOUT - BOILER PLANT
E9-01 1:100

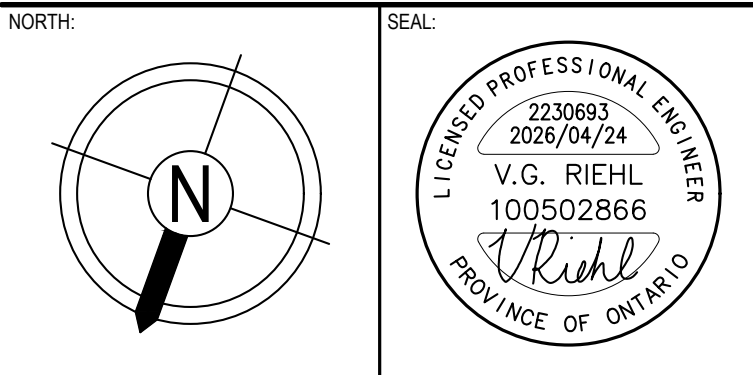
- DRAWING NOTES**
(NOTES AND NUMBERING BELOW PERTAINS TO THIS DRAWING ONLY.)
1. EXISTING GENERATORS G-1 AND G-2 TO BE REMOVED. REMOVE ALL POWER AND CONTROL CABLING BETWEEN GENERATORS AND EXISTING SWITCHBOARD. GENERATORS TO BE BROKEN DOWN IN LOCATION AND REMOVED THROUGH EQUIPMENT REMOVAL PATH.
 2. EXISTING GENERATOR SWITCHBOARD TO REMAIN.
 3. EXISTING PANEL DP-BH TO REMAIN.
 4. GENERATOR CONTROL PANEL TO BE REMOVED.
 5. FUEL OIL PUMP TO BE REMOVED. FED FROM DP-BH.
 6. EQUIPMENT REMOVAL PATH.

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DRAWING ISSUE		

KEYPLAN:



PROJECT:
**QUINTE HEALTH BELLEVILLE
GENERAL HOSPITAL GENERATOR
REPLACEMENT - PHASE 2**

HHA PROJECT NUMBER: 2230693
DRAWING TITLE:
ELECTRICAL DEMOLITION PLAN

PAGE SIZE:	ARCH D	DRAWN BY:
SCALE:	AS INDICATED	CHECKED BY:
DRAWING NUMBER:		

E9-01



**Electrical
Specification**
FOR

BGH GENERATOR REPLACEMENT
Quinte Health

Belleville General Hospital
265 Dundas St E
Belleville, ON K8N 5A9

Issued for Tender – Phase 2
03/30/2026

HHA #2230693

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LIST OF SECTIONS – ELECTRICAL, COMMUNICATIONS, AND SECURITY
26 00 01

DIVISION 26 – ELECTRICAL

26 00 01	List of Sections – Electrical; Communications; and Security
26 01 01	Electrical General Requirements
26 01 02	Qualifications and Authorities - Ontario
26 05 01	Electrical Basic Materials and Methods
26 05 02	Painting for Electrical Services
26 05 07	Excavation and Backfill
26 05 13	High- Voltage Cables
26 05 19	Low-Voltage Electrical Power Conductors
26 05 26.13	Primary Grounding and Bonding for Electrical Systems
26 05 26.16	Secondary Grounding and Bonding for Electrical Systems
26 05 29	Hangers and Supports for Electrical Systems
26 05 32	Splitters; Junction and Pull Boxes; Cabinets
26 05 33	Conduits; Fastenings and Fittings
26 05 35	Outlet Boxes; Conduit Boxes and Fittings
26 05 38	Installation of Cables in Trenches and Ducts
26 05 48	Vibration Isolation for Electrical Systems
26 05 49.20	Seismic Restraint for Electrical Services
26 05 49.23	Seismic Qualification for Electrical Equipment
26 05 53	Identification for Electrical Systems
26 05 73.15	Independent Power System Testing
26 07 03	Wiring for Mechanical Services
26 08 06	Electrical System Studies and Reports
26 08 11	Testing of Integrated Fire Protection and Life Safety Systems
26 08 15	Electrical Commissioning
26 11 11	Outdoor Substation
26 12 16	Dry-Type Medium-Voltage Transformers
26 22 13	Low-Voltage Distribution Transformers
26 26 12	Ground Fault Equipment Protection
26 27 26	Wiring Devices
26 27 28	Wire and Box Connectors 0-1000 V
26 28 16.16	Disconnect Switches up to 1000 V
26 32 13	Power Generation Diesel
26 32 13.53	Walk-in Generator Enclosures
26 77 19.20	Closeout Requirements for Electrical Work

DIVISION 27 – COMMUNICATIONS

Not Used

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

- | | |
|-------------|--|
| 28 46 11 | Fire Alarm Initiating and Input Devices |
| 28 46 21.11 | Addressable Fire Alarm System |
| 28 46 23 | Fire Alarm Notification and Output Devices |

END OF SECTION

ELECTRICAL GENERAL REQUIREMENTS

26 01 01

1 GENERAL

1.1 General Contract Documents

- .1 Comply with General Conditions of the Contract, Supplementary Conditions of the Contract and Division 01 - General Requirements.
- .2 Where content in this Specification section duplicates requirements in various Division 01 Specification sections, this section and the applicable Division 01 sections are to be read together and the most stringent requirements apply.

1.2 Work Included

- .1 Work to be done under Divisions 26, 27 and 28 to include furnishing of labour, materials, equipment and services required for installation, testing and putting into proper operation complete electrical systems as shown, as specified, as intended, and as otherwise required. Complete systems to be left ready for continuous and efficient satisfactory operation.
- .2 Read drawings and specifications together as a whole and in conjunction with other such documents included under the Construction Contract.

1.3 Document Organization

- .1 Applicable Divisions for Electrical Work:
 - .1 Division 26 - Electrical
 - .2 Division 27 - Communications
 - .3 Division 28 - Electronic Safety and Security
- .2 For clarity, any reference in the Contract Documents to Division 26 includes Division 27 and 28.
- .3 The Specifications for these Divisions are arranged in Sections for convenience. It is not intended to recognize, set or define limits to any subcontract or to restrict Contractor in letting subcontracts.
- .4 Contractor is responsible for completion of the Work whether or not portions are sublet.

1.4 Division 26, as it Applies to Division 27 and 28

- .1 Division 26 contains common work requirements that are applicable as necessary to the Work of Divisions 27 and 28 and apply as if written in full within those Divisions.

1.5 Language

- .1 Specifications are written as a series of instructions addressed to the Contractor, and by implication to subcontractors and to suppliers. For clarity and brevity, use is made of numbered lists and bulleted lists. Where the list follows a semi-colon (;) punctuation is for clarity, where the list follows a colon (:) punctuation is to be read as short-hand form of verb "to be" or "to have" as context requires.
- .2 It is not intended to debate with the Contractor reasons for these instructions, and words associated with justification for an instruction or restatement of anticipated performance have been omitted to avoid possible ambiguities.

1.6 Definitions and Abbreviations

- .1 Other specification sections of Divisions 26 to 28 of the Work may also include additional specific definitions and/or abbreviations that apply to that specification section.

- .2 The following terms apply to Divisions 26 to 28 of the Work:
- .1 The words "indicated", "shown", "noted", "listed" or similar words or phrases used in these Specifications, mean that the material or item referred to is "indicated", "shown", "listed" or "noted" on the Drawings or in the Specifications.
 - .2 Wherever the word "listed" is used in conjunction with a product and a product certification standard (including but not limited to CSA, ULC, CGSB, BNQ, UL), it shall be understood to mean that the product is "listed" by an accredited 3rd party testing laboratory as being certified to the referenced product standard.
 - .3 Wherever the words "approved", or similar words or phrases are used in the Specification they shall be understood, unless the context otherwise provides to mean that material or item referred to shall be "approved by" the Owner.
 - .4 Wherever the words "satisfactory", "as directed", "submit", "permitted", "reviewed", or similar words or phrases are used in the Specification they shall be understood, unless the context otherwise provides to mean that material or item referred to shall be "satisfactory to", "as directed by", "submitted to", "permitted by", or "reviewed by" the Consultant.
 - .5 Instructions using any form of the word:
 - (a) "install" means to place in position for service or use.
 - (b) "supply" means to procure and deliver materials, or to make available labour or services for the stated purpose.
 - (c) "provide" means to supply material, labour and services to install the referenced item.
 - .6 The term "building code" means the edition of the applicable building code at the location of the Work at the time of obtaining a building permit.
 - .7 The terms "electrical code" and "electrical safety code" mean the edition of the applicable electrical safety code adopted by regulation at the location of the Work at the time of obtaining an electrical works permit.
 - .8 The term "AHJ" and "local authority" means the "Authority Having Jurisdiction" and can include the local building inspector, the local fire department and the electrical safety inspector or their agents.
 - .9 Wherever manufacturers or manufacturer's products are identified in lists under the phrase "Standard of Acceptance", these are manufacturers and/or products which meet the project standards in regard to performance, quality of material and workmanship.
- .3 The following abbreviations apply to this specification section:
- .1 NECA – National Electrical Contractors Association

1.7 Examination

- .1 Examine any existing buildings and services, local conditions, building site, Specifications, and Drawings and report any condition, defect or interference that would prevent execution of the Work.
- .2 No allowance will be made for any expense incurred through failure to make these examinations of the site and documents prior to Tender or on account of any conditions on site or any growth or item existing there which was visible or known to exist at time of Tender.
- .3 Before commencing work under this Division, examine the work of other Divisions of the Work and report any defect or interference.

1.8 Design Services

- .1 Provide specialty design services for elements of the Work where specified in other sections of Division 26. Drawing and specifications prepared by such specialty design service providers shall be sealed by a professional engineer licensed in the jurisdiction of the Work.

1.9 Product Substitutions

- .1 In the absence of requirements concerning product substitution requests in Division 01, Contractor may propose a substitute product to that which is specified in accordance with the following.
- .2 All proposed substitutions shall be submitted using the Consultant's product substitution form and include all information stated therein.
- .3 The use of a substitute article or material which the Contractor represents to be of at least equal quality and of the required characteristics for the purpose intended may be permitted, subject to the following provisions:
 - .1 a substitution will not be considered for reasons of meeting the construction schedule unless the Contractor can demonstrate to the satisfaction of the Consultant that all reasonable efforts have been made to procure the specified product or material in a timely fashion,
 - .2 the manufacturer to advise the Consultant of the intention to use an alternative article or material before doing so,
 - .3 the burden of proof as to the quality and suitability of alternatives to be upon the manufacturer, the manufacturer to supply all information necessary, as required by the Consultant, at no additional costs to the contract,
 - .4 the Consultant to be the sole judge as to the quality and suitability of alternative materials and the Consultant's decision to be final,
 - .5 where use of an alternative material involves redesign or changes to other parts of the Work, the costs and the time required to affect such redesign or changes will be considered in evaluating the suitability of the alternative materials,
 - .6 no test or action relating to the approval of substitute materials is to be made until the request for substitution has been made in writing by the manufacturer and has been accompanied by complete data as to the quality of the materials proposed, such request to be made in ample time to permit appropriate review without delaying the Work, taking into consideration that such a substitution request may be rejected requiring that the product or material as originally specified be provided,
 - .7 whenever classification, listing, or other certification by a recognized standards body is a part of the specifications for any material, proposals for use of substitute materials is to be accompanied by reports from the equivalent body indicating compliance with the requirements of the specifications,
 - .8 the costs of testing required to prove equality of the material proposed to be borne by the manufacturer.]

2 SHIPPING, HANDLING AND STORAGE

2.1 Shipping

- .1 Provide adequate protection of equipment during shipping and handling to provide equipment at the site in ex-works condition when handled by commercial carrier systems.
- .2 Each drawout element such as high voltage circuit breakers, power circuit breakers, transfer switch modules, etc. to be packaged separately from its associated enclosure.
- .3 Provide as necessary, removable bracing of the internal components in each item of equipment so that the equipment can be moved on its side or back, without sustaining damage.
- .4 Where removeable internal bracing has been provided, the equipment to be provided with warning labels to call for the removal of the shipping bracing prior to energization.
- .5 Any component packaged or shipped separately to be individually crated and tagged with unit number and the equipment number of the assembly to which it belongs.

- .6 Provide each "shipping section" with a permanently-attached, readily-visible identification tag bearing the equipment number of the assembly of which it is a part.

2.2 Storage

- .1 Store equipment and materials at the worksite to protect them from any damage until placed into its final location. Maintain similar protection of installed equipment and materials to protect against damage until they are turned over to the Owner. Make good any damage to equipment or materials up to the time of ready for takeover
- .2 Store electrical materials and equipment such as switchboards, panels, transformers, bus ducts, fire alarm devices, luminaires, etc., in a dry, clean location and cover with polyethylene plastic to preserve factory finish.
- .3 Protect exposed or free standing equipment with plastic to minimize entry of dust and dirt and marring of finished surfaces during progress of work.
- .4 Schedule luminaires, lamps, diffusers and fire detectors for installation as late as possible during construction in order to minimize accumulation of dust and/or dirt on them. Clean luminaires and diffusers, not acceptable because of dust and dirt, in an approved manner in accordance with the manufacturer's instructions. Wrap surface mounted and suspended luminaires and fire detectors, installed prior to painting or dusty construction being completed in the area, in plastic to prevent dirt or paint from settling on them.
- .5 Wrap bus ducts in heavy gauge plastic to adequately prevent moisture and dirt from entering bus duct. Wrapping to remain until bus ducts are ready to be energized.
- .6 Provide adequate ventilation and temporary heating to prevent condensation of moisture within the enclosed equipment.

2.3 Provisions for Handling and Field Erection

- .1 For equipment that will require hoisting on site, provide removable side panels, lifting angles or lifting plates to accommodate the use of slings or crane hooks, for each shipping section.
- .2 For floor mounted equipment, provide on each shipping section, removable steel channel base plates to permit use of pipe rollers or dollies without damaging the equipment.

3 OWNER'S SPECIAL REQUIREMENTS FOR EXISTING SITES

- .1 The following special requirements are in addition to the requirements of Division 01 of the Work.
- .2 Provide a written list of names of employees and sub-trades employees entering the building, advising which areas they need access to at least 48 hours prior to expected time of arrival. This lead time is required to prearrange security passes.
- .3 Security passes to be visibly worn at all times by all employees.
- .4 Trades people to strictly adhere to Owner's building security procedures otherwise entrance into the building will be denied.
- .5 Trades people are to enter via the entrance identified by the Owner.
- .6 Park vehicles in designated areas. Do not block driveways.
- .7 Use only the freight elevator to transport tools and material. Freight elevator door to be shut immediately after exiting the cab.
- .8 Do not disable or activate any electrical or mechanical system without prior approval by the Owner's Project Manager. Also, prior to disabling or activation of any electrical or mechanical system, obtain approval from Building Operations and Building Security.

- .9 Submit prior notification to Building Security Staff before any construction activity commences which will result in heat, smoke, dust or fumes, such as welding, saw cutting, soldering, spray painting, which might affect sensitive fire detection and protection equipment.
- .10 Submit notifications sufficiently in advance such that the Owner will have at least 48 hours to make the necessary arrangements should Building Operations deem that work on a particular system requires a security escort. A security escort will be required for any work being done in secured areas, e.g. raised floor, computer room and mechanical/electrical rooms.
- .11 Provide at least 48 hours prior notification to Building Operations for any fire system isolation requests.
- .12 Schedule work and meet with sub-trades daily on site, to show trades people the work areas and work to be done.
- .13 Trades-people are to supply and use their own tools. No tools, ladders or equipment, etc. will be loaned by the Owner.
- .14 Provide environmental cleaning of the job site daily during construction and upon completion. This includes both under raised floor and above ceiling. Do not store materials or garbage on the loading dock.
- .15 Provide special care, attention and protection when transporting equipment and materials to prevent accidental damage to fire protection equipment, finishes, furnishings and fixtures.
- .16 "No Smoking" – this is a smoke-free building. Violators will be asked to leave and may be denied reentry. Smoking is not allowed on the roof.
- .17 If Building Operations deems that work on a particular system requires security escort, allow 48 hours to make appropriate arrangements.
- .18 For any open flame work, a fire extinguisher and security fire watch is required, and will be provided and paid for by the Owner. Provide 48 hours prior notice to allow the Owner to make the necessary arrangements.
- .19 Obtain the approval of the Building Manager for the storage of materials on site.
- .20 Perform a daily cleanup prior to leaving the site.
- .21 Secure oxygen and acetylene cylinders at all times and capped nightly.
- .22 Restore operating and redundant systems to their normal condition at the end of each work day.
- .23 At the conclusion of each work day, the Contractor's superintendent/supervisor is to advise the Building Manager on the day's activities and plans for the next day's work.

4 PROGRESS PAYMENT PROCEDURE

4.1 Schedule of Values

- .1 [Provide schedule(s) of values for progress payments in accordance with this part.
- .2 Prepare and submit a schedule of values ("SOV") for the Division 26 Work.
- .3 Each SOV is to be in the sample format shown in Article "Attachments", specifically that the SOV is to include four sections for:
 - .1 Contract price work element breakdown, which includes:
 - (a) detailed breakdown by work element as agreed with the Consultant,
 - (b) line items for coordination drawings, as-built documents and operating manuals,
 - (c) a summary line item for authorized Cash Allowance disbursements (if applicable),
 - (d) line items for each Itemized Price (if applicable),
 - (e) line items for each Separate Price (if applicable and included in the Contract Price)

- (f) a line item for the total of the original contract work element values,
- (g) a summary line item for approved change instructions,
- .2 Cash Allowance disbursement authorization, with separate work elements for each cash allowance,
- .3 Approved Change Instructions, with separate work elements for each change instruction,
- .4 Outstanding Change Instructions which are either not quoted or not yet approved.
- .4 Each work element in the SOV sections (except Outstanding Change Instructions) is to include:
 - .1 the original contract value and the percent of original contract total value (Contract Price section only),
 - .2 the completed to date amount and percent of original work element contract value,
 - .3 the previously billed amount and percent of original work element contract value,
 - .4 the current billing (payment request) amount and percent of original work element contract value, and
 - .5 the balance to complete amount and percentage of original work element contract value.
- .5 The required Contract Price work element breakdown will be determined by the Consultant, with the level of breakdown appropriate to the project such as
 - .1 by trade,
 - .2 by specification section or portion thereof,
 - .3 by labour vs material,
 - .4 by location in the building,
 - .5 or any combination of the above.
- .6 Submit a draft SOV for review and approval by the Consultant at least three weeks before the first request for progress payment. Do not submit requests for progress payments until the SOV has been reviewed and there are no outstanding comments from the Consultant.
- .7 Make requests for progress payments using the values on the reviewed SOV.
- .8 When a change in the Work has been approved by the Owner, include the approved changes on the SOV for the next payment application, whether or not payment is requested in full or in part for that change in that payment request period.
- .9 For each SOV, include a line item "As-Built & Operating Manuals" and includes a value that is the greater of:
 - .1 the value of the work or,
 - .2 1% of the Division 26 contract price.

Payment of the indicated amount will not be made until satisfactory documents have been received by the Consultant. Where satisfactory documents are not received, a Change Directive and an associated Change Order will be issued to delete this work element and the amount from the Contract Price.]

5 CONSTRUCTION CHANGES

5.1 General

- .1 [The valuation method to be used for a change instruction to the Work is to be determined by the Consultant from the following methods:
 - .1 by labour and material when the change instruction is by a Change Directive;
 - .2 by unit prices set out in the Contract or subsequently agreed upon for other change instructions;

- .3 by a detailed quotation for other change instructions; or
- .4 by a Cash Allowance Disbursement instruction.

5.2 Definitions

- .1 The following definitions apply to this section
 - .1 **RS Means manual** – the trade pricing reference book published by Codian Group Inc. that is applicable to the jurisdiction of the project.
 - .1 **Base wage rate** – the hourly rate actually paid to the trades person, determined in accordance with applicable collective bargaining agreement, or in their absence the actual gross wages paid to the worker.
 - .2 **Job Site Impact Multiplier** – a multiplier expressed as a decimal number that is included in the Labour Rate to account for special job site conditions that affect labour availability, labour productivity, procurement of materials, and materials management, that are specific to the project and site conditions.
 - .3 **Indirect labour** – any labour that is neither journeyperson labour that directly performs the work nor labour that directly supervises journeyperson(s).
 - .4 **Labour Rate** – the actual fully burdened labour cost per hour of labour consumed by a trades person including statutory and regulatory burden, collective bargaining burden, and other project related burden. For greater clarity, the labour rate includes but is not limited to the following:
 - (a) base wage rate,
 - (b) vacation and statutory holiday pay,
 - (c) union deductions and additional union charges,
 - (d) Legislated burdens including EHT, WSIB, EI, CPP, RST on H/W
 - (e) wage-based taxes,
 - (f) job site impact multipliers,
 - (g) expendable small tools charge,
 - (h) project insurance,
 - (i) financing of payroll,
 - (j) estimating,
 - (k) rest breaks and idle time,
 - (l) safety including training, safety meetings, WHMIS, fall protection, personnel protection equipment, and safety committees,
 - (m) preparation and handling of shop drawings and other submittals,
 - (n) preparation of as-built documents, including operation and maintenance manuals,
 - (o) labour warranties,
 - (p) site facilities,
 - (q) clean-up,
 - (r) parking.
 - .5 **Foreperson** – a first level supervisory position having direct control over the work performed by journeypersons.
 - .6 **Journeyperson** – a person working in a skilled construction trade which may be prescribed by regulation, and includes apprentices.
 - .7 **Labour Unit** – the number of journeyperson labour hours or part thereof, required to perform a specific construction task, and includes but is not limited to:
 - (a) receiving, unloading, stockpiling, distribution and handling of materials and equipment,

- (b) rigging or erecting of materials or equipment,
 - (c) fitting and joining of materials,
 - (d) pressure testing of piping and ductwork systems,
 - (e) testing of equipment and systems,
 - (f) electrical labour productivity factors in accordance with NECA.
- .8 **Line materials** – components that make up a distribution network for fluid, power, or electronic/digital information, and includes:
- (a) piping, pipe fittings, valves (of all kinds), pipe strainers and other pipe mounted equipment,
 - (b) ducting, duct fittings, duct balancing dampers and other duct mounted equipment,
 - (c) conduit, cable tray, cable, conductors, and wiring,
 - (d) supports, hangers and restraints,
 - (e) vibration isolators and seismic restraints associated with line materials,
 - (f) instrumentation including gauges and sensors/transmitters,
 - (g) electrical, pneumatic, and hydraulic actuators for valves and dampers, and
 - (h) any coatings or other protective elements applied thereto including insulation and painting.
- .9 **NECA manual** – the trade pricing reference book published by the National Electrical Contractors Association.
- .1 **Overhead** – administrative expenses of the Contractor's business and the project which are not included in a Labour Rate or Labour Unit. For greater clarity, overhead includes but is not limited to the following:
- (a) company office, storage, and fabrication spaces, and associated maintenance, utilities, and expenses,
 - (b) project site office, fabrication and storage spaces, washrooms, break rooms, and associated maintenance, utilities, and expenses,
 - (c) company office equipment, furniture and supplies,
 - (d) project site office equipment, furniture and supplies,
 - (e) labour time for project managers and project assistants,
 - (f) project site security,
 - (g) project site clean-up, recycling and waste disposal,
 - (h) materials management,
 - (i) property taxes, business licenses, and auto insurance,
 - (j) dues and subscriptions,
 - (k) postage and courier,
 - (l) advertising, telephone, IT services and equipment,
 - (m) legal and accounting fees and expenses,
 - (n) sales and marketing,
 - (o) salaries and benefits for company indirect labour including company management, sales force, dispatchers, estimators, clerical staff, and at-office general (non-trades) labour.
 - (p) all other indirect labour.
- .2 **Senior Foreperson** – the second (and subsequent) level supervisory position having direct control over one or more Forepersons, where the number of Forepersons supervised is in accordance with local regulatory requirements or collective bargaining agreements. ("Superintendent" or "Supervisor" has the same meaning.

5.3 Change Directive Method

- .1 Except where otherwise determined in the Construction Contract or Division 01 specification, the valuation of changes by the Change Directive method shall comply with the following:
 - .1 the form of presentation of costs and methods of measurement shall be agreed to by Consultant and Contractor before proceeding with the change,
 - .2 the adjustment in the Contract Price for a change carried out by way of Change Directive shall be determined on the basis of the cost of the Contractor's actual expenditures and savings attributed to the Change Directive. For clarity and by example, savings for deductions of similar materials, equipment, labour or services shall be valued at the same amount as for expenditures for additions of same.
 - .3 labour costs will be determined based on actual time spent and the agreed labour rate, the actual cost of installed line materials and equipment, and the agreed fee for overhead and profit,
 - .4 if the change results in a net decrease in Contract cost, the contract price will be decreased by the net decrease in the cost, without adjustment for the Contractor's percentage fee for overhead and profit,
 - .5 the Contractor shall keep accurate records, in an agreed upon form, of time, quantities and invoiced costs and present an account of the cost of the change in the Work, together with vouchers, material receipts and invoices,
 - .6 this time and material method shall be used until such time as a total cost estimate of the change is agreed between the Owner and the Contractor, at which time all payments made under this time and material method will be credited against the agreed total cost for the change.

5.4 Unit Price Method

- .1 Costing of changes by the Unit Price method:
 - .1 Costs for work identified by agreed unit costs shall be charged at those rates, unless the Owner agrees to other rates.

5.5 Proposed Changes; Other Change Instructions Method

- .1 For proposed changes to the Work or other similar instructions, submit a detailed quotation for approval.
- .2 The adjustment in the Contract Price for a change carried out by way of proposed change or other similar instruction shall be determined on the basis of the cost of the Contractor's actual expenditures and savings attributed to the Proposed Change. For clarity and by example, savings for deductions of similar materials, equipment, labour or services shall be valued at the same amount as for expenditures for additions of same.
- .3 Costs are to be approved by the Owner before the proposed change to the Work proceeds. The quotation for the change to the Work is to include a summary of charges made up of three components: labour charges, material costs and fees.
- .4 Labour Charges:
 - .1 The labour unit hour estimates are to be based on the current RS Means estimating manual or NECA manual unless otherwise agreed by the Consultant;
 - .2 The labour cost is to be determined using the agreed labour rates.
 - .3 Labour rates for Foreperson and Senior Foreperson shall be as per agreement, or in absence of such agreement shall be 1.15 times the journeyperson labour rate. The maximum allowable labour hours for supervision are not to exceed:
 - (a) for a Foreperson, a maximum of 10% of the total calculated journeyperson hours on a change, and

(b) for a Senior Foreperson of all levels, a maximum combined amount of 3% of the total calculated journeyperson hours on a change.

(c) no other supervisory hours will be permitted.

.5 Material Charges:

.1 Material costs for line materials and installed equipment are to be net of trade discounts. The discount to be applied to list prices for items included in RS Means manual or NECA manual shall not be less than:

(a) 20% for line materials, and

(b) 10% for equipment that is not line material.

.6 Fees:

.1 The Contractor and any sub-contractor is allowed a combined overhead and profit fee of 15% for work to be performed by their own forces,

.2 The Contractor and any sub-contractor is allowed a combined overhead and profit fee of 5% for work performed by a sub-contractor (in the case of the Contractor) or a sub-sub-contractor (in the case of work performed for a sub-contractor),

.3 For clarity, the allowable fees on direct work and on sub-contracted work apply to a sub-sub-contractor of any tier.

5.6 Cash Allowances; Contingency Allowances

.1 Instructions for changes to the Work to be performed under a cash allowance or contingency allowance ("Allowance") included in the contract price shall be authorized by a Cash Allowance Disbursement instruction.

.2 Except as described below, the determination of costs for Work performed under an Allowance shall be in accordance with the procedure for proposed changes unless otherwise instructed to proceed with the work, in which case the cost of such work shall be valued in accordance with the procedures for Change Directive.

.3 The contract price, not the Allowance, includes the overhead and profit fee for the value of the Allowance.

.4 Except where otherwise specified in the Construction Contract, where the cost of the Work performed under a Cash Allowance Authorization;

.1 is less than the Allowance value, the contract price includes the overhead and profit for the contractor and any sub-contractors. A change order will be issued for a credit for the balance of the Allowance, but shall not include the associated overhead and profit fee.

.2 exceeds the Allowance value, a Change Order will be issued for the amount in excess of the Allowance, and the excess amount is to include the agree fee for overheat and profit.]

6 SUBMITTALS

6.1 Shop Drawings and Product Data

.1 Submit shop drawings, manufacturers and product data and samples in accordance with the requirements of Specification sections of Division 01, this Part, and as further required in other specification Sections of Division 26.

.2 Submit for each item of equipment.

.3 Submit shop drawings in the same unit of measure as used on the drawings. Both metric and U.S. customary measures may be included.

- .4 Submit shop drawings by email to: shopdrawings@hhangus.com , except where a project document management web-service is used.
- .5 Include an H.H. Angus shop drawing cover sheet form prepared for this project, for each shop drawing submittal (refer to part "Attachment" for an example of this form), or, include the same information on the contractors submittal cover sheet:
 - .1 Provide the following information on each submission;
 - (a) Client/Architect name,
 - (b) Project Name,
 - (c) H.H. Angus project number,
 - (d) Date,
 - (e) Contractor name,
 - (f) Contractor reference No.,
 - (g) Manufacturer name,
 - (h) Product type,
 - (i) Specification section number,
 - (j) Contractor trade category: architectural, structural, conveying equipment, user equipment, mechanical, electrical, telecommunications, civil or other.
 - (k) If a re-submission, the Consultant's previous submittal reference number.
- .6 Submit shop drawings in PDF format except as follows;
 - .1 if the Consultant agrees to a shop drawing to be submitted in hardcopy format, submit in 11 x 17, black and white originals of graphic quality suitable for photocopying and digital scanning. Allow one additional week for processing of shop drawings submitted in hardcopy format.
- .7 Manufacturers' printed product data sheets for standard items are acceptable in place of shop drawings provided that physical characteristics are identified and are related to specification references.
- .8 Submit manufacturers' data sheets with typed schedules listing manufacturers' and suppliers' name and catalogue model numbers for such items as fire alarm system components, etc.
- .9 For luminaires, submit bound sets of luminaire fixture sheets with manufacturers' names and catalogue numbers for all luminaires to be used on the project. Identify and arrange the luminaire fixture sheets and catalogue numbers in the same sequence as the Specification Luminaire List.
- .10 Shop drawings and/or product data sheets to show;
 - .1 CSA or equivalent approval,
 - .2 dimensioned outlines of equipment and construction details,
 - .3 equipment weights and center of gravity,
 - .4 performance ratings,
 - .5 dimensioned details showing service connection points,
 - .6 general routing of bus ducts and connecting services,
 - .7 mounting and fixing arrangements,
 - .8 operating and maintenance clearances,
 - .9 access door swing spaces,
- .11 Where applicable, include;
 - .1 wiring, single line and schematic diagrams,
 - .2 diagrams showing interconnection with work of other Sections,

- .3 elevations illustrating locations of visible equipment such as pilot lights, breakers and their trip settings, windows, meters, and access doors,
 - .4 component assemblies,
 - .5 trip settings,
 - .6 description of operation.
- .12 Check and stamp each shop drawing as being correct before submission. Shop drawings without such stamps will be rejected and returned.
- .13 Keep one copy of each reviewed shop drawing and product data sheet on site and have them available for reference purposes.
- .14 Where equipment is delivered without reviewed shop drawings, equipment will be condemned and is to be removed from site and replaced with new equipment after shop drawings have been submitted and reviewed.

6.2 Coordination, Fabrication, or Installation Drawings

- .1 Contractor's coordination, fabrication, installation, and/or sleeving drawings will not be reviewed as shop drawings. If submitted as a shop drawing, a transmittal will be returned identifying that the submitted drawings have not been reviewed as a shop drawing.
- .2 Maintain a copy on site of such drawings for reference by the Consultant.
- .3 The Consultant reserves the right to request selected Contractor's coordination, fabrication, or installation drawings for review.

6.3 Effect of Consultants Review of Submittals

- .1 Consultant's review of shop drawings is performed on a sampling basis only, to confirm to Consultant's satisfaction that the Contractor understands the Work to be performed and is interpreting the design documents correctly, and such reviews are performed for the benefit of the Owner.
- .2 For greater certainty, the review of shop drawings by Consultant does not constitute a quality control function for the benefit of Contractor, nor does such a review relieve Contractor of their responsibility for complying with the Contract documents.

7 APPLICABLE CODES AND STANDARDS; PERMITS

7.1 Codes, Standards and Regulations

- .1 Where a published product standard or installation code is adopted by statute or regulation by an applicable AHJ, the applicable edition of the standard or code is the one that has been adopted
 - .1 at the time of obtaining a permit for the applicable portion of the Work, or
 - .2 in the absence of a requirement for a permit, the start date of construction.
- .2 Where a published product standard or installation code is not adopted by statute or regulation, then the most current edition of that standard or code at the start date of construction applies.
- .3 Install electrical systems in accordance with the electrical safety code adopted by the AHJ responsible for electrical safety at the location of the Work.
- .4 Install underground systems in accordance with the latest edition of CSA C22.3 No.7 *Underground Systems* except where specified otherwise.
- .5 Comply with CSA Certification Standards and safety bulletins issued by the AHJ for electrical safety applicable to the place of the Work

- .6 Where requirements of this specification exceed those of the above mentioned codes, standards, bulletins, this specification is to govern.
- .7 In the event of a conflict between codes, bulletins, regulations, or standards, or where work shown is in conflict with these documents, obtain interpretation before proceeding. Failure to clarify any ambiguity will result in an interpretation requiring the application of the most demanding requirements.

7.2 Confined Spaces

- .1 Unless otherwise prescribed by the Constructor's/Owner's workplace safety program, treat spaces not designed and constructed for continuous human occupancy as "confined spaces" in accordance with applicable health and safety legislation, including but not limited to;
 - .1 horizontal and vertical service spaces, shafts, and tunnels,
 - .2 inside of equipment which permits entry of the head and/or whole body, and
 - .3 ceiling spaces which are identified as containing a hazardous substance.

7.3 Permits, Fees and Inspections

- .1 Where required by legislation at the place of the Work, submit to the AHJ for electrical safety the necessary number of drawings and specifications for examination and approval prior to commencement of work.
 - .1 [for information, the Consultant has submitted or will be submitting the drawing plans to the AHJ for electrical safety for plans review.
- .2 Arrange and pay for permits, tests, and Certificates of Inspection required by the AHJ for electrical safety.
- .3 Consultant will provide drawings and specifications required by the AHJ for electrical safety at no cost.
- .4 Notify Consultant of changes required by the AHJ for electrical safety prior to making changes.
- .5 Furnish to Consultant, Certificates of Acceptance from the AHJ for electrical safety upon completion of the Work.

8 COMMON PRODUCT REQUIREMENTS

8.1 Standard of Material and Equipment

- .1 Provide materials and equipment in accordance with This Division.
- .2 Materials and equipment:
 - .1 new and of uniform pattern throughout the Work,
 - .2 of Canadian manufacture where obtainable,
 - .3 standard products of approved manufacture,
 - .4 labelled or listed (certified) to applicable standards in accordance with specification sections of the Work and as required by the AHJ for electrical safety; where there is no alternative to supplying equipment which is not certified, obtain special approval from the AHJ for electrical safety.
 - .5 in compliance with Standards and Regulations with respect to;
 - (a) chemical and physical properties of materials,
 - (b) design,
 - (c) performance characteristics, and
 - (d) methods of construction and installation,
 - .6 identical units of equipment to be of same manufacture within any unit of equipment,

- .7 identical component parts to be of same manufacture, but various component parts comprising the unit need not be from one manufacturer.
- .3 Materials and equipment are described to establish standards of construction and workmanship. Where manufacturers and/or products are listed under "Standard of Acceptance", select manufacturers and or products from these lists. Use of manufacturers or products other than as listed are subject to specification requirements concerning requests for substitution.
- .4 Include items of material and equipment not specifically noted on Drawings or mentioned in Specifications but which are required to make a complete and operating system.
- .5 Confirm capacity or ratings of equipment being provided, when based on ratings of equipment being provided under other trade Sections, before such items are purchased.
- .6 Provide equipment marked for use with 75°C wiring or with a higher temperature rating. If equipment is not marked with a temperature rating or if the only rating available is less than 75°C, increase the associated conductor sizes accordingly, to the satisfaction of the consultant.
- .7 Factory fabricate control panels and component assemblies are to be listed for electrical safety requirements.
- .8 Select materials and equipment in accordance with manufacturer's recommendations and these Specifications, and install in accordance with manufacturer's instructions and these Specifications,
- .9 Materials and equipment not satisfying these selection criteria will be condemned. Remove condemned materials from job site and provide properly selected and approved materials.

8.2 Voltage Ratings

- .1 Operating voltages: to latest edition of 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. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

8.3 Manufacturers Nameplates

- .1 Provide manufactured equipment with metal nameplate with raised or recessed lettering, mounted on each piece of equipment.
- .2 Manufacturer's nameplate to indicate equipment size, capacity, model designation, manufacturer's name, serial number, voltage, cycle, phase and power rating, and approval listings.
- .3 Certified products are to clearly show the mark of the certification agency when in the final installed state.

8.4 Finishes

- .1 Primary and final painting for Work, other than items specified as factory primed or finished, to be done under Finish Division 9.
- .2 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
- .3 Touch-up factory painted prime and/or final coats damaged during construction, with colour matching paint recommended by the equipment manufacturer.
- .4 Leave a quart can or a pressurized spray can of paint, as used with switchboards, with Owner for touch-up purposes.
- .5 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

8.5 Provision for Future

- .1 Where space is indicated as reserved for future equipment or for future extension to building, leave such space clear and install piping, raceways and equipment so that connections can be made to future apparatus or building.
- .2 Identify provisions and service terminations for future on Record Drawings.

8.6 Pre-purchased Equipment; Damage and Ownership

- .1 At time of receipt of pre-purchased or pre-tendered equipment at the job site by the installing electrical contractor, provide the services of the manufacturer/distributor/supplier's technical representative to:
 - .1 inspect the equipment prior to unloading,
 - .2 witness the unloading and advise the contractor on the appropriate method for handling the equipment in order to avoid damage during the unloading, moving and setting in place phase of the equipment, and
 - .3 report any damage to the Consultant.
- .2 In the event that the equipment or cable is found to be damaged before unloading it is to be returned immediately to the factory for repairs and/or replacement by the manufacturer/supplier.
- .3 In the event of damage occurring at any time during unloading and until the equipment is accepted by the Owner, the installing contractor is responsible for repairs and/or replacement of the damaged equipment to the satisfaction of the Owner.

9 OFFICE, STORAGE & TOOLS

9.1 Office and Storage

- .1 Provide temporary office and lunchroom facilities, workshop, tools and material storage space in accordance with Division 01.

9.2 Tools, Temporary Equipment and Materials

- .1 Provide tools, equipment, scaffolding, extension cords, lamps and miscellaneous consumable materials, as required to carry out the Work.

10 COORDINATION; INSTALLATION DRAWINGS

10.1 Coordination

- .1 Consultant's drawings are diagrammatic and illustrate the general location of equipment, and intended routing of ductbanks, conduits, cable trays, feeders, etc. and do not show every structural detail. In congested areas drawings at greater scale may be provided to improve interpretation of the Work. Where equipment or systems are shown as "double line", they are done so either to improve understanding of the Work, or simply as a result of the use of a CAD drawing tool, and in either case such drawings are not represented as fabrication or installation drawings.
- .2 Lay out and coordinate the Work to avoid conflict with work under other Divisions.
- .3 Make good damage to Owner's property or to other trade's work caused by inaccurate layout or careless performance of the Work.
- .4 Where equipment provided under other Divisions connects with material or equipment supplied under this Division, confirm capacity and ratings of equipment being provided.
- .5 Take information involving accurate measurements from dimensioned Architectural Drawings or at the building.
- .6 Install services and equipment which are to be concealed, close to the building structure so that furring is kept to minimum dimensions.

- .7 Location of conduit, bus duct, raceways and equipment may be altered without extra cost provided instruction is given or approval is obtained, in advance of installation of items involved. Changes will be authorized by site instructions and are to be shown on Record Drawings.
- .8 Include incidental material and equipment not specifically noted on Drawings or mentioned in Specifications but which is needed to complete the Work as an operating installation.

10.2 Field, Fabrication, and Installation Drawings

- .1 Prepare field, fabrication, and/or installation drawings to show location of equipment and relative position of services and to demonstrate coordination with the work of other trades;
 - .1 drawing scale: minimum 1:50 (1/4"=1'-0"),
 - .2 use information from manufacturer's shop drawings for each trade and figured dimensions from latest Architectural and Structural Drawings,
 - .3 layout equipment and services to provide access for repair and maintenance,
- .2 Circulate drawings to other trades involved in each area, and conduct coordination meetings with those trades.

11 ANCHORS AND INSERTS

- .1 Supply anchor bolts and locating templates for installation in advance of concrete pouring.

12 CUTTING AND REMEDIAL WORK

12.1 General

- .1 Assume responsibility for prompt installation of work in advance of concrete pouring, masonry, roofing, finishing and similar work. Should any cutting or repairing of either unfinished or finished work be required because such installation was not done, employ the particular trade, whose work is involved, to do such cutting and patching and pay for any resulting costs.
- .2 Neatly cut or drill holes required in existing building elements to accommodate equipment such as cables, raceways, bus ducts, cable trays, etc.
- .3 Arrange and pay for cutting and patching as required for the Work. Before cutting, drilling, or sleeving structural load bearing elements, obtain the Consultant's approval of location and methods in writing. Employ original installer or expert in the finishing of material required to perform cutting or patching for weather-exposed, moisture-resistant elements or sight-exposed surfaces.

12.2 Structure Scanning and Cutting

- .1 Layout cutting of structural elements, such as floor slabs, walls, columns or beams and obtain approval before starting work. Conduct an initial electromagnetic or ground-penetrating radar scan of reinforcing rods and electrical conduit, such as by use of Hilti PS200/250 Ferrosan, and review with Structural Engineer.
- .2 Layout cutting of structural elements, such as floors slabs, walls, columns or beams and obtain approval before starting work. Conduct an initial electromagnetic scan of reinforcing rods and electrical conduit, and review with structural engineering Consultant.

Standard of Acceptance

- Hilti - fig. PS 300 Ferrosan
- .3 Based on the preceding results, arrange and pay for supplemental radiographic examination where necessary to improve on locating concrete reinforcement, conduits and other embedment's.
 - .1 submit radiographic results to the structural engineer and obtain comments before starting work,

- .2 the use of radiographic imaging methods is subject to approval by the Owner on a case by case basis.
- .4 As an alternative to radiographic examination for areas where the Owner does not permit radiographic examination, based on the preceding results, provide two-dimensional ground penetrating radar scans to locate concrete reinforcement, conduits and other embedment's. Scanners to be operated by personnel trained by the measurement device manufacturer.

Standard of Acceptance

- ° Hilti PS1000 X-SCAN
- .5 Relocate core drilling location if steel, conduit or other embedment is found in the proposed location and repeat procedure. Repair and reroute any circuits damaged by core drilling.
- .6 Scan for all shots and anchors in floors, walls, and ceilings.

13 PROTECTION OF PERSONNEL, WORK, AND PROPERTY

13.1 Personnel Protection

- .1 Without limiting the Contractor's responsibilities regarding occupational health and safety requirements at the construction site, provide specific personnel protection as follows:
 - .1 protect exposed live equipment during construction for personnel safety,
 - .2 shield and mark live parts "LIVE 120 VOLTS", or with appropriate voltage,
 - .3 arrange for installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of electrician,
 - .4 do not leave conduit, wires, cables, tools, equipment or materials in such a way that they constitute a hazard,
 - .5 provide toe guards around openings in the roof or floor to prevent materials or debris from dropping down to a lower level,
 - .6 remove loose equipment and tools from overhead areas before leaving each day,
 - .7 cut off bolts at floor level to eliminate a possible tripping hazard.

13.2 Protection During Construction

- .1 Provide protection required to enable existing building and equipment to remain in continuous and normal operation.
- .2 Take the necessary precautions to protect equipment, existing building and service from damage during the Work. Accept responsibility for any damage and make good without cost to the Owner.
- .3 Protect existing surfaces and items so that they are not damaged in any way whatsoever by the work of all trades. Take precautions as necessary to prevent damage to walls, floors, ceilings, windows, doors, door frames, moldings, finishes, piping, ductwork, light fixtures, etc. Provide protection, hoarding, tarpaulins, dust sleeves etc., as required. Any damage caused because of lack of adequate protection to be made good at no cost to the Owner.
- .4 Take care when working above or around equipment that must remain in service.
- .5 Take care to eliminate dust in equipment areas.
- .6 Protect switchgear fronts from accidental breaker trips when working around or above them. Provide an extended shield constructed of 12 mm (½") fire retardant plywood a minimum of 450 mm (18") from board front to allow access to board.

13.3 Core Drilling

- .1 Wherever core drilling is required, provide temporary dust proof screens.

- .2 In areas where core drilling through a slab in an operating facility is necessary, clearly mark out the areas to be drilled on the underside of slab. Owner's representative to be notified at least 1 week prior to core drilling operation. Provide tarping of equipment supervised by the Owner.
- .3 During core drilling operations, station at least one person directly below the area of drilling with a large plastic container pressed to underside of slab to capture and hold core and water upon completion of operations.
- .4 Continuously use a wet/dry commercial quality vacuum at location of drilling operation to remove all excess water from the area.

13.4 Temporary Dust Proof Screens

- .1 Provide temporary dust proof screens in accordance with Specification Division 01.

13.5 Protection of Floors During Equipment Installation

- .1 Provide protection of floor finishes during installation or removal of equipment, and at any other time when moving or installing heavy equipment.
- .2 Install 19mm (¾") plywood over 6 mil plastic over finished floor areas when moving heavy equipment that could damage floor finish, or when installing equipment or line materials overhead.
- .3 Repaint or re-tile any floors or walls damaged or scratched during construction.

13.6 Housekeeping

- .1 Maintain a high level of cleanliness.
- .2 Remove scrap and refuse from the work area daily.
- .3 Whenever possible, clean up immediately following completion of work.
- .4 Deposit oily and waste solvent rags in approved containers to minimize the fire hazard.
- .5 Sweep and damp mop daily.

14 WORK IN EXISTING BUILDING

14.1 General

- .1 Comply with Specification section [01 14 00 *Work Restrictions*][of Division 01] for restrictions on working in existing occupied buildings and as follows.
- .2 During the tender period, perform a site inspection of the place of work and surroundings including the accessible ceiling spaces and other areas where access could be considered reasonable. Make a thorough investigation of the as built conditions to determine the scope of renovation and demolition work required prior to submitting a tender.
- .3 The Work includes changes to the existing building and changes at junction of old and new construction. Route cabling, ducts, conduits and other services to avoid interference with existing installation.
- .4 Perform core drilling at a time coordinated with the owner.
- .5 Relocate existing pipes, ducts, conduits, bus ducts and any other equipment or services as necessary to accommodate the Work.
- .6 Maintain or relocate existing services which pass through the area of renovation or demolition, but which feed items located outside of these areas. Rewire devices to the original circuits.
- .7 Remove existing lighting fixtures, wiring, devices and equipment to suit new construction. Cut back and cap conduits and electrical outlets not being used, so that finished work presents a neat and clean appearance. Disconnect at point of electrical supply, remove obsolete wiring and conduits, and make

- existing systems safe. Blank off openings in panels or boxes created by the removal of cables, conduits, wireways or ducts.
- .8 Where an existing ceiling is to be removed and reinstalled or replaced under another trades scope of work, and the existing electrical items such as luminaires, fire detectors, speakers, exit signs, emergency lighting heads etc., are to be reused, provide the following regarding the electrical items:
 - .1 remove,
 - .2 store in a secure, clean, dry location,
 - .3 install in the new ceiling, extend wiring and raceways as necessary,
 - .4 provide new items to match existing where existing items have been lost or damaged,
 - .5 make connections,
 - .6 clean,
 - .7 relamp luminaires,
 - .8 test,
 - .9 verify fire alarm devices,
 - .10 replace defective items with new, then retest/reverify,
 - .11 submit test and verification reports.
 - .9 Unless noted otherwise removed materials and equipment become the property of the Contractor and are to be taken from the site and disposed of appropriately.
 - .10 Review removed luminaires and equipment with the Owner's representative, and if the Owner instructs they wish to keep any items, move them to a designated location on the site. Luminaires and equipment that the Owner does not want become the property of the Contractor and are to be taken from the site and disposed of appropriately.
 - .11 For devices, fixtures and equipment to be relocated, provide junctions boxes, outlet boxes, wiring, plates, supports, etc., as necessary.
 - .12 Revise panelboard directories accordingly if affected by the Work.
 - .13 Clean and relamp relocated luminaires and replace any faulty ballasts.
 - .14 On completion of relocations, confirm that relocated devices and luminaires are in proper working order.
 - .15 Co-ordinate work affecting fire alarm system, fire safety, or protection systems with the Owner, Consultant, fire alarm system manufacturer and authorities having jurisdiction prior to commencing work. Retain the original fire alarm system manufacturer to verify relocated fire alarm devices, modified equipment and revised wiring. Provide temporary fire protection and/or a fire watch in all areas affected by the demolition and as required by authorities having jurisdiction.
 - .16 Where the Owner wishes to take over renovated areas ahead of the project completion date and these areas are intended to be fed from the distribution systems in the new building, make temporary connections to the existing services in these areas. Reconnect to permanent services at a later date, when the new distribution systems are available.

14.2 Continuity of Services

- .1 Keep existing buildings in operation with minimum length of shutdown periods.
- .2 Make connections to existing systems at approved times.
- .3 Obtain written approval, recording times when connections can be made.
- .4 Arrange the Work so that physical access to the existing buildings is not unduly interrupted.
- .5 Be responsible for and make good any damages caused to existing systems when making connections.

- .6 Provide premium time labour to tie-in feeders or wiring at night or on weekends.
- .7 Provide temporary feeders and connections as required to maintain systems in operation where shutdown periods will exceed 8 hours, or extend beyond the allowable time frame determined by the Owner.

15 MOVING AND SETTING IN PLACE OWNER'S EQUIPMENT

15.1 General

- .1 The requirements of this Part applies to;
 - .1 Division 26 equipment that has been pre-tendered or pre-purchased by the Owner, and
 - .2 other Owner-supplied products or equipment (i.e. process equipment) that has building services requirements.
- .2 Comply with the requirements of Specification section of [01 11 00 *Summary of Work*] and as specified herein.

15.2 Supplied by Owner Equipment (SBO)

- .1 Items marked SBO on drawings are to be;
 - .1 purchased by the Owner,
 - .2 received, checked, stored, by the Contractor, and
 - .3 subsequently unpacked, uncrated, assembled and located in its final location by the Contractor, and installed in accordance with the manufacturer instructions,
 - .4 participate in the start-up and testing of the equipment and placing into service.
- .2 Provide electrical services to this equipment.

15.3 Existing Owners Equipment to be Relocated

- .1 Applies to owners existing equipment which has mechanical and electrical services, and marked on the drawings as existing to be relocated.
- .2 Except as indicated below, items so marked on drawings will be moved from their present location and reinstalled by the Contractor. Disconnect and reconnect electrical services to accommodate the relocation of this equipment.
- .3 Disconnect, remove, store as necessary, move into place, reinstall, clean and reconnect electrical items so marked, such as;
 - .1 luminaires,
 - .2 fire detectors,
 - .3 speakers,
 - .4 switches,
 - .5 receptacles,
 - .6 disconnects,
 - .7 splitters,
 - .8 panelboards,
 - .9 switchgear,

- .10 transformers,
- .11 etc.

16 CONSTRUCTION POWER AND TEMPORARY ELECTRICAL SERVICES

16.1 Temporary Power Service

- .1 Temporary power services are provided under Division 01

16.2 Temporary Construction Power and Lighting

- .1 Temporary electrical power distribution is provided under Division 01.

17 FINAL CLEANING

17.1 Final Cleaning

- .1 Conduct final cleaning in accordance with Division 01 requirements and as specified herein.
- .2 Perform final cleaning after construction activities that create dust have been completed.
- .3 Clean electrical equipment and devices installed as part of this project.
- .4 Clean lighting reflectors, lenses, and other lighting surfaces that have been exposed to construction dust and dirt, including the top surface, whether exposed or in the ceiling space.
- .5 Clean switch, receptacle, and communications outlets, cover plates, and exposed surfaces.
- .6 Clean and vacuum any smoke detectors exposed to construction dust, do not use compressed air.
- .7 Electrical rooms, generator rooms, and electrical or communication closets:
 - .1 Thoroughly vacuum and clean interiors and buswork of switchboards, panels, cabinets and other electrical equipment of construction debris and dust prior to energization using a HEPA vacuum cleaner. Final clean using clean lint free cloths with a cleaning liquid as recommended by the manufacturer for the purpose.
 - .2 HEPA vacuum the top of switchboards, panels, cabinets, bus ducts, cable trays and conduits, and mechanical duct work in the room, followed by a thorough HEPA vacuuming of the floors. Thoroughly wash floors with wet mop and clean water. Control access to the room after cleaning. Provide temporary filter media on air supply ducts to these rooms to prevent re-contamination from other areas of construction.
 - .3 Thoroughly re-clean as necessary prior to final turn over.
 - .4 Do not lay permanent switchboard matting in electrical rooms until rooms are thoroughly re-cleaned, and floors wet mopped and dried, immediately prior to final turn over.

18 RECORD DRAWINGS

18.1 General

- .1 Maintain record drawings in accordance with Division 01 during the course of the Work and as follows.
- .2 A set of design drawings in AutoCAD, Revit, or PDF format (as determined by the Consultant) will be provided by the Consultant. Record changes in actual installation as the Work progresses by the following method:
 - .1 make sets of white prints for each phase of Work and mark-up the print drawings, or
 - .2 revise the AutoCAD or Revit file directly, and identify all changes made.

- .3 Mark-up these record drawings to provide dimensioned locations of drains, pipes, ductwork, conduit, manholes, foundations and similar buried items within the building, with respect to building column centres. Mark level with respect to an elevation which will be provided.
- .4 Retain on-site the survey information from excavation and backfill of site services, and after approval, transfer this information to the record documents.
- .5 Retain these drawings and make available to Consultant for periodic review.
- .6 At 50%, 75% and 90% project completion, scan marked-up drawings to PDF format and submit copy to the Consultant, or to the project on-line document management service if one is used.

18.2 As-built Drawings

- .1 Prior to testing, balancing and adjusting, transfer site record drawing information to a copy of the computer aided drafting/design program ("CAD") files, in the same software format used for the Consultants design drawings, to record final as-built condition.
- .2 Obtain a current set of CAD files from the Consultant, The Consultant's CAD files may not reflect all or any construction changes.
- .3 Drawings are to remain set to and follow Consultants CAD Standards - do not alter drawing scales, reference files, colours, layers or text styles,
- .4 Where items have been deleted, moved, renumbered or otherwise changed from contract drawings, revise the CAD files to record these changes. "Bubble" these revisions, and place these annotations on a separate and easily identified drawing layer.
- .5 Show on electrical as-built drawings final locations of conduit, outlets, panels, branch wiring, system wiring, pull boxes, bus ducts, and equipment.
- .6 Show on site services as-built drawings survey information provided by an accredited land surveying service.
- .7 Identify each drawing in lower right hand corner in letters at least 12 mm (½") high with a note as follows:

AS-BUILT DRAWINGS. This drawing has been revised to show systems as installed (Signature of Contractor) (Date).
--

- .8 Submit one (1) set of white prints of the draft as-built CAD files for the Consultant's review.
- .9 Once "AS BUILT DRAWINGS" white prints are reviewed, transfer Consultant's comments to the CAD files. Return CAD files modified to "As Built" condition to Consultant in electronic format by removable mass storage device or by electronic file transfer as designed by the Consultant.
- .10 Submit three (3) sets of white prints and one (1) electronic copy of CAD files with Operating and Maintenance Manuals to the Owner.

19 OPERATING AND MAINTENANCE INSTRUCTIONS

19.1 Operating and Maintenance Data

- .1 Provide operating and maintenance manuals in accordance with Section [01 78 00 *Closeout Submittals*] and as follows.
- .2 Provide operation and maintenance data bound in vinyl covered, hard back, three-ring covers, nominally 50 mm (2 in) thick, suitable for paper size of 210 mm x 300 mm (8½ in x 11 in)
 - .1 Organize material in volumes, generally grouped by Division Section;

- (a) Table of Contents
 - (b) General Information
 - (c) Sub-contractors (list)
 - (d) Site services,
 - (e) Power,
 - (f) Lighting,
 - (g) Low Voltage Systems,
 - (h) Fire Alarm,
 - (i) Security,
 - (j) Testing Reports,
 - (k) As-Built Drawings,
 - (l) Warranties.
- .2 Title sheet in each volume to be labeled "Operating and Maintenance Manual" and to bear;
- (a) Project Name,
 - (b) Project Number,
 - (c) Date,
 - (d) Trade Section, and
 - (e) List of Contents.
- .3 Provide three hard-copies to Owner.
- .3 In addition, provide PDF files for each document, produced from original direct-to-digital file creations.
- .1 Organize documents into separate PDF files for each Division Section identified above, and apply PDF Bookmarks to create a Table of Contents.
 - .2 Manuals will be rejected if Table of Contents and PDF Bookmark is not included.
- .4 Operating and maintenance data to include;
- .1 details of design elements, construction features, component function and maintenance requirements, to permit effective start-up, operation, maintenance, repair, modification, extension and expansion of any portion or feature of installation,
 - .2 technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items, and parts lists; advertising or sales literature not acceptable,
 - .3 wiring and schematic diagrams and performance curves,
 - .4 names and addresses of local suppliers for items included in maintenance manuals,
 - .5 reviewed shop drawings,
 - .6 operating characteristics of the equipment supplied such as calibration curves and coordination data to allow proper co-ordination with Owner's equipment,
 - .7 description of operation of the controls and protective devices used,
 - .8 maintenance and adjustment procedures,
 - .9 lifting and jacking instructions,
 - .10 fault locating guide,
 - .11 spare parts list and an itemized price list,
 - .12 name and telephone numbers of service organization and technical staff that will provide warranty service on the various items of equipment.
- .5 Approval procedure;

- .1 submit one set of first draft of Operating and Maintenance Manuals for approval at least one month prior to planned substantial performance date,
- .2 make corrections and resubmit for a final review,
- .3 review contents of Operating and Maintenance Manuals with Owner's operating staff or representative to ensure thorough understanding of each item of equipment and its operation,
- .4 hand-over two (2) copies and one (1) PDF copy on removable storage device of the Operating and Maintenance Manuals to the Owner's operating staff and obtain written confirmation of delivery. Provide a copy of the delivery record to the Consultant.

19.2 Operating and Maintenance Training

- .1 Provide operating and maintenance training in accordance with Section [01 79 00 *Demonstration and Training*] and as follows.
- .2 Provide training to Owner's operations staff to thoroughly explain operation and maintenance of each system, incorporating specialized instruction by manufacturers as described under other Sections. Include classroom instruction and hands-on instruction, delivered by competent instructors.
- .3 Develop the proposed training plan, and submit an outline of the training program for review and adjustment by the Owner. Obtain approval from the Owner before commencing training.
- .4 Structure each session to start with the classroom instruction for the overall system, followed by hands-on instruction for each item of equipment, utilizing the services of the manufacturers' representative as required.
- .5 Organize and schedule each training session to deliver the required instruction in an efficient and effective manner on a schedule agreed upon with the Owner. Allow for two (2) training sessions for each training topic, separated by approximately one week each. Develop the proposed training plan and obtain approval from the Owner before commencing training.
- .6 All training to be scheduled and provided between the hours of 7 am to 5 pm, Monday to Friday. Where training is required to be performed outside of these hours due to availability of Owners operations personnel, if the trainers are paid for overtime outside of these hours, the overtime portion only is eligible to be paid by the Owner as an extra cost.
- .7 Complete the training as close to Substantial Performance as possible, so that the operations staff are prepared to operate the systems after Substantial Performance is certified.
- .8 Keep a record of date and duration of each instruction period together with names of persons attending. Submit signed records at completion of instruction.
- .9 For each training session, include the following topics;
 - .1 general purpose of the system (design intent),
 - .2 use of O & M manuals,
 - .3 review of single line drawings and control schematics,
 - .4 start-up, normal operation, shutdown, unoccupied operation, seasonal changeover, manual operation, control set-up and programming, troubleshooting and alarms,
 - .5 interaction with other systems,
 - .6 adjustments and optimizing methods for energy conservation,
 - .7 maintenance requirements,
 - .8 special maintenance and replacement sources,
 - .9 health and safety issues,
 - .10 occupancy interaction issues, and

- .11 system response to different operating conditions.
- .10 Develop and provide training material, including printed documents and electronic presentation aids (e.g. MS PowerPoint) for each session. Submit three (3) copies of materials in both hardcopy and PDF format, in accordance with article on Operating and Maintenance Manuals.
- .11 Sessions may be videotaped by the Owner as an aid to ongoing training of Owner's staff.

20 CARE, OPERATION AND START-UP

- .1 Provide all labour and materials as necessary to perform start-up and testing of equipment and systems.
- .2 Arrange and pay for services of manufacturer's factory service technicians to supervise start-up of installation, check, adjust, balance and calibrate components and equipment as specified in the specification sections of Division 26.
- .3 Provide these services for such periods, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with every aspect of the operation, care and maintenance thereof.
- .4 Arrange and pay for services of applicable manufacturer's factory service engineer or certified independent testing organization to supervise initial start-up of specialized portions of installation and to check, adjust, balance and calibrate components including related wiring and controls. Provide these services for such periods, and for as many visits as may be necessary to put applicable portion of the installation in complete working order. Provide a certificate indicating that the equipment is free and clear of deficiencies.

21 TESTING

21.1 General

- .1 The following describes the general requirements for testing of electrical systems; refer to additional testing requirements in applicable sections of Division 26 of the Work.
- .2 Conduct and pay for the following tests;
 - .1 power 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, communications,
 - .6 additional testing as specified in other Sections.
- .3 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.
- .4 Insulation resistance testing;
 - .1 megger circuits, feeders and equipment up to 350 V with a 500 V instrument,
 - .2 megger 350-600 V circuits, feeders and equipment with a 1000 V instrument,
 - .3 check resistance to ground before energizing.
- .5 Carry out tests in presence of Consultant.
- .6 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

- .7 Submit test results for Consultant's review. Test electrical equipment to standards and function of specifications, applicable codes and standards in an approved manner. Replace defective equipment and wiring with new material and leave entire system in complete first class operating condition.

21.2 Testing of Integrated Life Safety and Fire Protections Systems

- .1 Conduct testing of integrated life safety and fire protection systems in accordance with specification Section 26 08 11 *Testing of Integrated Electrical Life Safety and Fire Protection Systems* .

22 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. Revise circuit labelling as appropriate.
- .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
- .3 Submit, at completion of work, report listing phase and neutral current on panelboards, dry-core transformers and motor control centres, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

23 CO-ORDINATION OF PROTECTIVE DEVICES

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings as per equipment manufacturers' recommendations for each piece of equipment.

24 COMMISSIONING

- .1 Participate in commissioning of equipment and systems in accordance with Section 26 08 15 *Electrical Commissioning*.
- .2 Equipment supplied on this project will be subject to detailed factory inspection and/or on-site testing and commissioning prior to being placed in service. The electrical contractor, their major system and equipment suppliers, and the Independent Testing Agent (ITA) will be required to participate in special commissioning meetings to review progress and status of the commissioning program.
- .3 Include in Bid amount for licensed electricians to participate in the commissioning program, to undertake temporary power connections, operation of equipment, opening and closing of panel boards and switchboards, testing of power and control wiring, and assisting the ITA and the equipment suppliers' field personnel in the startup and testing of the equipment.
- .4 The contractor and equipment suppliers to include in the Bid amount the costs to accommodate and undertake factory and site testing.]

25 TEMPORARY AND TRIAL USAGE

- .1 Temporary and trial usage by Owner of any electrical device, machinery, apparatus, equipment or any other work or materials before final completion and written acceptance, is not to be construed as evidence of acceptance by the Owner.
- .2 Owner to have the privilege of such temporary and trial usage, as soon as the Contractor claims that said work is completed and in accordance with specifications, for such reasonable length of time as is deemed to be sufficient for making a complete and thorough test of same.
- .3 No claims will be considered for damage to or failure of any parts of such work so used which may be discovered during temporary and trial usage, whether caused by weakness or inaccuracy of structural parts or by defective materials or workmanship of any kind whatsoever.
- .4 Defects in workmanship and materials identified during temporary and trial usage are to be rectified under warranty.

26 CONSULTANT REVIEWS

26.1 General

- .1 Consultant's attendance at site including but not limited to site meetings, demonstrations, site reviews and any resulting reports are for the sole benefit of the Owner and as required by the local authority have jurisdiction. It is the Contractor's responsibility to ensure that the Work is complete and constructed in accordance with the design documents.

26.2 Site Reviews

- .1 General reviews and progress reviews do not record deficiencies during the course of the Work until such time as a portion or all of the work is declared complete. In some instances, before the work is completed, readily noticeable deficiencies may be recorded by the Consultant where the deficient item is indicative of issues such as poor workmanship, incorrect materials or installation methods, or may be difficult to correct at a later date. Any such reported items, or lack thereof, shall not be relied on in any way as part of the Contractors quality assurance program nor relieve the Contractor in the performance of the Work, specifically in identification and rectification of deficiencies or incomplete Work.
- .2 Deficiency reviews conducted by the Consultant are performed on a sampling basis, and any deficiency item is to be interpreted as being indicative of similar locations elsewhere in the Work, unless indicated otherwise.

26.3 Milestone Reviews

- .1 Specific milestone reviews may be conducted at key stages by the Consultant, including;
 - .1 before backfilling of buried services,
 - .2 before closing of shafts,
 - .3 before closing of walls,
 - .4 before closing of ceilings,
 - .5 equipment demonstration,
 - .6 Substantial Performance deficiency review,
 - .7 Total Performance deficiency review.
- .2 Coordinate with the Consultant the type and quantity of milestone reviews required and incorporate these requirements into the construction schedule.
- .3 Prior to Work being concealed, notify the Consultant in writing seven (7) calendar days in advance of the planned concealment to arrange a site review, where required by the Consultant. Correct noted deficiencies before concealing the Work. Failure to provide notification can result in the Work being exposed for review at the Contractor's cost.

26.4 Partial Occupancy Reviews

- .1 Where the Work is planned to include occupancy by the Owner of a part of the Work but not the entire Work ("partial occupancy"), the procedures specified for Substantial Performance Review will apply to the portion of the Work being considered for partial occupancy.

26.5 Substantial Performance Review

- .1 At the time of applying for project Substantial Performance, submit to Consultant a comprehensive list of items to be completed or corrected.

26.6 Final Review

- .1 At project completion submit written request for final review of electrical systems. Refer to section 26 77 19.20 Close-Out Requirements for Electrical Work.
- .2 Include with the request a written certification that;
 - .1 deficiencies noted during job inspections have been completed,
 - .2 systems have been balanced and tested and are ready for operation,
 - .3 completed maintenance and operating data have been submitted and approved,
 - .4 equipment/line material tags are in place and equipment identification is completed,
 - .5 cleaning is finished in every respect,
 - .6 electrical panels, switchboards, cabinets, and equipment surfaces have been touched up with matching paint, or re-finished as required,
 - .7 spare parts and replacement parts specified have been provided and receipt acknowledged,
 - .8 As-built and Record drawings are completed and approved,
 - .9 Owner's operating personnel have been instructed in the operation and maintenance of systems,
 - .10 fire alarm verification is 100% completed and Verification Certificate has been submitted and accepted.

27 CONTRACTOR INSPECTIONS

27.1 General

- .1 The Division 26 contractor shall assign one person responsible for ensuring that Work from all electrical trades is complete prior to;
 - .1 closing in wall, ceilings or burying of services,
 - .2 partial-occupancy reviews, and
 - .3 substantial performance reviews.
- .2 In conjunction with the Contractor's Mechanical and Electrical sub-contractors, the Contractor shall walk the site and thoroughly inspect that the work is complete, in good workmanship and installed according to the contract documents and derived documents therefrom. The Contractor shall then submit a report attesting to the completed state of the Work (the "Statement of Completion" report, as detailed later in this part).
- .3 In the case of Contractor inspections for partial-occupancy or substantial performance, submit the Statement of Completion report at least 24 hours prior to the scheduled review by the Consultant.

27.2 Contractor Inspections for Partial Occupancy and Substantial Performance

- .1 In preparation for the Consultants general review for partial-occupancy and/or substantial performance of the Work, the Contractor shall perform a comprehensive inspection of the Work to ensure that their contractual obligations are met before requesting a Consultant's review of the Work. In performing this inspection, the Contractor shall create a Statement of Completion report which is to include;
 - .1 date and time of the Contractor's inspection, signed by the person who conducted the inspection,
 - .2 names of the electrical contractor's personnel who participated in the inspection,
 - .3 confirmation that previously noted deficiencies have been completed,
 - .4 confirmation that the work is 100% complete, tested, balanced and free of deficiencies, or include a list of outstanding deficiencies and incomplete Work with;

- (a) a reason why the Work has not been completed (i.e. another trade has to complete their work)
 - (b) a plan of action to complete the Work, and
 - (c) a commitment date for completion of the Work including rectification of all deficiencies.
- .2 The format of the Statement of Completion shall be approved by the Consultant.
 - .3 The Consultant shall review and sign-off the Statement of Completion Report and return a copy to the Contractor. The Contractor shall retain on-site a log of all signed off Statement of Completion reports.
 - .4 If a required Statement of Completion report is not received, the Consultant reserves the right to withhold conducting a review for partial-occupancy or substantial performance.
 - .5 After receipt of the Contractor's Statement of Completion report, if upon entering an area of the work covered by the Statement of Completion report the Consultant determines, in its sole opinion, that the applicable Work is not ready for review, the Consultant may elect to cancel the review of the Work or the affected portion of the Work, and shall assume no responsibility for any damages or losses as a result of cancellation of the review. The Contractor shall remedy the incomplete work and request another review with 72 hours prior written notice, and shall resubmit the revised Statement of Completion at least 24 hours prior to the new review.

28 CORRECTION AFTER COMPLETION

28.1 General

- .1 At completion, submit a written warranty, undertaking to remedy defects in work for a period of one year from date of substantial performance of the Work. This warranty is not to supplant other warranties of longer period called for on certain equipment or materials.
- .2 Warranties are to encompass replacement of defective workmanship, parts, materials or equipment, and to include incidental fluids, gaskets, lubricants, supplies, and labour for removal and reinstallation of the corrected Work.
- .3 Submit similar warranties for one year from date of acceptance for any part of work accepted by Owner, before completion of the whole Work.

29 ATTACHEMENTS

29.1 Schedule of Values Form

- .1 Attached sample of the Schedule of Values form layout.

29.2 Shop Drawing Submittal Form

- .1 Attached sample of shop drawings submittal form.

SCHEDULE OF VALUES

Project Name: <<name of project>>
Owner Name: <<owner name>>
Contractor Name: <<name of trade contractor: mechanical, electrical, etc>>
Division(s) of the Work: <<i.e. 20, 21, 22...>>
For the billing period ending: dd-mmm-YYYY

This sheet is an example of a required schedule of values to be developed by the Contractor, to be submitted with each progress payment request.
Specific level of detail for each work element to be approved by the Consultant.

Item	Base Contract Element	Contract Value		Complete to Date		Previously Billed		This Billing		Balance to Complete	
		\$	%	\$	%	\$	%	\$	%	\$	%
1.1	<<work element>>	1,000,000.00	65.9%	400,000.00	40.0%	225,000.00	22.5%	175,000.00	17.5%	600,000.00	60.0%
1.2	<<work element>>	250,000.00	16.5%	30,000.00	12.0%	5,000.00	2.0%	25,000.00	10.0%	220,000.00	88.0%
1.3	<<work element>>	125,000.00	8.2%	50,000.00	40.0%	22,000.00	17.6%	28,000.00	22.4%	75,000.00	60.0%
X.X	Itemized Price No. 1	25,000.00	1.6%	0.00	0.0%	0.00	0.0%	0.00	0.0%	25,000.00	100.0%
X.X	Separate Price No. 1	12,500.00	0.8%	5,000.00	40.0%	0.00	0.0%	5,000.00	40.0%	7,500.00	60.0%
CCA.1	Cash Allowance Disbursements Summary	75,000.00	4.9%	34,000.00	0.0%	8,000.00	0.0%	26,000.00	0.0%	41,000.00	0.0%
X.X	Coordination drawings	15,000.00	1.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	15,000.00	100.0%
X.X	As-built documents and operating manuals	15,000.00	1.0%	0.00	0.0%	0.00	0.0%	0.00	0.0%	15,000.00	100.0%
Original Contract Values		1,517,500.00	100.0%	519,000.00	34.2%	260,000.00	17.1%	259,000.00	17.1%	968,500.00	63.8%
CO.1	Approved Changes Summary	13,400.00		5,200.00	38.8%	2,000.00	14.9%	3,200.00	23.9%	8,200.00	61.2%
Total Current Contract Values		1,530,900.00		524,200.00	34.2%	262,000.00	17.1%	262,200.00	17.1%	976,700.00	63.8%

Reference	Cash Allowance Disbursement	CA Value		Complete to Date		Previously Billed		This Billing		Balance to Complete	
		\$	%	\$	%	\$	%	\$	%	\$	%
CAA_1	<<description of cash allowance>>	20,000.00	100.0%	20,000.00	100.0%	8,000.00	40.0%	12,000.00	60.0%	0.00	0.0%
CAA_2	<<description of cash allowance>>	55,000.00	25.5%	14,000.00	25.5%	-	0.0%	14,000.00	25.5%	41,000.00	74.5%
Total		75,000.00		34,000.00	45.3%	8,000.00	10.7%	26,000.00	34.7%	41,000.00	54.7%

Reference	Approved Changes	Change Value		Complete to Date		Previously Billed		This Billing		Balance to Complete	
		\$	%	\$	%	\$	%	\$	%	\$	%
CO_01	<<description of change of work>>	5,800.00	0.0%	-	0.0%	-	0.0%	0.00	0.0%	5,800.00	100.0%
CD-01	<<description of change of work>>	7,600.00	68.4%	5,200.00	68.4%	2,000.00	31.6%	3,200.00	42.1%	2,400.00	31.6%
Total		13,400.00		5,200.00	38.8%	2,000.00	14.9%	3,200.00	23.9%	8,200.00	61.2%

Reference	Unquoted/Unapproved Changes	Status	Quotation	
			\$	
CCN=01	<<description of change of work>>	Waiting for approval	12,000.00	
CCN=02	<<description of change of work>>	Unquoted		
Total			12,000.00	



Toronto Montreal Vancouver Dallas Chicago

SHOP DRAWING SUBMITTAL

***Include this cover page with each shop drawing submission.
Submissions without this form will be returned without review.
Submit one submittal form per shop drawing; do not group under one submittal sheet***

Client/Architect: Click or tap here to enter text.

Project Name: Click or tap here to enter text.

HHA Project No: Click or tap here to enter text.

Contractor to complete the following for each submission.

Date:

Contractor Name:

Ref. No:

Manufacturer Name:

Product Type/Description:

Specification section number:

Contractor Trade Category:

- | | | | |
|--|-------------------------------------|--|---|
| ☐ Architectural | ☐ Structural | ☐ Conveying Equipment | ☐ User Equipment |
| ☐ Mechanical | ☐ Electrical | ☐ Telecommunications | ☐ Civil |
| ☐ Other | | | |

If this is a resubmission, check here:

☐

Previous submission HHA reference no.:

hhangus.com



END OF SECTION

QUALIFICATIONS AND AUTHORITIES - ONTARIO

26 01 02

1 GENERAL

1.1 Scope

- .1 This specification section:
 - .1 describes the qualification requirements for tradesmen in the province of Ontario;
 - .2 defines the applicable authorities having jurisdiction related to construction in Ontario; and
 - .3 describes the responsibilities of the contractor and/or Owner for registration and inspection of systems and application for construction or installation permits.

1.2 Definitions

- .1 **ESA:** Electrical Safety Authority

2 QUALIFICATIONS

2.1 Trades Qualification and Apprenticeship

- .1 Tradesmen to hold a certificate of competency for the following applicable trades:
 - .1 Electrician, R.R.O. 1990, Reg. 1051

3 AUTHOURITIES

3.1 Authorities having Jurisdiction

- .1 When referenced in specification sections in Division 26 to 28, the authority-having-jurisdiction ("AHJ") over regulated portions of the work are identified in the following table.

Work Element	Authority	AHJ Abbreviation
Electrical	ESA	ESA

4 PERMITS, REGISTRATION AND INSPECTION

4.1 Building Code Permits

- .1
- .2 Application for Building Permit has been made by the Owner. Submit and pay for separate plumbing and HVAC permits and arrange and coordinate for municipal inspections required under the Ontario Building Code

4.2 Other Work Permits, Registration and Inspection

- .1 Arrange, provide documentation, and pay for permits, registration, and inspection of the following work elements:
 - .1 Electrical work performed, and
 - .2 Where described elsewhere in Division 26 to 28.
- .2 Arrange, provide documentation, and pay for variance approvals and field inspections where specified elsewhere in Division 26 to 28.

END OF SECTION

ELECTRICAL BASIC MATERIALS AND METHODS

26 05 01

1 GENERAL

1.1 Scope

- .1 Articles that are of a general nature, apply to each Section of Divisions 26, 27 and 28.

2 ACCESS DOORS

2.1 Construction

- .1 Access doors, unless shown or specified otherwise:
 - .1 constructed from galvanized steel sheet,
 - .2 flush mounted,
 - .3 concealed hinges,
 - .4 180° opening door,
 - .5 round safety corners,
 - .6 anchor straps,
 - .7 plaster lock,
 - .8 screwdriver operated latches,
 - .9 without visible screws,
 - .10 finished prime coat only.
- .2 Door metal thickness as follows:
 - .1 up to and including 400 x400 (16" x 16"): 1.6 mm (16 gauge)
 - .2 height or width larger than 400 (16"): 2 mm (14 gauge)
- .3 Constructed of stainless steel for areas finished with tile or marble surfaces
- .4 Constructed of stainless steel with neoprene gasketed door where used in damp and high humidity areas.
- .5 Dish type door design to receive a tile insert where acoustic tile is applied to plaster or gypsum board ceilings.
- .6 Fire rated where installed in fire rated walls or ceilings. Fire rating to match the rating of the wall or ceiling.
- .7 With keyed cylinder locks, keyed alike, for areas subject to security risks, EG;
 - .1 public corridors,
 - .2 psychiatric patient areas,
 - .3 public washrooms,
 - .4 etc.
- .8 Inside clear dimensions:
 - .1 approximately 400 mm x 400 mm (16" x 16") for hand access,
 - .2 at least 600 mm x 600 mm (24" x 24") where personnel are to enter through doors,
 - .3 larger where indicated or required.

- .9 Submit access door shop drawings for approval as soon as possible after award of contract, showing size, type and exact location of access doors.

Standard of Acceptance

- Acudor
- Cendrex (up to 400 x 400 only)
- Elmdor (up to 400 x 400 only)
- Mifab (up to 400 x 400 only)
- Nystrom
- Williams Brothers – GP

2.2 Installation

- .1 Provide access doors for locations where equipment requiring access, maintenance or adjustment is "built-in".
- .2 Submit a list of proposed access door locations and obtain approval before commencing installation.
- .3 Access doors to be installed under the Division in whose work they occur. Arrange for and pay cost of access doors and their installation.
- .4 Access doors are not required in removable acoustic panel type ceilings.
- .5 Size and locate access doors in applied tile, or in glazed or unglazed structural tile to suit tile patterns. Refer to Architectural Room Finish Schedule and details on Architectural drawings in this regard.

3 SLEEVES AND CURBS

3.1 Materials

- .1 Sleeves for bus ducts, wireways and cable trays: minimum 3 mm (1/8") galvanized steel.
- .2 Integral flashing clamp on sleeves that pass through floors with a waterproof membrane.
- .3 Removable (non fire rated) sealing material: Duxseal or acceptable alternative.
- .4 Fire rated sealing material: per Article "Fire Stopping and Smoke Seals".

3.2 Installation

- .1 Provide sleeves for bus ducts, wireways, conduits and cable runs passing through;
 - .1 concrete walls, beams, slabs and floors,
 - .2 fire rated walls, partitions and ceilings.
- .2 Place and secure sleeves in concrete form work.
- .3 Supply sleeves to be set in concrete and masonry walls with installation detail drawings.
- .4 Terminate sleeves flush with surfaces of concrete and masonry walls.
- .5 Extend sleeves 100 mm (4") above finished floor.
- .6 Size sleeves to accommodate fire stopping materials where required.
- .7 Make watertight connections between sleeves and waterproof membranes.
- .8 Fill any spaces between sleeves and masonry walls;
 - .1 with non-shrink grout,
 - .2 with a rated fire stopping material for rated walls.

- .9 Seal spare sleeves and the space between sleeves and the through conduits, cables, wireways, bus ducts etc;
 - .1 using removable sealing material,
 - .2 using a rated fire stopping material for floors and rated walls,
 - .3 seal watertight where sleeves penetrate a floor slab.
- .10 Sleeves in existing concrete and masonry walls and floors;
 - .1 cutting and drilling of structural elements, such as floors, slabs, walls, columns, or beams to be carried out in accordance with procedure set out in Article "Cutting and Remedial Work" in Section "Electrical General Requirements",
 - .2 neatly cut or drill holes in existing construction,
 - .3 terminate sleeves flush with surfaces of concrete and masonry walls,
 - .4 extend sleeves 100 mm (4") above finished floor with flange, countersunk, and bolted down flush into floor surface,
 - .5 fill opening between sleeve and wall;
 - (a) with non-shrink grout,
 - (b) with a rated fire stopping material for rated walls.
 - .6 fill opening between sleeve and floor with rated fire stopping material with water barrier,
 - .7 seal as indicated above.
- .11 Provide concrete curbs, minimum 100 mm (4") high above finished floor surrounding sleeves and openings for;
 - .1 conduits,
 - .2 cables,
 - .3 telephone cable risers,
 - .4 bus ducts,
 - .5 wireways,
 - .6 cable trays, and
 - .7 other openings for electrical services through slabs above grade.
- .12 Size concrete curbs for bus ducts to provide sufficient area to adequately carry bus duct support brackets.
- .13 Size openings to accommodate fire stopping materials as required.

4 WALL AND FLOOR PLATES

4.1 General

- .1 Provide finishing plates fitted to electrical conduits and cables which pass through walls, floors and ceilings in finished areas.

4.2 Products

- .1 Escutcheons for small diameter electrical conduit:
 - .1 manufactured chrome plated two-piece split type with hinge and set-screw.
- .2 Finishing plates for electrical cables and large diameter electrical conduits:
 - .1 finishing plate (ring) fabricated from minimum 0.9 mm (20 ga) thick T304 stainless steel with No. 4 brushed finish, with minimum 25 mm (1 in) high collar ring,

- .2 mounting holes drilled at not less than three (3) symmetrically location positions around the ring to allow mechanical fastening,
- .3 plate diameter to be sufficiently sized to overlap the wall, floor or ceiling opening by not less than 25 mm (1 in) all around the opening.

4.3 Installation

- .1 Escutcheons:
 - .1 secure escutcheons to electrical conduit with mechanical fastener.
- .2 Finishing plates:
 - .1 set finishing plates flat against the finished surfaces, and secure to the surface with stainless steel pan-head mechanical fasteners. Provide insert anchor plugs in the finished surface as necessary to secure the fasteners.

5 FIRE STOPPING AND SMOKE SEALS

5.1 General

- .1 Maintain the integrity of floor and wall, fire separations and smoke seals, around EMT, conduits, electrical raceways, cables, bus ducts, boxes and any other electrical equipment passing through rated floors or walls.
- .2 Fire stop materials to be impervious to water when installed in a horizontal separation, including waterproof service sleeves.
- .3 Firestop material manufacturer or their designated service representative to provide the following services:
 - .1 selection of listed fire stopping assemblies for each applicable service penetration and fire separation assembly/rating,
 - .2 provide training of contractor's staff for proper installation of fire stopping assembly; create and maintain a log of those personnel who obtain training,
 - .3 inspect the completed installation of all penetrations and submit a written report to the Consultant, including photo record of randomly selected instances of each fire stopping method. Where deficiencies are discovered, note the deficiencies in the report and provide remedial instructions to the contractor to correct the deficiency. After deficiencies are corrected, re-inspect the deficiencies to conform their correction, update and resubmit the report to the Consultant.
- .4 Submit a complete fire stopping and smoke seal shop drawing schedule to the Consultant for review. Include details, cut sheets, system description and location for each proposed fire stopping and smoke sealing application.

5.2 Products

- .1 Materials and firestopping system to be listed for conformance with CAN/ULC-S115 "*Standard Method of Fire Tests of Firestop Systems*".
- .2 Firestop systems to have F duration rating equal to the fire resistance rating of the applicable fire separation. In addition, where required by the applicable building code for the specific service penetration, the fire stop assembly shall:
 - .1 have a F rating equal to the fire resistance rating of the applicable fire separation with a pressure differential of 50 Pa (0.2 in.w.c.) between exposed and unexposed side with the highest pressure on the exposed side, and
 - .2 have an FT rating equal to the fire resistance rating of the applicable fire separation,

Standard of Acceptance

- Hilti Firestop Systems
 - 3M
 - A/D Fire Protection System Inc.
 - Eastern Wire + Conduit
- .3 Other manufacturers having products with explicitly similar characteristics, listings or classifications and approvals are acceptable.

5.3 Installation

- .1 Install firestopping and smoke seals in accordance with the manufacturer's recommendations and in accordance with the ULC or cUL listing.
- .2 Firestopping and smoke seals to be installed only by personnel trained by the manufacturer on the installation of such systems.
- .3 Seal space between penetrating service and sleeve or opening in fire rated floors and walls with a fire stopping and smoke sealing system.
- .4 Select thickness and arrangement of back-up materials to suit size of service, length of sleeve and anticipated movement.
- .5 At time of application of materials, surfaces to be clean, dry and free from dust, oil, grease, loose or flaking paint, loose concrete or masonry and foreign materials.
- .6 Wiring may penetrate a fire rated assembly provided it is enclosed in non-combustible conduit, and the passage of the conduit in turn is suitably sealed to the assembly with fire stop and smoke sealing materials.
- .7 Where wiring with a combustible covering and not enclosed in non-combustible conduit penetrates a fire resistance rated assembly, group the wiring into separate fire and smoke sealed penetrations to ensure the overall diameter of the combined wire(s) in each penetration does not exceed 25 mm.
- .8 Arrange single conductor metal sheathed cables to individually penetrate the fire rated assembly and be individually fire stopped and smoke sealed. Where these cables have combustible jackets, space cables at least 300mm apart throughout the penetration.
- .9 Where wiring is installed in cable trays and penetrates a fire rated assembly;
 - .1 terminate and independently support the cable tray on each side of the fire rated assembly, and
 - .2 provide sufficient working room to properly install and inspect the fire stopping and smoke sealing materials.
- .10 Smoke seal and fire stop electrical boxes that penetrate a fire rated wall using fire rated putty pads, install putty pads on the outside of boxes.
- .11 Smoke seals and fire stopping in horizontal separations to be watertight with sleeves terminating not less than 100mm (4") above the finished floor.
- .12 Co-ordinate installation of cast-in-place fire stopping devices with the Division responsible for the placement of concrete.

6 SPRINKLER PROTECTION

6.1 Materials

- .1 Surface panelboards, switchboards and other electrical equipment in sprinklered areas to be fitted with watertight hubs with insulated throat, for each conduit entrance.

Standard of Acceptance

- ABB Installation Products Ltd. (T & B) - Series 401
 - Efcor of Canada Ltd. - Series 40-50B
- .2 Provide equipment in sprinklered areas, with hoods or shields and gasketed doors for protection against entry of sprinkler discharge, and to comply with the requirements of the electrical code, alternatively, and where indicated, provide indoor weatherproof equipment.
 - .3 Ventilation openings to be overhanging drip proof type.
 - .4 Indoor weatherproof equipment, where noted in the specifications and/or drawings to have CSA type 3R enclosures in accordance with the requirements of CSA Standard C22.2 No. 94.

7 PENETRATIONS OF BELOW GRADE WALLS AND SLABS ON GRADE

7.1 Materials

- .1 Expanding cement water stop material.
- .2 Submit manufacturer's literature.

Standard of Acceptance

- Cetco WATERSTOP-RX
- W.R. Meadows WATERSTOP EC PLUS
- or acceptable equivalent

7.2 Installation

- .1 Fit each cable, conduit and duct passing through floor slab in contact with ground or walls below grade, with a water stop.
- .2 Submit schedule showing location, service.
- .3 Install water stop in accordance with the manufacturer's instructions.
- .4 Encircle each cable, conduit and duct and the perimeter of the wall opening with the water stop material.
- .5 Fill the wall openings around the cables, conduits or ducts with hydraulic cement injected for the full width of the wall.
- .6 Seal the exterior of the wall around the cables, conduits or ducts with a waterproof coating. Waterproof coating to be compatible with any existing waterproofing.

8 EQUIPMENT SUPPORTS, AND BASES

8.1 Supports for Electrical Work

- .1 Equipment supplementary supports to be provided by this Division.
- .2 Concrete housekeeping bases for electrical equipment to be provided by this Division.
- .3 Work to be done by firms specializing in these fields.
- .4 Submit shop drawings for steel and concrete work, prepared by licensed Professional Engineers.

8.2 Supplementary Supports and Support Brackets:

- .1 Fabricated from structural grade steel with anchor bolts and fastenings.
- .2 Designed in consultation with building structural consultant to transfer live loads and dead loads to building structural elements.

- .3 Constructed as frames bracketed from walls, and/or supported from building structure above, and/or floor below.

8.3 Concrete Bases for Housekeeping Pads

- .1 Constructed using plywood form work and 20 Mpa (3000 lb) concrete.
- .2 Dowelled to concrete floor slab with steel rods not less than 13 mm (1/2 in) in diameter. For existing concrete floors, floors are to be drilled and dowels secured in the holes with chemically-hardening adhesive.
- .3 Refer to Specification section 26 05 49.13 *Seismic Restraint for Electrical Systems* for additional requirements for housekeeping pads where equipment is to be seismically restrained.
- .4 Finish to make flat, level, smooth, neat surfaces.
- .5 Chamfer corners 25 mm (1 in).
- .6 Dimensions:
 - .1 75 mm (3 in) larger all around than base of apparatus for non-seismic applications,
 - .2 minimum 200 mm (8 in) larger all around than equipment-base anchor attachment points for seismically restrained equipment.
 - .3 height: 100 mm (4 in)

8.4 Installation

- .1 Locate supporting steel to permit service or repair, and to allow clear access to junction boxes and equipment.
- .2 Set equipment on supporting frames and brackets and install hangers, anchor bolts, and vibration mountings.
- .3 Install anchor bolts, and vibration mountings between equipment and housekeeping pad.
- .4 Erect metalwork square, plumb, straight, and true, accurately fitted, with tight joints and intersections.
- .5 Provide anchorage, dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.
- .6 Make field connections with bolts to CAN/CSA-S16.1, or weld.
- .7 Supply items for casting into concrete or building into masonry to appropriate trades together with setting templates.
- .8 After completion of erection, touch-up field welds, bolts and burnt or scratched surfaces with primer.
- .9 Where gratings or trench covers are cut in field or damaged, touch up with zinc rich paint.

9 GENERAL WIRING REQUIREMENTS

9.1 Wiring Terminations

- .1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.
- .2 Manufacturers' and CSA labels to be visible and legible after equipment is installed.

9.2 Location of Outlets

- .1 Locate outlets in accordance with Division 01 - General Requirements.
- .2 Do not install outlets back-to-back in wall.
- .3 Where back boxes on opposite sides of a wall occupy the same stud bay, apply acoustical putty pads to the outside of the boxes.

- .4 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm (10'), and information is given before installation.
- .5 Locate light switches on latch side of doors. Locate disconnect devices in mechanical and elevator machine rooms on latch side of door.

9.3 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 For Barrier Free areas verify the mounting heights with the authority having jurisdiction prior to rough-in.
- .4 Install wall-mounted electrical devices at elevations in accordance with the Architectural drawings. In the absence of such drawings, install at elevations in accordance with the following heights unless otherwise shown.

Description	General Area	Barrier Free
Local switches	1200 mm (47")	1050 mm (41")
Wall receptacles: General	300 mm (12")	450 mm (18")
Wall receptacles: Hospitals	450 mm (18")	450 mm (18")
Wall receptacles: above top of continuous baseboard heater	200 mm (8")	200 mm (8")
Wall receptacles: above top of counters or counter splash backs	175 mm (7")	175 mm (7")
Wall receptacles shown above top of counters where there is no counter: height above finished floor	1200 mm (47")	1050 mm (41")
Wall receptacles: In Mechanical rooms	1200 mm (47")	1050 mm (41")
Telephone outlets	300 mm (12")	450 mm (18")
Outlets for wall mounted telephones	1500 mm (59")	1000 mm (39")
Fire alarm pull stations	1500 mm (59")	1200 mm (47")
Fire alarm bells	2100 mm (83")	2100 mm (83")
Wall mounted speakers	2100 mm (83")	2100 mm (83")
Wall mounted door operator push pads	1000mm (39")	1000mm (39")
Wall or floor mounted, vertical panel type door operator controls	from ≤200mm to ≥900mm (from ≤7.9" to ≥36")	from ≤200mm to ≥900mm (from ≤7.9" to ≥36")
Television outlets	300 mm (12")	450 mm (18")
Clocks	2100 mm (83")	2100 mm (83")
Other controls	1200 mm (47")	1050 mm (41")

Description	General Area	Barrier Free
Panelboards	As required by code or as indicated	As required by code or as indicated

9.4 Conduit and Cable Installation

- .1 Install embedded conduit prior to pouring of concrete.
- .2 Arrange for holes through exterior walls and roof to be flashed and made weatherproof under Division 7.
- .3 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.
- .4 Supply and deliver inserts to site in ample time to be built into work of other trades. Provide necessary templates and adequate instructions and assistance to locate and install inserts.
- .5 Secure inserts firmly to form work before concrete is poured.
- .6 Provide insert drawings as required.

9.5 Plywood Backboards

- .1 Provide plywood backboards in electrical and telecommunications rooms and closets where indicated or specified for mounting of equipment.
- .2 Plywood to be securely attached to the building structure.
- .3 Plywood to be 19mm, void free, good one side, mounted with good side exposed.
- .4 Plywood to be Class A fire retardant, FSC certified and contain no added urea formaldehyde.

END OF SECTION

PAINTING FOR ELECTRICAL SERVICES

26 05 02

1 GENERAL

1.1 Scope

- .1 Provide industrial sealer and anti-corrosion coatings for electrical building services and related construction elements including:
 - .1 electrical services and supporting elements as specified under other sections of Divisions 26 to 28,
 - .2 concrete curbs, housekeeping pads, floor trenches and electrical containment floor areas,
- .2 General painting of service room floors and decorative finish painting of building services is provided under Division 09.

1.2 Applicable Codes and Standards

- .1 Legislation:
 - .1 SOR/2009-264 Canadian Environmental Protection Act, *Volatile Organic Compound (VOC) Concentration Limits for Architectural Coatings Regulations*
- .2 Installation standards and codes:
 - .1 LEED v4 New Construction, credit EQ Cr 4.2
 - .2 SSPC Society for Protective Coatings, Surface Preparation Standards
- .3 Product standards:
 - .1 Green Guard GC-03 Green Seal Environmental Criteria for Anti-Corrosion Paints

1.3 Submittals

- .1 Submit product data sheets which demonstrate compliance with LEED VOC requirements.

2 PRODUCTS

2.1 Industrial Anti-Corrosion Coatings – Carbon Steel Materials

- .1 Outdoor applications:
 - .1 top coat: industrial urethane alkyd enamel top coat, or single compound 100% acrylic coating,
 - .2 primer coat: as per manufacturers' recommendation for coating of steel piping,
 - .3 colour: Sherwin Williams No SW4027 (Galvano), unless specified elsewhere,
 - .4 VOC limit: 340 g/L of product less water and excluded compounds.

Standard of Acceptance

- Sherwin Williams – Pro Industrial Urethane Alkyd Enamel
- Sherwin Williams – Pro Industrial Acrylic

- .2 Indoor applications:
 - .1 top coat: single compound 100% acrylic coating,
 - .2 primer coat: as per manufacturers' recommendation for coating of steel piping,
 - .3 colour: Sherwin Williams No SW4027 (Galvano), unless specified elsewhere,

- .4 LEED: certified to Green Guard standard GC-03 for anti-corrosion coatings,
- .5 VOC limit: 250 g/L of product less water, U.S. EPA method 24.

Standard of Acceptance

- Sherwin Williams – Pro Industrial Acrylic

- .3 Zinc rich primer applications for field painting of carbon steel material, or touch-up of galvanized steel material:

- .1 top coat: as specified for interior or exterior applications,
- .2 primer: single or multi-part zinc rich coating,
- .3 colour: gray-green,
- .4 LEED compliance: certified to Green Guard standard GC-03 for anti-corrosion coatings,
- .5 VOC limit: 250 g/L of product less water, U.S. EPA method 24.

Standard of Acceptance

- Sherwin Williams – Zinc Clad III HS 100

2.2 Industrial Coatings – Poured Concrete

- .1 For field painting of concrete floor trenches, housekeeping pads, and curbs in service rooms:
 - .1 resistant to fuel oil, general solvents and water,
 - .2 top coat: water based urethane floor enamel,
 - .3 primer coat: water based epoxy,
 - .4 colour: Sherwin Williams Deck Gray,
 - .5 colour: Sherwin Williams Safety Yellow where shown,
 - .6 VOC limit: 250 g/L of product less water, U.S. EPA method 24.

Standard of Acceptance

- Sherwin Williams – Armorseal Floor Plex 7100 Primer / Amorseal 1K Topcoat

3 EXECUTION

3.1 General

- .1 Refer to requirements for services to be painted in the relevant sections of Division 26 to 28 and as follows.
- .2 Touch up any damage to factory prime coat resulting from shipping or installation with appropriate primer for indoor/outdoor installation with appropriate top coat, of colour to match existing. Materials to be compatible with the original factory finish.
- .3 Touch up any damage to factory galvanized finish resulting from site welding, shipping or installation with zinc rich primer.

3.2 Installation

- .1 Surface preparation
 - .1 Clean surfaces to be painted in accordance with paint manufacturer recommendations and as follows.

- .2 Surfaces to be clean, dry and free from dust, oil, grease, loose or flaking paint and foreign materials at time of application of paint materials.
 - .3 For carbon steel materials, remove all loose mill scale, loose rust, loose paint, and other loose detrimental foreign matter by hand chipping, scraping, sanding, and wire brushing in accordance with SSPC-SP2 Hand Tool Cleaning.
 - .4 For galvanized steel material, solvent clean to SSPC-SP1 Solvent Cleaning. If galvanized surface is already rusty, remove loose rust and dirt in accordance with SSPC-SP2 and prime the exposed metal the same day as being cleaned.
 - .5 For concrete materials, clean surfaces to SSPC-SP13/NACE 13 by mechanical, chemical or thermal methods.
 - .6 Tape-off adjacent materials which are not to be painted. Provide drop sheets to protect other surfaces from falling paint or over-spray.
- .2 Application - General
- .1 Apply one coat of primer to metal items, with exception of galvanized or concrete encased items.
 - .2 Use primer unadulterated, as prepared by manufacturer.
 - .3 Apply top coat in the number of coats recommended by the manufacturer, to obtain 100% coverage to the minimum recommended thickness, free of streaks, drips and sags.
 - .4 Do not paint when temperature is lower than 7°C.
- .3 Application – Galvanized base metal finish
- .1 Where material is galvanized, touch up welded sections or other locations where protective galvanized surface has been damaged, with zinc rich primer.
 - .2 Apply a top coat to match base material colour.
- .4 Application – Concrete trenches, housekeeping pads, and curbs.
- .1 Apply one coat of primer and two top-coats.
 - .2 After paint has dried, seal joints between curbs and floors with a silicone based industrial caulking in matching colour.

End of Section

EXCAVATION AND BACKFILL

26 05 07

1 GENERAL

1.1 Scope

- .1 Provide excavation and backfilling for work of Division 26, outside of the building.
- .2 Coordinate with the site services work to be performed under other Divisions of the Work.

1.2 Applicable Codes and Standards

- .1 Legislation:
 - .1 Occupational Health and Safety Act, and Regulations for Construction Projects
 - .2 Occupational Health and Safety Act, and Regulations for Industrial Establishments.
- .2 Installation codes and standards:
 - .1 ASTM D698 Test method for Laboratory compaction characteristic of soil using standard effort.
 - .2 Ontario Provincial Standard Specification 401 Construction Specification for Trenching, Backfilling, and Compacting.
- .3 Product standards:
 - .1 Ontario Provincial Standard Specification 1010 Material Specification for Aggregates - Base, Subbase, Select Subgrade, and Backfill Material

1.3 Position and Extent of Existing Services

- .1 Drawings are schematic and show the approximate routing of underground conduits, ducts, cables and duct banks.

2 PRODUCTS

2.1 Aggregates

- .1 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.1.
- .2 Fine aggregates to be one, or blend of the following:
 - .1 natural sand,
 - .2 manufactured sand,
 - .3 screenings produced in crushing of quarried rock, boulders, gravel or slag.
- .3 Coarse aggregates to be one of or blend of the following:
 - .1 crushed rock,
 - .2 gravel composed of naturally formed particles of stone.

2.2 Asphalt Material

- .1 Anionic emulsified asphalt to CAN/CGSB-16.2, grade SS-1.
 - .1 aggregate material of crushed stone or gravel.
 - .2 thoroughly mixed to achieve a uniform coating of asphalt over the aggregate.

2.3 Concrete

- .1 As specified in Division 3, Cast-in-Place Section.

2.4 Warning Tapes

- .1 Non-Detectable Warning tape:
 - .1 suitable for direct burial,
 - .2 polyethylene,
 - .3 150 mm (6") wide,
 - .4 continuous black lettering on red background, indicating buried electrical services below.
- .2 Detectable warning tape:
 - .1 waterproof and corrosion proof, suitable for direct burial,
 - .2 detectable from grade using a metal detector,
 - .3 metallic core encased in polyethylene or polyester,
 - .4 continuous black lettering indicating buried electrical services below.

3 EXECUTION

3.1 Preparation Prior to Excavation

- .1 Carefully review drawings of other trades.
- .2 Examine area to determine where excavations for this Work interfere with existing paved areas, curbs, walks, concrete floors and other finished floors.
- .3 Obtain current "locates reports" for existing buried services from:
 - .1 local government source,
 - .2 service providers as applicable, or
 - .3 a professional locate service.
- .4 Review "locates reports" for any interferences with the Work.
- .5 Carefully check on site, the actual locations of existing services shown on the drawings and report any serious discrepancies.
- .6 Layout the final routing of services.

3.2 Excavation

- .1 Saw cut pavements, curbs and sidewalks before proceeding with excavation.
- .2 Excavate as required for the Work, both inside and outside the building.
- .3 Remove and dispose of concrete, masonry paving, walks, demolished foundations, rubble, and other obstructions encountered in course of excavation.
- .4 Shore and brace excavations exceeding 1200 mm (48 in) in depth in accordance with applicable Occupational Health and Safety Act and provincial regulations.
- .5 Provide bracing, shoring and underpinning as required to prevent movement or settlement of adjacent structures, earth, services, walks, paving, trees, curbs, adjacent grade.
- .6 Carefully check and avoid disturbing or damaging any existing underground piping, conduit or other services uncovered during execution of the Work.
- .7 Prior to any excavation close to building footings, obtain approval from project structural engineer.

- .8 Do not excavate within the 45 degree splay of bearing from the bottom of any footing without written permission from the project structural engineer.
- .9 Do not disturb soil within branch spread of trees or shrubs that are to remain. Where excavating through roots, excavate by hand and cut roots with sharp axe or saw. Seal cuts with approved tree wound dressing.
- .10 Make good at no cost to the Owner any damage caused by settlement resulting from the excavation.
- .11 Cleanly cut and trim banks of excavations and shore as required to prevent caving in.
- .12 Replace, in an acceptable manner, excavation which has been carried to a depth greater than shown or authorized, with 10 MPa concrete, at no additional expense to Owner, to give a bearing value equal to that provided by undisturbed soil.
- .13 Prepare excavation for underground services so that no portion of any conduit, duct, cable or duct bank bears directly against any rock or other hard surface.
- .14 Form bottoms of trenches so that pipes, conduits, duct banks, etc. are supported on undisturbed soil and will not be subject to undue strain.
- .15 Grade bottoms of excavation for conduits, ducts or duct banks to provide drainage.
- .16 Report to the Consultant any unsuitable sub grade conditions.
- .17 Remove rock encountered by drilling and wedging. Blasting will not be allowed unless approved and authorized in writing.
- .18 Break up rocks and boulders removed from excavations as required to permit handling.

3.3 Protection

- .1 Store excavated materials in acceptable locations and in a manner so as to minimize damage to existing surfaces.
- .2 Cover excavated materials and provide protection to prevent runoff into local drainage facilities.
- .3 Protect from freezing, excavated earth that is to be used for backfilling.
- .4 Grade around excavations to prevent surface water runoff into excavated area.
- .5 Keep excavations dry by bailing, pumping or other acceptable means.
- .6 Cleanly cut and trim banks of excavations and shore as required to prevent caving in.
- .7 Keep sides and bottoms of excavations from freezing and protect as required to prevent damage to the Work or to existing services, by weather or other conditions.

3.4 Backfilling

- .1 Prior to backfilling, remove formwork, shoring etc.
- .2 Do not commence backfilling until approval has been obtained.
- .3 Backfill as required for the Work, both inside and outside the building
- .4 Provide detectable warning (tracer) tape directly above centerline of buried services.
- .5 Provide non-detectable warning (marker) tape midway between buried services and finished grade.
- .6 For trenches exceeding 500 mm (20") in width, provide two non-detectable warning (marker) tapes, one laid 100 mm (4") from each trench edge, midway between buried services and finished grade.
- .7 Backfill excavations, required in close proximity to, or below footing level with 10 MPa concrete up to the top of highest adjacent footing.

- .8 Where solid undisturbed soil is not obtainable at the trench level eg: adjacent to a foundation wall or maintenance hole, provide granular 'A' material from undisturbed soil, compacted in 300mm (12") layers up to bottom of trench.
- .9 Do not use frozen earth for backfilling nor place any backfilling on or against frozen earth.
- .10 Repair, at no cost to the Owner, any of the Work and existing services damaged during backfilling.
- .11 Backfill trenches under building floors, roads and paved areas with sand placed in layers and compacted in an approved manner to achieve 95% modified Proctor compaction. Do not use material from excavation for backfilling.
- .12 For conduits, ducts and cables;
 - .1 provide a base layer of sand at least 100mm (4") deep,
 - .2 tamp sand around and over conduits, ducts and cables, in 150 mm (6") layers to a height of at least 300 mm (12") above top of conduits, ducts and cables.
 - .3 compact each sand layer,
 - .4 fill remainder of trench in 300 mm (12") layers with approved excavated material, free from stone,
 - .5 compact each layer to prevent undue settlement.
- .13 For duct banks at maintenance holes and foundation walls;
 - .1 backfill in 300mm (12") layers with Granular 'A' material to height of at least 300 mm (12") above top of duct banks,
 - .2 compact each layer,
 - .3 fill remainder of space in 300 mm (12") layers with approved excavated material, free from stone,
 - .4 compact each layer to prevent undue settlement.
- .14 Where excavations interfere with new or existing paved areas, curbs, walks, concrete floors and other finished floors, backfill with sand.
- .15 Patch paved areas, walls, walks, lawns and road surfaces, damaged by the Work, in an acceptable manner.
- .16 Make up settlement of backfilling as soon as possible. Fill depressions to restore the correct grade after a period, adequate to reveal settlement, has passed. Make good any subsequent settlement of such fill.
- .17 Pay costs to make good paving, lawns, curbs and any other surfaces damaged by settlement and subsequent restoration.
- .18 Dispose of excess excavated material and leave the site clean.

3.5 Traffic Control

- .1 Comply with requirements of Acts, Regulations and By-Laws in force for the regulation of traffic or use of roadways upon or over which it is necessary to carry out work or haul materials or equipment.
- .2 When working on traveled way:
 - .1 place equipment in positions to present minimum of interference and hazard to traveling public,
 - .2 keep equipment units as close together as working conditions permit and preferably on same side of traveled way,
 - .3 do not leave equipment on traveled way overnight.
- .3 Do not close any lanes of road without approval of Consultant.

- .4 Before re-routing traffic erect suitable signs and devices.
- .5 Keep traveled way graded, free of pot holes and of sufficient width for required number of lanes of traffic.

3.6 Informational and Warning Devices

- .1 Provide and maintain signs, and other devices required to indicate construction activities or other temporary and unusual conditions resulting from the Work that requires road user response.
- .2 Supply and erect signs, delineators, barricades and miscellaneous warning devices as required by the Provincial Standards.
- .3 Place signs and other devices in acceptable locations.
- .4 Meet with the Consultant prior to commencement of the Work to prepare a list of signs and other devices required. If the situation on site changes, revise the list, acceptable to the Consultant.
- .5 Continually maintain traffic control devices in use by:
 - .1 checking signs frequently for legibility, damage, suitability and location. Clean, repair or replace to ensure clarity and reflectance,
 - .2 relocating, removing or covering signs and other devices which do not apply to the prevailing conditions,
 - .3 adding signs and other devices to suit the prevailing conditions.

3.7 Control of Public Traffic

- .1 Provide flag persons, trained in accordance with, and properly equipped as specified in, MUTCD and Provincial Standards for Roadways and Public Works, in the following situations:
 - .1 when public traffic is required to pass working vehicles or equipment which block all or part of traveled roadway,
 - .2 when it is necessary to institute one-way traffic system through the construction area or other blockage where traffic volumes are heavy, approach speeds are high and traffic signal system is not in use,
 - .3 when workmen or equipment are employed on traveled way over brow of hills, around sharp curves or at other locations where oncoming traffic would not otherwise have adequate warning,
 - .4 where temporary protection is required while other traffic control devices are being erected or taken down,
 - .5 for emergency protection when other traffic control devices are not available,
 - .6 in situations where it is deemed necessary for the protection of workmen, equipment and public traffic.
- .2 Where a roadway, carrying two-way traffic, is restricted to one lane, for 24 h each day, provide a portable traffic signal system. Adjust, as necessary, and regularly maintain the system throughout the period of restriction. Signal system to meet requirements of Provincial Standards.

3.8 Restoration of Roads

- .1 Restore roads in accordance with the requirements of the Provincial Standards for roadways and public works. Place and compact aggregate sub-base over duct banks and excavation.
- .2 Do not place frozen material.
- .3 Place material only on clean unfrozen surfaces, free from snow and ice.
- .4 Shape each layer to smooth contour and compact to density of not less than 98% corrected maximum dry density.

- .5 Place and compact asphalt material on base surface in a layer of uniform depth and width. Compact to achieve the required density.

END OF SECTION

HIGH- VOLTAGE CABLES

26 05 13

1 GENERAL

1.1 Scope

- .1 Provide high voltage cables including accessories and pre-delivery testing, as shown.

1.2 Applicable Codes and Standards

- .1 Product standards:
 - .1 CSA C22.2 No 131 Type TECK 90 Cable,
 - .2 CSA C68.1 Impregnated Paper Insulated Metallic Sheathed Cable,
 - .3 CSA C68.5 Primary Shielded and Concentric Neutral Cables for Distribution Utilities,
 - .4 CSA C68.10 Shielded Power Cable for Commercial and Industrial Applications,
 - .5 IEEE 48 Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminations.

1.3 Submittals

- .1 Submit shop drawings and product data in accordance with Section 26 05 01 Electrical General Requirements.

2 PRODUCTS

2.1 High Voltage Cables

- .1 Construct and test to the applicable standards for the system voltage specified.

2.2 Three Conductor Cables

- .1 Type: TECK 90]].
- .2 Nominal Voltage rating: 5 kV]].
- .3 Conductor Material: Copper.
- .4 Size: [As shown on drawings.
- .5 Stranding: Compact or compressed round.
- .6 Conductor Shield: Semi-conducting extrusion.
- .7 Insulation:
 - .1 90°C rated,
 - .2 cross-linked polyethylene,
 - .3 tree ret3ardant.
- .8 Insulation Thickness: 100%of thickness required for rated voltage.
- .9 Insulation Shield: Strippable semi-conducting extrusion.
- .10 Metallic Insulation Shield: gapped copper tape
- .11 Bonding (ground) conductor: Bare copper in contact with copper tape shields.
- .12 Fillers: as required, non hygroscopic material.

- .13 Binding tape: as required.
- .14 Inner jacket:
 - .1 PVC,
 - .2 FT4 flame retardant,
 - .3 low acid gas emitting,
 - .4 low temperature (-40°C) rated.
- .15 Armour: interlocked aluminum.
- .16 Outer Jacket:
 - .1 PVC
 - .2 FT4 fire retardant],
 - .3 low acid gas emitting,
 - .4 low temperature (-40°C) rated,
 - .5 sunlight (UV) resistant,
- .17 Fault Current Withstand: 2000 Amps for 15 cycles without damage.
- .18 Ground Fault Current Withstand: 2000 Amps for 15 cycles without damage.

2.3 Testing

- .1 Manufacturer to test cables prior to shipping. Tests to include:
 - .1 manufacturer's standard quality control testing to verify cable construction parameters,
 - .2 insulation resistance,
 - .3 tests as called for in the applicable CSA standard.

2.4 Delivery

- .1 Deliver cables on reels in a manner to suit the installation requirements of the Electrical Contractor.

Standard of Acceptance

- Aetna Insulated Wire
- General Cable
- Nexans
- Okonite Cables
- Prysmian
- Southwire
- United Wire and Cable

2.5 Terminations

- .1 3M QT-III] cold shrink packaged kits, constructed as per the cable manufacturer's recommendations.
- .2 Moulded rubber cold shrink type:
 - .1 to IEEE Standard 48, Class 1,
 - .2 one piece construction,
 - .3 for [outdoor applications,
 - .4 suitable for full exposure to the weather,
 - .5 exposed outer components UV protected for direct sunlight exposure,

- .6 BIL of not less than 60kV,
- .7 stress control sleeve with a dielectric constant > 15,
- .8 skirted insulator of track resistant silicone rubber with silicone top seal.
- .3 Packaged kits to include all components necessary for the termination, including:
 - .1 instructions,
 - .2 cable preparation (cleaning) materials,
 - .3 ground braid assemblies,
 - .4 constant force spring(s),
 - .5 mastic strips,
 - .6 stress control sleeve,
 - .7 re-jacketing kit including breakout boot (for 3 conductor cables).
- .4 Fault current rating of the ground braids to match the rating of the cable.

Standard of Acceptance

- 3M

2.6 Cable Lugs

- .1 Two hole long barrel compression type, Burndy YA-2N series.

2.7 Fire-Proofing Tape

- .1 Scotch 77 elastomeric, 75 mm (3") wide.
- .2 Scotch 69 glass cloth electrical tape.

3 EXECUTION

3.1 Installation

- .1 Install cables in accordance with the cable manufacturer's instructions.
- .2 Determine cable lengths with care, using field measurements where possible so that wastage is kept to a minimum.
- .3 Clean and test ducts prior to pulling cable into ducts, by pulling a steel wire brush through ducts followed by a steel bound mandrel made up of four discs having an overall length of not less than 200 mm (8"). Diameter of the discs to be not less than 6 mm ($\frac{1}{4}$ ") less than the nominal inside duct diameter.
- .4 Take necessary precautions in handling cable on reel as well as when installing in duct or tray, to ensure that no damage will result.
- .5 Pull cables in accordance with best standard practices.
- .6 Use a pulling eye attached directly to conductors that make up the cable, except for short runs provided that the Consultant is in agreement.
- .7 Use CSA approved cable lubricants, suitable for the ambient temperature during the pull.
- .8 While cable is being pulled, inspect jacket for any visible cracks or other damage. If any damage is evident, stop the cable pull immediately.
- .9 Replace damaged cables. Do not attempt to repair damaged cables unless the Consultant has agreed in writing.
- .10 Install service entrance and unarmoured cables in rigid steel conduit except where installed in concrete encased ductbanks.

- .11 Where high voltage cables are shown on cable tray, maintain a separation of 25 mm (1") between adjacent cables.
- .12 Provide waterproof and weatherproof connectors for attachment of cables to equipment enclosures where applicable.
- .13 Install terminations in accordance with the instructions of the manufacturer of the cable and the manufacturer of the termination kits.
- .14 Seal cable ends to prevent entrance of moisture.
- .15 Do not splice cables. Where a splice is believed to be essential review with the consultant and if acceptable provide a 3M cold shrink inline splice kit that is compatible with and equivalent to the cable.
- .16 Terminations and splices (where essential) to be made by personnel skilled in this type of work. Submit evidence of this prior to commencing the work.
- .17 Do not make terminations or splices during damp or inclement weather, except in an emergency. In an emergency, provide a tent or other satisfactory means of protection.
- .18 Ground shielding at each termination, unless instructed otherwise and verified.
- .19 Bond armour to ground.
- .20 Fireproof cables, in maintenance holes and vaults, using [one][two] half lapped layers of Scotch 77 fireproofing tape with an overall protective layer of Scotch 69 glass cloth tape.
- .21 Installation of cable, terminations and splices (if allowed) to be made by a firm specializing in this type of work.

Standard of Acceptance

- Black & McDonald Ltd.
- BG High Voltage
- Power Station Construction
- PBW High Voltage
- Independent High Voltage

3.2 Site Testing

- .1 Test high voltage cable installation before placing into regular service.
- .2 High voltage cable testing to be done by the Independent Testing Organization.
- .3 Testing to include:
 - .1 phase verification,
 - .2 grounding verification,
 - .3 Hi-Pot Test of insulation strength to I.C.E.A. Specifications (Leakage Curves to be obtained),
 - .4 verification of proper installation of terminations, and torquing of cable lug bolts.
- .4 Conduct these tests with the Consultant present as a witness and at a time suitable to the Consultant.
- .5 Witnessing of a successful test is mandatory before ownership of cable will be accepted.
- .6 Include cost of testing.

END OF SECTION

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS

26 05 19

1 GENERAL

1.1 Scope

- .1 Provide wires and cables for systems operating between 0 and 1000 Volts, including:
 - .1 building wires,
 - .2 armoured cables,
 - .3 aluminium sheathed cables,
 - .4 mineral insulated cables including fire rated cables,
 - .5 instrumentation and control cabling.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 26 05 33 Conduits, Fastenings and Fittings
 - .2 26 05 37 Wireways and Auxiliary Gutters
 - .3 26 27 28 Wire and Box Connectors - 0 - 1000 V

1.3 Applicable Codes and Standards

- .1 Product standards:
 - .1 CSA C22.2 No. 38 Thermoset-Insulated Wires and Cables
 - .2 CSA C22.2 No. 51 Armoured Cables
 - .3 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Non-Environmental Considerations
 - .4 CSA C22.2 No. 123 Metal Sheathed Cables
 - .5 CSA C22.2 No. 124 Mineral-Insulated Cables
 - .6 CSA C22.2 No. 131 Type TECK 90 Cable
 - .7 CSA C22.2 No. 239 Control and Instrumentation Cables
 - .8 ULC S139 Standard for Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control, and Data Cables

1.4 Design Criteria

- .1 Conductor sizes are based on connected equipment having a temperature marking of 75°C or higher. Where equipment does not have a temperature marking or it has a marking lower than 75°C, increase the size of the conductors accordingly, to the satisfaction of the consultant.
- .2 For wires in conduit, conductor sizes are based on not more than 3 current carrying conductors in a conduit. Where more than 3 current carrying conductors are installed in a conduit increase the conductor size accordingly, to the satisfaction of the consultant.
- .3 Do not reduce conductor sizes, conductors may have been oversized due to voltage drop constraints.

1.5 Submittals

- .1 Submit product data sheets for materials specified herein.

2 PRODUCTS

2.1 Building Wires

- .1 Conductors: copper conductors: size as indicated.
- .2 Minimum wire size: No. 12 AWG.
- .3 Stranded conductors for 10 AWG and larger.
- .4 Insulation:
 - .1 chemically cross-linked thermosetting polyethylene material,
 - .2 RW90 or RWU90 to CSA C22.2 No. 38,
 - .3 1000V and 600V ratings.
- .5 Conductors to be colour coded. Conductors to have colour impregnated into insulation at time of manufacture. Phase conductors No. 8 AWG and larger, with black insulation, may be colour coded with adhesive colour coding tape.

Standard of Acceptance

- Aetna Insulated Wire
- General Cable
- Nexans Canada Inc.
- Prysmian Cables & Systems Ltd.
- Southwire

2.2 Armoured Cables

- .1 Type: AC90, 600V 90C to CSA C22.2 No. 51, FT4 rated.
- .2 Conductors:
 - .1 copper, minimum size #12,
 - .2 bare copper bonding wire sized per the electrical code.
- .3 Insulation: RW90 XLPE.
- .4 Armour: interlocking type fabricated from galvanized steel or aluminum strip.

2.3 Armoured Cables with Insulated Bonding Conductor

- .1 Type: AC90 ISO-BX, 600V 90C to CSA C22.2 No. 51, FT4 rated.
- .2 Conductors:
 - .1 copper, minimum size #12,
 - .2 green insulated copper bonding wire, same size as the phase conductors.
- .3 Insulation: RW90 XLPE.
- .4 Armour: interlocking type fabricated from galvanized steel or aluminum strip.

2.4 Armoured Cables Teck

- .1 Type: TECK90, 600V to CSA C22.2 No. 131.

- .2 Conductors: insulated copper, quantity and size as indicated.
- .3 Insulation: RW90 XLPE.
- .4 Inner jacket; FT-4 rated PVC.
- .5 Armour: interlocking steel for multiconductor cable, interlocking aluminum for single conductor cables
- .6 Bonding conductor:
 - .1 bare in multiconductor cables,
 - .2 bare concentric in single conductor cables,
 - .3 same material as phase conductors,
 - .4 copper for feeders serving patient care areas,
 - .5 isolated from the armour by the inner jacket.
- .7 Outer jacket: FT-4 rating with rating permanently identified on jacket.
- .8 Connectors:
 - .1 Watertight,
 - .2 Equal to T&B Star Teck type,
 - .3 Non-magnetic connectors for single conductor cables.

Standard of Acceptance (armoured, aluminium sheathed and TECK cables)

- Aetna Insulated Wire
- General Cable
- Nexans Canada Inc.
- Northern Cables Inc.
- Prysmian Cables & Systems Ltd.
- Southwire

2.5 Fire Rated Mineral Insulated Cable

- .1 Type: MI, 600V to CSA C22.2 No. 124.
- .2 Conductors: solid annealed copper, quantity and size as indicated.
- .3 Insulation: compacted magnesium oxide.
- .4 Sheath: seamless annealed copper.
- .5 Terminations: as supplied by the cable manufacturer.
- .6 Polymer jacket on cables that are to be buried or embedded, or installed in environments corrosive to copper.
- .7 Fire rating: listed 2 hour rating to ULC S139, cables labelled accordingly.
- .8 Cables to be shipped with ends sealed.

Standard of Acceptance

- Pentair/Pyrotenax System 1850
- Vitalink MC

2.6 Instrumentation and Control Cabling

- .1 Control cables to CSA C22.2 NO. 239.
- .2 Control cables as follows:

Conductors	Quantity, arrangement and gauge shown on drawings or specified elsewhere.
Identification	Colour coded or numbered.
Insulation	XLPE
Armour	Steel (No armour required if installed in conduit or approved wireway).
Jacket	FT4 Flame Retardant, FT6 when installed in open style cable trays in ceiling spaces that are used as return air plenums.

- .3 Shielded cables to provide 100% shield coverage complete with drain wire.
- .4 Multipair twisted shielded cables to have individually shielded pairs, overall shield, drain wires and overall rated jacket.

Standard of Acceptance

- General Cable (Carol)
- Belden
- Nexans Canada Inc.

3 EXECUTION

3.1 General

- .1 Conductor colour coding to be as follows:
 - .1 Phase A - Red
 - .2 Phase B - Black
 - .3 Phase C - Blue
 - .4 Neutral - White
 - .5 Ground - Green
 - .6 Control - Orange
- .2 Where colour coding tape is utilized, apply at least 50 mm (2") at terminations, junction boxes and pull boxes. Do not paint conductors.
- .3 Use:
 - .1 1000 V insulation for 600 Volt systems,
 - .2 600 V insulation for 347/600 V and 120/208 V systems.
- .4 Wiring installed underground: RWU90.
- .5 Store wire and cable in a clean, dry, well ventilated area.
- .6 Protect white insulated wire from exposure to NOx gas (eg: exhaust from propane fuelled equipment) by wrapping with shrink wrap, by locating away from sources of NOx and by maintaining adequate ventilation to minimize NOx levels.
- .7 Where white insulated wire has discoloured:

- .1 do not install,
- .2 dispose of the wire,
- .3 remove and replace wire that has been installed.
- .8 Neatly train circuit wiring in cabinets, panels, pullboxes and junction boxes and hold with nylon cable ties.
- .9 Splice wires:
 - .1 up to and including No. 6 AWG: with nylon insulated expandable spring type connectors with moulded thermoplastic body and expandable square edge design spring.
 - .2 larger than #6 AWG: with compression sleeve connectors and heat shrink insulating sleeves, voltage rating of sleeves equal to or greater than the cable.
 - .3 aluminum Conductors: with long barrel compression sleeve connectors approved for use with aluminum conductors and heat shrink insulating sleeves, voltage rating of sleeves equal to or greater than the cable.
- .10 Do not splice conductors used in parallel runs.
- .11 Where the Consultant agrees that splicing of conductors in a parallel run is unavoidable, connect the paralleled runs of the feeder together in a junction box at the splice location, using:
 - .1 copper bus bars of quantity and size to match the circuit,
 - .2 a two hole long barrel compression lug on each cable,
 - .3 two nuts and bolts on each lug,
 - .4 two oversized flat washers and a spring lock washer, or two Belleville washers, on each bolt,
 - .5 an oversized enclosure to house the above; CSA 22.2 No 94.1 Type 3R.

3.2 Installation of Building Wires

- .1 Install wiring as follows:
 - .1 in conduit systems in accordance with Section 26 05 33.
 - .2 in wireways and auxiliary gutters in accordance with Section 26 05 37.
- .2 Home runs, of 15 and 20 Ampere circuits to lighting and receptacle panels, which exceed:
 - .1 25 m (75') in length: No. 10 AWG or larger,
 - .2 40 m (120') in length: No. 8 AWG or larger,
 - .3 60 m (180') in length: No. 6 AWG or larger.
- .3 Increase the size of branch circuit conductors and home runs as required so that the total voltage drop, from panelboards to loads, does not exceed 3% under load.
- .4 For branch circuit wiring provide a dedicated neutral conductor for each phase conductor. Where the load does not produce harmonic currents a common neutral conductor may be used with two or three phase conductors, subject to prior approval by the Consultant.
- .5 For branch wiring, common neutral conductors may be used in the following applications:
 - .1 lighting circuits, excluding dimming circuits,
 - .2 housekeeping receptacles,
 - .3 specific purpose receptacles for equipment that does not produce harmonic currents, such as resistance heating.
- .6 Where wires are damaged or contaminated during installation, remove and dispose of wires, swab out conduits and pull in new, clean conductors.

3.3 Installation of Armoured Cables AC90(BX)

- .1 May be used for drops to surface and recessed mounted fluorescent luminaires.
- .2 Do not use in patient care areas.
- .3 Terminate cables in accordance with Section 26 27 28.

3.4 Installation of Armoured Cables AC90 ISO-BX

- .1 May be used for drops to surface and recessed mounted fluorescent luminaires in patient care areas.
- .2 Terminate cables in accordance with Section 26 27 28.

3.5 Installation of Armoured Cables ACWU and TECK

- .1 Install and terminate cables in accordance with manufacturer's recommendations.
- .2 Use non-magnetic connectors for single conductor cables.
- .3 In systems that serve patient care loads, provide:
 - .1 cables with copper bonding conductors,
 - .2 bonding conductors isolated from the cable armour by an inner PVC jacket or by insulation on the bonding conductor.
- .4 For single conductor cables in free air circuits rated up to and including 400Amperes:
 - .1 Space cables one cable diameter apart throughout the run.
 - .2 Cut an opening in the enclosure at each end of the run, opening to be large enough for all cables of the circuit to pass through with spacings maintained.
 - .3 Provide a 6mm thick aluminium termination plate at each end of the run.
 - .4 Size the termination plates to overlap the openings by at least 20mm on all sides.
 - .5 Seal the plates to the enclosures with silicone sealant and secure to the enclosures with nuts, bolts and lock washers every 150mm.
 - .6 Terminate all cables of the circuit on the same terminal plate.
 - .7 Connect the cable bonding conductors to the enclosure bonding lug or bus at each end of the run.
 - .8 Bond each aluminium termination plate to its associated enclosure.
- .5 For single conductor cables in free air circuits rated greater than 400Amperes:
 - .1 Space cables one cable diameter apart throughout the run.
 - .2 Cut an opening in the enclosure at each end of the run, opening to be large enough for all cables of the circuit to pass through with spacings maintained.
 - .3 At the supply end of the run:
 - (a) provide a 6mm thick aluminium termination plate,
 - (b) size the termination plate to overlap the opening by at least 20mm on all sides,
 - (c) seal the plate to the enclosure with silicone sealant and secure to the enclosure with nuts, bolts and lock washers every 150mm,
 - (d) terminate all cables of the circuit on the terminal plate,
 - (e) connect the cable bonding conductors to the enclosure bonding lug or bus,
 - (f) bond the aluminium termination plate to the enclosure.
 - .4 At the load end of the run:

- (a) provide a 6mm thick non-conductive fire-resistant FRP (Glastic) termination panel,
 - (b) size the termination panel to overlap the opening by at least 20mm on all sides,
 - (c) seal the panel to the enclosure with silicone sealant and secure to the enclosure with nuts, bolts and lock washers every 150mm,
 - (d) terminate all cables of the circuit on the terminal panel,
 - (e) cut off the cable bonding conductors at the connector and cover with insulating tape, ensure that the cable bonding conductors do not make any electrical contact.
 - (f) ensure that the cable connectors do not make electrical contact with the enclosure.
- .5 Install a separate bonding conductor for the circuit:
- (a) of copper wire,
 - (b) sized per the Electrical Safety Code,
 - (c) run from the bonding lug or bus in the supply end enclosure to the bonding lug or bus in the load end enclosure,
 - (d) separated from the phase cables throughout the run, by a distance of not less than the spacing between the phase cables,
 - (e) securely fastened throughout the run.
- .6 For single conductor cables in direct buried circuits:
- .1 Space cables apart per Diagram D8 of the electrical code.
- .2 Maintain cable spacing throughout the run.
- .3 Cut an opening in the enclosure at each end of the run, opening to be large enough for all cables of the circuit to pass through with spacings of not less than one cable diameter.
- .4 At the supply end of the run:
- (a) provide a 6mm thick aluminium termination plate,
 - (b) size the termination plate to overlap the opening by at least 20mm on all sides,
 - (c) seal the plate to the enclosure with silicone sealant and secure to the enclosure with nuts, bolts and lock washers every 150mm,
 - (d) terminate all cables of the circuit on the terminal plate,
 - (e) connect the cable bonding conductors to the enclosure bonding lug or bus,
 - (f) bond the aluminium termination plate to the enclosure.
- .5 At the load end of the run:
- (a) provide a 6mm thick non-conductive fire-resistant FRP (Glastic) termination panel,
 - (b) size the termination panel to overlap the opening by at least 20mm on all sides,
 - (c) seal the panel to the enclosure with silicone sealant and secure to the enclosure with nuts, bolts and lock washers every 150mm,
 - (d) terminate all cables of the circuit on the terminal panel,
 - (e) cut off the cable bonding conductors at the connector and cover with insulating tape, ensure that the cable bonding conductors do not make any electrical contact,
 - (f) ensure that the cable connectors do not make electrical contact with the enclosure.
- .6 Install a separate bonding conductor for the circuit:
- (a) insulated RWU90 copper,
 - (b) sized per the Electrical Safety Code,
 - (c) run from the bonding lug or bus in the supply end enclosure to the bonding lug or bus in the load end enclosure,

- (d) separated from the phase cables throughout the run, by a distance of not less than the spacing between the phase cables.

3.6 Installation of Mineral Insulated Cables

- .1 Provide fire rated mineral insulated cables unless non-fire rated cables are indicated.
- .2 Store cables under dry conditions.
- .3 Handle cables with care to avoid cable kinks; it is recommended that cable be uncoiled from supply reel by rolling. Do not install kinked cables.
- .4 Install and terminate cables in accordance with the manufacturer's recommendations.
- .5 Install fire rated cables in accordance with ULC S139 and in accordance with the manufacturer's recommendations.
- .6 Install cables in trays, on hangers or on channels secured to walls, beams or floor slabs, using clamps supplied by or recommended by the manufacturer.
- .7 For cable tray installations:
 - .1 install fire rated cables in stainless steel trays only,
 - .2 non fire rated cables may be installed in galvanized, aluminium, fibreglass or stainless steel trays.
- .8 Support cables with clamps, straps, clips of:
 - .1 copper,
 - .2 stainless steel,
 - .3 steel material,
 - .4 aluminum, for non fire rated cables only.
- .9 Secure cables so that they cannot contact any dissimilar metals other than the approved supporting materials.
- .10 In damp or wet areas wrap cables with electrical tape where the cable contacts the supporting materials unless the supporting materials are copper or stainless steel. For non-fire rated cables only, clamps with integral rubber insets may be used in lieu of tape.
- .11 Support fire rated cables:
 - .1 directly from fire rated structure per ULC FHITC.1850 or, where ULC FHITC.1850 cannot be applied, support cables in accordance with written instructions from the Consultant,
 - .2 on centres not exceeding:
 - (a) 1219 mm (4') for cables less than or equal to 7.6mm (0.3") in diameter,
 - (b) 1828 mm (6') for cables greater than 7.6mm (0.3") in diameter,
 - .3 with stainless steel clamps or straps on cable groups midway between supports, for single conductor cables.
- .12 For non-fire rated cables provide supports on centres not exceeding 2000mm (6.56').
- .13 Bend cables using a suitable hickey with a bending radius of not less than six times the cable diameter.
- .14 Protect embedded cables from punctures and mechanical damage.
- .15 For unjacketed single conductor cables that form a circuit or form one run of a feeder with parallel runs, install the cables with their sheaths in contact with one another throughout their length, excluding 1m at each point of connection to equipment or box.
- .16 For single conductor cables in circuits rated 200 A and higher:

- .1 Cut an opening in the enclosure at each end of the run, opening to be large enough for all cables of the circuit to pass through with spacings maintained.
- .2 Provide a 6mm thick brass termination plate at each end of the run.
- .3 Size the termination plates to overlap the openings by at least 20mm on all sides.
- .4 Seal the plates to the enclosures with silicone sealant and secure to the enclosures with nuts, bolts and lock washers every 150mm.
- .5 Terminate all cables of the circuit on the same termination plate.
- .6 Provide a copper bonding conductor, sized per Table 16 of the ESC, from each brass termination plate to the equipment ground lug or bus in the associated enclosure.
- .7 Connect to the termination plate and to the equipment ground lug or bus using Burndy YA compression connectors with 12mm stainless steel bolts and matching hardware.
- .17 For parallel runs, install cable groups at least 2.15 cable diameters apart.
- .18 Terminate cables using glands and seals as supplied by the cable manufacturer. Install gland and seal assemblies using tools specifically designed for the purpose.
- .19 For fire rated feeders to fire pump controllers:
 - .1 terminate the mineral insulated cable in a type 3R junction box located adjacent to the fire pump controller,
 - .2 extend the feeder using RW90 in EMT, sized to match the ampacity rating of the mineral insulated cables,
 - .3 connect the EMT to the bottom of the fire pump controller enclosure, do not connect to the top or sides of the controller enclosure.
- .20 Upon completion of cable terminations and prior to energization, test the insulation resistance of each cable with an insulation tester. Where measured values are not acceptable to the Consultant, rework or replace the cable until satisfactory results are obtained.
- .21 For fire rated cables, provide the services of the cable manufacturer to inspect the cable installation and termination methods and provide a written report documenting that the cables have been installed in accordance with the requirements of the ULC standard and the ULC listing and in accordance with the manufacturer's recommendations. Submit the report to the Consultant.

3.7 Installation of Instrumentation, Communication and Control Cabling

- .1 Install wiring as follows:
 - .1 in conduit systems in accordance with Section 26 05 33,
 - .2 in wireways and auxiliary gutters in accordance with Section 26 05 37,
 - .3 in open style cable trays in ceiling spaces, using FT6 plenum rated cable assemblies,
 - .4 in open style cable trays in ceiling spaces, using FT6 or FT4 rated cable where the ceiling space is not used as a return air plenum, as directed by the Consultant.
- .2 Neatly train circuit wiring in cabinets, panels, pull boxes and junction boxes and hold with nylon cable ties.
- .3 Run instrumentation, communication and control cabling point to point and terminate on terminal strips. Do not splice communication or control cabling. Where long runs make a continuous point to point installation impractical, make splices on labelled terminal blocks in an accessible labelled terminal cabinet, installed at 1200 mm (48") above floor, and indicate cabinet location, terminal and wire numbers on the As-built drawings.
- .4 Terminate control cables in equipment with suitable connectors.

- .5 Clearly identify cables at both ends, with permanent PVC wire markers, Weiland type Z or equal, indicating cable number and wire numbers.

END OF SECTION

PRIMARY GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

26 05 26.13

1 GENERAL

1.1 Scope

- .1 Provide grounding and bonding for substations or for electrical distribution above 750 V, as shown.
- .2 Refer to Section 26 11 01 for grounding and bonding of outdoor substations.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 26 01 01 Electrical General Requirements
 - .2 26 05 53 Identification for Electrical Systems.
 - .3 26 08 05 System Co-ordination, Verification and Testing.
 - .4 26 11 11 Outdoor Substation.

1.3 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 ANSI/IEEE 80 IEEE Guide for Safety in AC Substation Grounding.
 - .2 ANSI/IEEE 142 IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems
 - .3 ANSI/IEEE 837 Standard for Qualifying Permanent Connections Used in Substation Grounding.
- .2 Product standards:
 - .1 CSA C22.2 No 41 Grounding and Bonding Equipment.

1.4 Submittals

- .1 Submit product data sheets for materials specified herein.
- .2 Operation and Maintenance Data:
 - .1 Provide operation and maintenance data for incorporation into operating and maintenance manuals.

2 PRODUCTS

2.1 Connections

- .1 For:
 - .1 conductor to conductor,
 - .2 conductor to rod electrode,
 - .3 conductor to perimeter ground bus,
 - .4 conductor to structural column.
- .2 Compression connectors:
 - .1 made from wrought copper.

Standard of Acceptance:

- Burndy Hyground series
- Approved alternative

.3 Exothermic welded connections:

Standard of Acceptance:

- ABB Installation Products Ltd. (T & B) - Furseweld
- Erico -Cadweld
- Burndy - BURNDYWeld

2.2 Electrodes

.1 Rod electrodes:

- .1 material: steel with a bonded copper cladding not less than 254 μm (10 mils) thick,
- .2 size: 19 mm dia by 3 m long ($\frac{3}{4}$ " dia by 10' long),
- .3 listed to C22.2 No 41.

2.3 Soil Enhancement Material

.1 For embedding ground rods into augured holes:

- .1 permanent,
- .2 non-corrosive,
- .3 resistivity less than 1 ohm-m,
- .4 sodium bentonite clay. or conductive concrete (Erico GEM).

2.4 Conductors

.1 Buried grounding conductors:

- .1 bare, stranded, tinned, soft annealed copper,
- .2 size #4/0 AWG except where indicated otherwise.

.2 Exposed grounding conductors:

- .1 bare, stranded, composite cable with tinned, soft annealed copper core and a galvanized steel wire outer layer,
- .2 size #4/0] AWG except where indicated otherwise.

.3 Insulated bonding conductors:

- .1 stranded, soft annealed copper,
- .2 green insulation, type RW90,
- .3 size #4/0 AWG except where indicated otherwise.

2.5 Accessories

.1 Accessories:

- .1 non-corroding copper, bronze and/or stainless steel construction,
- .2 types including but not limited to:
 - (a) grounding and bonding bushings,
 - (b) protective type clamps,
 - (c) bolted type conductor connectors,

- (d) exothermic welded type conductor connectors,
 - (e) bonding jumpers, straps,
 - (f) pressure wire connectors,
- .Ground rod inspection boxes:
- .3 cylindrical with removable lid to provide access to ground rod connections,
 - .4 250 mm diameter x 300 mm deep (10" diameter x 12" deep),
 - .5 hot dipped galvanized steel.

Standard of Acceptance

- ABB Installation Products Ltd. (T & B) - #51629
- Approved alternative

3 EXECUTION

3.1 Grounding Installation

- .1 Install continuous grounding system including, electrodes, conductors, connectors and accessories in accordance with the electrical code, ANSI/IEEE Standards 80 and 142, and requirements of local authority having jurisdiction.
- .2 The completed ground grid to have a resistance of not more than 5 Ohms.
- .3 Use not less than No. 4/0 AWG bare conductors for ground grid, electrode interconnections, transformers, switchgear, ground grid to perimeter ground bus connections.
- .4 Use not less than No. 2/0 AWG bare conductors for lightning arrestors, metal structures, gradient control mats, motors, perimeter ground bus to equipment connections.
- .5 Use not less than No. 4 AWG insulated conductors for bonding cable sheaths, raceways, pipe work, screen guards, potential transformers.
- .6 Install connectors in accordance with manufacturer's instructions.
- .7 Protect exposed grounding and bonding conductors from mechanical injury.
- .8 Make buried connections, and connections to electrodes, structural steel work, conductive water main in accordance with ANSI/IEEE 837, using permanent mechanical connectors or exothermic welded connections.
- .9 Provide removable connectors for connections to the following:
 - .1 metallic water mains,
 - .2 transmission line overhead ground wire,
 - .3 line neutral conductor.
- .10 Use mechanical connectors for connections to equipment provided with lugs.
- .11 Use tinned copper conductors for buried installations.
- .12 Use tinned copper conductors where the conductors are in contact with zinc coated or aluminium structures.
- .13 Provide inspection boxes at connections to ground rods as indicated.

3.2 Electrode Installation

- .1 Install at least four ground rod] electrodes around each transformer. Provide additional electrodes where detailed on the drawings.
- .2 Connect separate, multiple electrodes together.

- .3 Where rock or sand terrain prevails, provide:
 - .1 additional electrodes,
 - .2 deep electrodes,
 - .3 soil enhancement,
 - .4 satellite electrodes, etc.,as required until acceptable resistance value to ground is obtained.

3.3 System Grounding

- .1 For solidly grounded systems, connect secondary neutral terminals of transformers to ground using not less than [2/0 bare copper.
- .2 Install grounding conductors in PVC conduit.

3.4 Equipment Bonding

- .1 Bond the following to the main ground grid:
 - .1 metallic raceways,
 - .2 potential transformers,
 - .3 meter and relay cases,
 - .4 pothead bodies,
 - .5 transformer enclosures,
 - .6 switch and fuse bases,
 - .7 sub-station fences,
 - .8 outdoor lighting,
 - .9 any other conductive items.
- .2 Bond hinged doors to main frame of electrical equipment enclosure with flexible jumpers.

3.5 Cable Sheath Bonding

- .1 Bond single conductor, metallic sheathed cables together at one end only. Break sheath continuity by inserting insulating sleeves in cables.
- .2 Use not less than No. 4 AWG flexible copper wire secured to cable sheath in accordance with the cable manufacturer's instructions.
- .3 Connect sheaths to ground with not less than No. 2/0 AWG copper conductor.

3.6 Miscellaneous Bonding

- .1 Bond the following to the main ground grid:
 - .1 metallic piping (water, oil, air, etc) inside station at several locations, including at each service location within station,
 - .2 metallic water main, at the entry and exit points of the ground grid and every 12m (39'),
 - .3 any exposed building metal, within or forming part of a station enclosure.

3.7 Identification

- .1 For the grounding of each system, show the location and method of grounding on the single line electrical diagrams, in accordance with Section 26 05 53.

3.8 Field Quality Control

- .1 Perform tests in accordance with Section 26 01 01 and Section 26 08 05.
- .2 Verify completed installation as follows:
 - .1 Dynamic ground resistance measurements at the high voltage substation using the drop of potential method.
 - .2 Dynamic bonding verification of the switchgear, power transformers, substation enclosure, and associated apparatus using 60 Hz AC excitation current method.
- .3 Perform tests before energizing the electrical system.

END OF SECTION

SECONDARY GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

26 05 26.16

1 GENERAL

1.1 Scope

- .1 Provide grounding and bonding for electrical distribution at 750 V and lower, as shown.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 26 01 01 Electrical General Requirements.
 - .2 26 05 53 Identification for Electrical Systems.
 - .3 26 08 05 System Co-ordination, Verification and Testing.

1.3 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 ANSI/IEEE 142 IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems
 - .2 ANSI/IEEE 837 Standard for Qualifying Permanent Connections Used in Substation Grounding.
 - .3 ANSI/TIA 568A General Telecommunications Cabling for Customer Premises
 - .4 ANSI/TIA 569 Telecommunications Pathways and Spaces
 - .5 ANSI/TIA 607 General Telecommunications Bonding and Grounding (Earthing) for Customer Premises
 - .6 CSA-Z32 Electrical Safety and Essential Electrical Systems in Health Care Facilities.]
- .2 Product standards:
 - .1 CSA C22.2 No 41 Grounding and Bonding Equipment.

1.4 Submittals

- .1 Submit product data sheets for materials specified herein.
- .2 Submit list of nameplates.
- .3 Operation and Maintenance Data:
 - .1 Provide operation and maintenance data for incorporation into operating and maintenance manuals.

2 PRODUCTS

2.1 Clamps

- .1 Conductor to water main clamps suitable for grounding connections,
- .2 Type and size as required to make electrically conductive connections to underground water pipe,
- .3 Non-corroding copper, bronze and/or stainless steel construction.

2.2 Electrodes

- .1 Rod electrodes:
 - .1 material: steel with a bonded copper cladding not less than 254 µm (10 mils) thick,
 - .2 size: 19 mm dia by 3 m long ($\frac{3}{4}$ " dia by 10' long),
 - .3 listed to C22.2 No 41.

2.3 Conductors

- .1 Buried grounding conductors:
 - .1 bare, stranded, tinned, soft annealed copper,
 - .2 size #4/0 AWG unless indicated otherwise.
- .2 Insulated grounding and bonding conductors:
 - .1 bare, stranded, soft annealed copper,
 - .2 type RW90 green insulation.

2.4 Accessories

- .1 Accessories including but not limited to:
 - .1 grounding and bonding bushings,
 - .2 protective type clamps,
 - .3 bolted type conductor connectors,
 - .4 exothermic welded type conductor connectors,
 - .5 bonding jumpers, straps,
 - .6 pressure wire connectors,to be of non-corroding copper, bronze and/or stainless steel construction.

3 EXECUTION

3.1 Installation

- .1 Ground electrical systems in accordance with the Electrical Safety Code and the latest edition of ANSI/IEEE Standard 142.
- .2 Bond electrical equipment in accordance with the Electrical Safety Code and the latest edition of ANSI/IEEE Standard 142.
- .3 Install connectors in accordance with manufacturer's instructions.
- .4 Protect exposed grounding and bonding conductors from mechanical injury.
- .5 Make buried connections, and connections to conductive water main and electrodes, using copper welding by exothermic process.
- .6 Use mechanical connectors for grounding and bonding connections to equipment provided with lugs.
- .7 Soldered joints not permitted.
- .8 Provide a bonding wire for flexible conduit, connected at both ends to bonding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- .9 Provide a separate bonding conductor in each conduit:
 - .1 sized as per Table 16 of the ESC,

- .2 not less than #12 AWG copper,
- .3 with one bond conductor for every three line conductors.
- .10 Bond building structural steel and metal siding to ground by welding copper to steel.
- .11 Make grounding connections in radial configuration only, with connections terminating at a single grounding point. Avoid loop connections.
- .12 Install grounding conductors outside electrical rooms and electrical closets in PVC conduit and conceal where possible. Where PVC conduit is not permitted use EMT and bond the EMT to the conductor at both ends.

3.2 Electrodes

- .1 Make ground connections to continuously conductive underground water pipe on street side of water meter.
- .2 Provide a 4/0 AWG copper water meter shunt.
- .3 Install rodelectrodes and make grounding connections.
- .4 Bond grounding electrodes together with 4/0 AWG copper conductors.
- .5 For main electrical rooms on grade, provide a rod electrode at each corner of the room and connect to perimeter ground bus.
- .6 For main electrical rooms on a suspended slab, provide:
 - .1 two runs of 4/0 AWG copper conductor,
 - .2 connect runs to opposite corners of the perimeter ground bus,
 - .3 install in PVC conduit,
 - .4 run via separate routes,
 - .5 connect to opposite corners of the building ground grid.
- .7 Where high resistivity soil conditions exist such as rock or sand, provide:
 - .1 additional electrodes,
 - .2 deeper electrodes,
 - .3 soil enhancement material or,
 - .4 chemically filled grounding rods,as required to achieve an acceptable resistance to ground value.

3.3 System Grounding

- .1 Provide system grounding connections to neutral point of secondary systems using not less than #6 copper conductor unless indicated otherwise.
- .2 Install insulated copper grounding conductor for service raceways and service equipment as required by the electric utility company.
- .3 Install grounding conductors in PVC conduit.

3.4 Equipment Bonding

- .1 Install insulated copper bonding connections:
 - .1 sized not less than #12 AWG and not less than indicated in Table 16 of the electrical code,
 - .2 to typical equipment including, but not necessarily limited to the following list:
 - (a) service equipment,

- (b) transformers,
 - (c) switchboards,
 - (d) panelboards,
 - (e) splitters,
 - (f) disconnect switches,
 - (g) junction and outlet boxes,
 - (h) receptacles,
 - (i) luminaires,
 - (j) transfer switches,
 - (k) UPS systems,
 - (l) battery enclosures,
 - (m) capacitor banks,
 - (n) frames of motors,
 - (o) frames of generators (alternators),
 - (p) motor control centres,
 - (q) starters,
 - (r) fire alarm systems,
 - (s) security systems,
 - (t) CCTV systems,
 - (u) audio systems,
 - (v) communications systems,
 - (w) control panels,
 - (x) outdoor lighting,
 - (y) elevators,
 - (z) other equipment that is supplied with electrical power.
- .2 Where applicable, run bonding conductors as part of the feeder.
 - .3 Where bonding conductors are run separately, install in PVC conduit.
 - .4 In healthcare facilities, for circuits to patient care receptacles, oversize the bonding conductor as necessary to comply with the voltage drop criteria in CSA standard Z32.

3.5 Communications Systems

- .1 Install bonding connections for telephone, sound, fire alarm, intercommunication systems as follows:
 - .1 telephones: make telephone bonding system in accordance with telephone company's requirements,
 - .2 communications system bonding: in accordance with ANSI/TIA 607, 568A, 569 standards,
 - .3 sound, fire alarm, intercommunication systems: as required by the electrical code except where indicated otherwise.

3.6 Bonding of Other Items

- .1 Install insulated copper bonding connections:
 - .1 sized not less than #6 AWG,
 - .2 run in PVC conduit,

- .3 to typical items including, but not necessarily limited to following list:
 - (a) metallic water piping systems,
 - (b) metallic waste water piping systems,
 - (c) metallic gas piping systems,
 - (d) metallic vacuum piping systems,
 - (e) metallic compressed air piping systems,
 - (f) building steel work.
- .2 Review the design and installation of each piping system with the system installer and provide bonding jumpers where necessary to ensure that each piping system is electrically continuous.

3.7 Identification

- .1 For the grounding of each electrical system, show the location and method of grounding on the single line electrical diagrams, in accordance with Section 26 05 53.

3.8 Field Quality Control

- .1 Perform tests in accordance with:
 - .1 Section 26 01 01 - Electrical General Requirements.
 - .2 Section 26 08 05 - System Co-ordination, Verification and Testing.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Consultant and local authority having jurisdiction.
- .3 Perform tests before energizing electrical system.

END OF SECTION

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

26 05 29

1 GENERAL

1.1 Scope

- .1 Provide fasteners and supports for electrical services.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 01 61 00 Common Product Requirements.
 - .2 26 05 01 Electrical Basic Materials and Methods
 - .3 26 05 49.13 Seismic Restraint for Electrical Services

1.3 Submittals

- .1 Submit design drawings for custom fabricated trapeze hangers, sealed by a professional engineer licensed in the project location jurisdiction.
 - .1 Shop drawing details:
 - (a) construction detail drawings for each loading condition,
 - (b) span deflection calculations,
 - (c) building attachment load calculations and type.
 - .2 Provide services of engineer who sealed the custom trapeze hanger shop drawings to conduct a general review of the completed installation on site.

2 PRODUCTS

2.1 Support Channels

- .1 Hot dipped galvanized steel, U shape, size 41 mm x 41 mm x 2.5 mm (1-1/2" x 1-1.2" x 1/10") thick, surface mounted, suspended or set in poured concrete walls and ceilings.

2.2 Inserts

- .1 Inserts for conduits and raceway hangers, for single, double and multiple runs: galvanized steel.

Standard of Acceptance

- Unistrut Canada
- Burndy (Canada) Ltd. - Flexibar
- Pilgrim Technical Products Ltd. - Tufstrut

2.3 Hangers

- .1 Hangers for electrical conduit: hot-dipped galvanized after fabrication.

Standard of Acceptance

- Burndy Canada Ltd.
- Canstrut
- Electrovert Ltd.
- E. Myatt & Co. Ltd

- Steel City Electric Ltd.
- Pilgrim Technical Products Ltd.

2.4 Trapeze hangers

- .1 Performance:
 - .1 Manufactured:
 - (a) to product load listings.
 - .2 Custom fabricated:
 - (a) maximum deflection between supports: 1/250 (0.4%) of span
 - (b) minimum factor of safety : 5 times load to ultimate tensile or compressive strength.
- .2 Construction:
 - .1 Carbon steel shapes, to suit load application:
 - (a) hollow steel section,
 - (b) equal leg EI section, or
 - (c) double C channel "strong-back", with welded clips.
 - .2 Hanger rods:
 - (a) as specified above, and
 - (b) minimum two support rods,
 - (c) rods selected for minimum factor of safety of 5 times load to ultimate tensile or compressive strength of rod.
- .3 Finish:
 - .1 hot dipped galvanized finish in mechanical rooms and outdoors.
 - .2 black steel finish in other areas.

Standard of Acceptance

- Anvil Fig 45, 46, 50

3 EXECUTION

3.1 Installation

- .1 Supply and deliver inserts to site in ample time to be built into work of other trades. Provide necessary templates and adequate instructions to locate and install inserts.
- .2 Secure equipment to masonry, tile and plaster surfaces with lead anchors.
- .3 Secure equipment to poured concrete with expandable inserts.
- .4 Secure surface mounted equipment with T-bar support hanger fastened to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.

Standard of Acceptance

- Caddy - fig. No. 512 c/w BHC clip
- .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 (2") and smaller.
- .2 Two-hole steel straps for conduits and cables larger than 50 mm (2").
- .3 Beam clamps to secure conduit to exposed steel work.
- .7 Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm (¼") dia threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6 mm (¼") dia threaded rod hangers where direct fastening to building construction is impractical.
- .8 For surface mounting of two or more conduits use channels.
- .9 Provide galvanized after fabrication 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.
- .14 Supply and erect special structural work required for the installation of electrical equipment. Provide anchor bolts and fastenings unless noted otherwise. Mount equipment required to be suspended above floor level, where details are not shown, on a frame or platform bracketed from the wall or suspended from the ceiling. Carry supports to either the ceiling or the floor, or both as required, at locations where, because wall thickness is inadequate, it is not permitted to use such brackets.
- .15 Electrical panels, switches or other electrical equipment shall be complete with suitable bases or mounting brackets. Install angle or channel iron supports to bear the equipment where it is shown in or on structural tile walls, or walls that are inadequate to bear the equipment.
- .16 Provide channel iron or other metal supports where necessary to adequately support lighting fixtures. Do not use wood. Lighting fixtures shall be supported totally independent of ceiling and supported from structure above.
- .17 Support hangers, in general, from inserts in concrete construction or from building structural steel beams, using beam clamps. Provide additional angle or channel steel members required between beams for supporting conduits.
- .18 Do not use explosive drive pins in any section of work without obtaining prior written approval.
- .19 Provide re-enforced concrete pads under switchboards, generators, and all other floor mounted electrical equipment. Pads are to be formed with chamfered edges to prevent chipping. Pads are to be sealed and painted to prevent dust from entering and interfering with electrical equipment.

3.2 Housekeeping Pads

- .1 Conform to Specification section 26 05 01.

END OF SECTION

SPLITTERS, JUNCTION AND PULL BOXES, CABINETS

26 05 32

1 GENERAL

1.1 Scope

- .1 Provide splitters, junction boxes, pull boxes and cabinets.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 26 24 16.14 Panel Trim

1.3 Applicable Codes and Standards

- .1 Product standards:
 - .1 CSA C22.2 No. 76 Splitters.
 - .2 CSA C22.2 No. 40 Junction and Pull Boxes.

1.4 Submittals

- .1 Submit shop drawings and product data for cabinets in accordance with Section 26 05 01 Electrical General Requirements.

2 PRODUCTS

2.1 Splitters

- .1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2 Main and branch lugs and 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.
- .4 Distribution riser splitters shall be of special construction with hinged access door, copper bus bars predrilled to accept two hole compression connectors for all incoming and outgoing cables.

2.2 Junction and Pull Boxes

- .1 Welded steel hot dipped galvanized construction with screw-on flat covers for surface mounting.
- .2 Covers with 25 mm (1") 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, lock and catch, for surface mounting.
- .2 Type T: sheet steel cabinet, with hinged door, latch, lock, 2 keys, containing sheet steel backboard for surface or flush mounting as indicated.
- .3 Cabinet trim to conform to Specification section 26 24 16.14.
- .4 Surface mounted cabinet finish colour: ASA 61 grey.

2.4 Instrumentation and Control Terminal Cabinets

- .1 Surface mounted, gasketed, drip proof and dust tight, JIC enclosure, CEMA type 12 With hinged door, lock, 2 keys, white raised and removable internal mounting panel, diagram pocket, finished with ASA 61 grey.

Standard of Acceptance

- Hammond
- .2 Panel wiring to be contained in PVC wiring ducts complete with cover strips, minimum 50 mm x 50 mm (2" x 2"). Wireway fill to be limited to 60%. Where there are a large number of door mounted devices, door wiring harnesses shall also be contained in wiring ducts at rear door. All door wiring devices to emanate from the control panel terminal strips. Wiring to panel face mounted devices to be bundled neatly on hinge side of panel, enclosed in flexible spiral wrap, and installed such that wiring will not be damaged when opening and closing door. Ground panel door to panel with a flexible copper bonding strap. Label all wiring with permanent PVC sleeve type markers.
 - .3 Phoenix contact terminal blocks with mounting rails, end covers, terminal markers, partition plates and accessories: UK 2.5 termination of wiring 22 to 12 AWG; UK 5 and UK 10 series for current transformers and other leads #10 AWG and #8 AWG; UDK or UK 5 twin for connecting two or more conductors to one terminal block; DIK 1.5 for three wire sensor device wiring; MTKD for thermocouple leads.
 - .4 Provide lamacoid nameplates for all panel mounted control and indicating devices, and all internal components such as terminal strips, control transformers, control devices, relays, etc. as per 26 05 01.

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 (6'-6") 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}{100'} of conduit run between pull boxes.

3.3 Identification

- .1 Provide equipment identification in accordance with Section 26 05 01 - Electrical - General Requirements.
- .2 Install size 2 identification labels indicating system name, voltage, phase and source of power.
- .3 Provide a typed directory in cabinets showing following information: Nature, actual quantities and room number of device or devices connected to each terminal, as well as signal circuit number where applicable.

END OF SECTION

CONDUITS, FASTENINGS AND FITTINGS

26 05 33

1 GENERAL

1.1 Scope

- .1 Provide conduits, fastenings and fittings for electrical conductors.

1.2 Submittals

- .1 Submit shop drawings and product data for products specified herein.

1.3 Applicable Codes and Standards

- .1 Product standards:
 - .1 CSA C22.2 No. 18.1 Metallic Outlet Boxes
 - .2 CSA C22.2 No. 45.1 Electrical Rigid Metal Conduit - Steel
 - .3 CSA C22.2 No. 83 Electrical Metallic Tubing
 - .4 CSA C22.2 No. 56 Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit
 - .5 CSA C22.2 No 211.2 Rigid PVC (unplasticized) Conduit

2 PRODUCTS

2.1 Conduits

- .1 Rigid hot dipped galvanized steel threaded conduit to CSA C22.2 No. 45.1.
 - .1
 - .2 PVC coated hot dipped galvanized rigid steel conduit: with 40 mil PVC exterior coating, 2 mil urethane interior and thread coating equal to Rob Roy Plastibond RedHot
- .2 Electrical metallic tubing (EMT), [hot dipped] galvanized: with couplings to CSA C22.2 No. 83
- .3 Rigid PVC conduit to CSA C22.2 No 211.2.
- .4 Flexible metal conduit and liquid-tight flexible metal conduit to CSA C22.2 No. 56.
- .5 Size conduits sufficiently to allow easy removal of conductors at any time. Conduit sizes, where shown, are minimum and shall not be reduced.

2.2 Conduit Fastenings

- .1 One hole steel straps to secure surface conduits 50 mm (2 in.) and smaller. Two hole steel straps for conduits larger than 50 mm (2 in.).
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits.
- .4 Six mm dia threaded rods to support suspended channels.

2.3 Conduit Fittings

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- .2 Factory "ells" where 90 degree bends are required for 25 mm (1 in.) and larger conduits
- .3 raintight insulated throat steel compression connectors and couplings for EMT.

- .4 Threaded or compression type raintight/concrete tight insulated throat zinc plated steel connectors and couplings for rigid steel conduit.
- .5 Raintight insulated throat steel connectors at all surface panelboards, switchboards and other electrical equipment in sprinklered areas for all conduit terminations.

2.4 Expansion Fittings

- .1 Electrogalvanized steel with internal grounding for EMT suitable for 100mm (4 in.) linear conduit movement.

Standard of Acceptance

- Cooper Crouse Hinds XJG-EMT
- .2 Weatherproof expansion fittings with internal bonding assembly suitable for 100mm (4 in.) linear expansion.
- .3 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm (3/4 in.) deflection in all directions.
- .4 Concrete type, water tight, corrosion resistant for conduit installations embedded in concrete
- .5 Weatherproof expansion fittings for linear expansion at entry to panel.

2.5 Fish Cord

- .1 Polypropylene.

3 EXECUTION

3.1 Location of Conduit

- .1 Drawings do not indicate all conduit runs. Those indicated are in diagrammatic form only.

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: in cast concrete, underground or where installed exposed within 2.0m (6'-6") of floor.
- .4 Use rigid galvanized steel conduit where installed surface mounted within 2.0m (6'-6") of floor.
- .5 Use rigid PVC conduit in slab on grade cast concrete and underground. Do not use PVC conduits in slabs above grade. All conduits shall be surface mounted to minimize risks of future damage when core drilling during future renovations. Where localized congestion or circumstances forces the use of conduits in the floor slabs, they shall be epoxy coated rigid galvanized steel.
- .6 Provide PVC conduit with bonding conductor as per Table 16A of Ontario Electrical Safety Code.
- .7 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment
- .8 Use explosion proof flexible connection for connection to explosion proof motors.
- .9 Install conduit sealing fittings in hazardous areas. Fill with compound.
- .10 Use raintight connectors or hubs for terminating conduits at all surface or floor mounted panelboards, switchboards, and other equipment located in sprinklered areas or where at risk of exposure to dripping liquids.

- .11 Install wiring in conduit unless otherwise specified.
- .12 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .13 Mechanically bend steel conduit over 19mm (3/4") dia.
- .14 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .15 Install fish cord in empty conduits.
- .16
- .17 Where conduits become blocked, remove and replace blocked section. Do not use liquids to clean out conduits.
- .18 Dry conduits out before installing wire.
- .19 Conduit manufacturer's touch up enamel shall be used to repair all scratches and gouges on epoxy-coated conduit.
- .20 Install junction boxes or cable anchor boxes wherever necessary for proper pulling or anchoring of cables. Install so as to be accessible after building is completed and set to come within finished lines of building.
- .21 Where EMT or rigid PVC is used, run green insulated bonding conductor in conduit, with minimum one bonding conductor per three ungrounded conductors.
- .22 Provide expansion couplings, with bonding jumper and ground clamps where raceways cross building control joints.
- .23 Where circuits are required in the vicinity of a steel roof deck:
 - .1 support the conduits, EMT or cables at least 38mm (1½") below the underside of the deck,
 - .2 do not run conduits, EMT or cables on the top side of the roof deck,
 - .3 do not cut openings in the roof deck unless specifically indicated,
 - .4 where circuits must be located within 38mm (1½") of the underside of a roof deck, use galvanized rigid steel conduit and cast fittings,
 - .5 where there is no option to running conduits on the top side of a roof deck, use epoxy or PVC coated galvanized rigid steel conduit with epoxy or PVC coated cast fittings.
- .24 Where conduits or cables are installed under raised floors and are required to be fastened in place, use two hole inverted "U" straps. No sharp edges or corners will be permitted which may damage PVC jackets or cables.
- .25 Runs of conduit and cables, where shown, are indicated only by general location and routing. Install conduits and cables so as to provide maximum head room and to interfere as little as possible with free use of spaces through which they pass. They shall be installed as close to building structure as possible such that, where concealed, necessary furring can be kept to a minimum. Arrange conduits, installed in suspended ceilings, to provide minimum interference with removal of tiles.

3.3 Wiring Methods

- .1 Install wiring in surface mounted EMT conduit unless otherwise specified. In finished areas, conceal conduit in walls and ceiling spaces.
- .2 In areas designated as Explosion Proof on Drawings, conduit and wiring shall be Class I, Group D, Division I.
- .3 Where shown on drawings, armoured cable shall be Teck 90 type. Jackets of cable shall have FT-4 rating identified. Connectors shall be equal to ABB Installation Products Ltd. (T & B) - Star Teck Type.

- .4 Rigid PVC conduit with ground wire as per Electrical Safety Code Table 16 shall be used throughout below grade areas and may be used in or under slab on grade areas. It shall not be used in above grade slabs.
- .5 [Epoxy enamel] [or] [PVC] coated rigid galvanized steel conduit shall be used throughout basement; in damp locations including but not limited to intake and exhaust shafts and air handling units; for rigid metallic conduit underground or in floor slabs; for wiring outdoors and in unheated buildings; and where noted on Drawings.
- .6 Runs of conduit and cables, where shown, are indicated only by general location and routing. Install conduits and cables so as to provide maximum head room and to interfere as little as possible with free use of spaces through which they pass.
- .7 Use EMT conduit for branch circuit and signal wiring in ceilings, furred spaces, and in hollow walls and partitions.
- .8 Use rigid galvanized steel conduit for wiring where conduits are exposed to possible mechanical damage.
- .9 Use epoxy coated rigid galvanized steel conduit for wiring in poured concrete.
- .10 Aluminum conduits shall not be used
- .11 Flexible conduit and armoured cable will be accepted in parts of existing building, where furred spaces above ceilings are too congested to permit conduit to be installed, but only Consultants written permission. Terminate armoured cable, where shown, in accordance with the manufacturer's recommendations.
- .12 Conduit shall be of sufficient size to permit easy removal of conductors at any time. Conduit sizes, where shown, are minimum and shall not be reduced.
- .13 Arrange conduits, installed in suspended ceilings, to provide minimum interference with removal of tiles.
- .14 Where existing locations of flush mounted electrical devices (switches, receptacles, etc.) correspond to new devices shown, the existing dropdown conduit and outlet box may be re-used. Provide new devices, new coverplates, new home-run conduit and complete new wire.
- .15 Vertical raceways to be provided with insulated cable support bushings or other approved method of supporting the weight of the cable, where vertical runs exceed those of Table 21 of the Electrical Code.

3.4 Surface Conduits

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5m (5') 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 (3") parallel to steam or hot water lines with minimum of 25 mm (1") at crossovers.

3.5 Concealed Conduit

- .1 Do not install horizontal runs in masonry walls.
- .2 Do not install conduits in terrazzo or concrete toppings.

3.6 Conduits in Cast-in-place Concrete

- .1 Locate to suit reinforcing steel. Install in centre one third of slab.

- .2 Protect conduits from damage where they stub out of concrete.
- .3 Install sleeves where conduits pass through slab or wall.
- .4 Where conduits pass through waterproof membrane provide oversized sleeve before membrane is installed. Use cold mastic between sleeve and conduit.
- .5 Do not place conduits in slabs in which slab thickness is less than 4 times conduit diameter.
- .6 Encase conduits completely in concrete with minimum 25 mm (1") concrete cover.
- .7 Organize conduits in slab to minimize cross-overs.

3.7 Conduits in Cast-in-place Slabs on Grade

- .1 Run conduits 25 mm (1") and larger below slab and encased in 75 mm (3") concrete envelope. Provide 50 mm (2") of sand over concrete envelope below floor slab.

3.8 Conduits Underground

- .1 Slope conduits to provide drainage.

END OF SECTION

OUTLET BOXES, CONDUIT BOXES AND FITTINGS

26 05 35

1 GENERAL

1.1 Scope

- .1 Provide outlet boxes, conduit boxes and fittings for electrical services.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 26 27 28 Wire and Box Connectors 0-1000V

1.3 Applicable Codes and Standards

- .1 Product standards:
 - .1 CSA C22.2 No. 18. Outlet Boxes, Conduit Boxes, and Fittings

2 PRODUCTS

2.1 General

- .1 Outlet boxes, conduit boxes, and fittings listed to CSA C22.2 No. 18.

2.2 Outlet and Conduit Boxes - General

- .1 Size boxes in accordance with CSA C22.1
- .2 102 mm (4") 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 Combination boxes with barriers where outlets for more than one system are grouped.

2.3 Sheet Steel Outlet Boxes

- .1 Hot dipped galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 mm x 50 mm x 38 mm (3" x 2" x 1½") or as indicated. 102 mm (4") square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .2 102 mm (4") square or octagonal outlet boxes for lighting fixture outlets.
- .3 102 mm (4") square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster or tile walls.

2.4 Masonry Boxes

- .1 Hot dipped galvanized steel masonry single and multi-gang boxes for devices flush mounted in exposed block walls.

2.5 Concrete Boxes

- .1 Hot dipped galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.6 Floor Boxes

- .1 Concrete tight hot dipped galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with brass or brushed aluminum faceplate. Device mounting plate to accommodate short or long ear duplex single or receptacles. Minimum depth: 28 mm (1¼") for receptacles; 73 mm (3") for communication equipment.
- .2 Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 12 mm (½") and 19 mm (¾") conduit. Minimum size: 73 mm (3") deep.

2.7 Conduit Boxes

- .1 Cast FS boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle, outside building and where weatherproof boxes are required.
- .2 Explosion proof boxes in areas indicated on drawings.

2.8 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 (1½") and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

2.9 Acoustical Putty Pads

- .1 Moldable putty sheets:
 - .1 3mm (1/8") thick,
 - .2 Sound Transmission Class (STC) rating of not less than 23 for one layer,
 - .3 self adhesive,
 - .4 non-combustible,
 - .5 non-hardening,
 - .6 non-shrinking,
 - .7 non-corrosive to:
 - (a) boxes,
 - (b) EMT,
 - (c) conduit,
 - (d) PVC,
 - .8 asbestos free.

Standard of Acceptance

- 3M - Fire Stop Moldable Putty Pads
- Hilti – Firestop Putty Pads
- Kinetics - IsoBacker

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 (1/4") of opening.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.
- .5 Provide a suitable outlet box for each light, switch, receptacle or other outlet, approved for the particular area in which it is to be installed.
- .6 Locate outlet boxes, mounted in hung ceiling space, so they do not obstruct or interfere with the removal of lay-in ceiling tiles.
- .7 Offset outlet boxes, shown back to back in partitions, horizontally to minimize noise transmission between adjacent rooms.
- .8 Box connectors to conform to Specification section 26 27 28.
- .9 For outlet boxes installed in walls with a Sound Transmission Class (STC) rating:
 - .1 apply acoustical putty pads to the outlet box,
 - .2 cover all openings and EMT, conduit and cable entrances/exits,
 - .3 install putty pads on the outside of boxes,
 - .4 provide additional layers and/or provide other sound control measures, as necessary to maintain the STC rating of the wall assembly,
 - .5 install pads and other sound control measures, if applicable, in accordance with the manufacturers recommendations.
- .10 Use gang boxes at locations where more than one device is to be mounted. Use combination boxes with suitable barriers where outlets for more than one system are shown.
- .11 Where 100 mm (4") square boxes are installed in exposed concrete or cinder block in finished areas, blocks will be cut under masonry division as instructed under this section. Openings shall be cut to provide a close fit to boxes and covers so that edges of openings are not visible after installation of plates. Mortar shall not be used to patch up openings that are cut too large or to patch ragged edges.
- .12 Where boxes are required for wiring and equipment on the underside of a steel roof deck:
 - .1 support the boxes at least 38mm (1 1/2") below the underside of the deck,
 - .2 do not cut openings in the roof deck unless specifically indicated,
 - .3 where boxes must be located within 38mm (1 1/2") of the underside of a roof deck, use cast conduit boxes.

END OF SECTION

INSTALLATION OF CABLES IN TRENCHES AND DUCTS

26 05 38

1 GENERAL

1.1 Scope

- .1 Installation of cables in trenches and ducts as shown.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 Division 31.

2 PRODUCTS

2.1 Cable Protection

- .1 38mm x 140mm (1e" x 5½") planks, pressure treated with water repellant preservative.
- .2 50mm (2") thick poured concrete.
- .3 50mm (2") thick concrete slabs.

3 EXECUTION

3.1 Trench Excavation and Backfill

- .1 Construct trenches for direct buried cables and for duct in accordance with Specification section 26 05 07.

3.2 Direct Burial of Cables

- .1 After sand bed is in place, lay cables into trench, do not pull cables into trench.
- .2 Maintain separation between cables as shown and as required to achieve required ampacity.
- .3 Maintain at least 75mm (3") clearance from each side of trench to nearest cable.
- .4 Maintain separation between cables of not less than:
 - .1 75mm (3") between cables of different circuits,
 - .2 300mm (12") horizontal separation between low and high voltage cables,
 - .3 300mm (12") vertical separation where low voltage cables cross high voltage cables, with low voltage cables in upper position,
 - .4 75mm (3") vertical separation between low voltage cables at crossover,
 - .5 150 mm (6") vertical separation between high voltage cables at crossover,
 - .6 300 mm (12") horizontal and vertical separation for fire alarm and control cables when crossing other cables, with fire alarm and control cables in upper position.
- .5 At crossovers, install concrete slabs over lower cables and extend 0.6 m (2') in each direction.
- .6 Provide offsets for thermal action and minor earth movements. Offset cables 150mm (6") for each 60m (200') run. Maintain cable separation and bending radius thru offsets.
- .7 Maintain radius of cable bends as per the manufacturer's instructions but not less than:
 - .1 8 times diameter of cable for:

- (a) rubber jacketed cables,
 - (b) plastic jacketed cables,
- .2 12 times diameter of cables for:
 - (a) armoured cables,
 - (b) lead covered cables,
 - (c) tape shielded cables,
 - (d) aluminum sheathed cables (corrugated).
- .8 Make terminations and splices as indicated, leaving 0.6 m (2') of surplus cable in each direction.
- .9 Make splices and terminations in accordance with manufacturer's instructions using approved splicing and termination kits.
- .10 Underground cable splices not acceptable.
- .11 After sand protective cover is in place, install poured concrete to cover length of run.

3.3 Cable Installation in Ducts

- .1 Install cables in accordance with the manufacturer's instructions.
- .2 Examine duct routing and ensure that duct size, radius of bends and maintenance hole sizing is compatible with cable manufacturer's recommendations.
- .3 Calculate pulling tensions and sidewall pressures and confirm that they do not exceed the manufacturer's recommendations.
- .4 Install cables as indicated in ducts.
- .5 Use CSA approved lubricants of type compatible with cable jacket to minimize pulling tension.
- .6 Monitor cable pulling tension and stop the pull if the tension exceeds the allowable limit.
- .7 Do not pull spliced cables inside ducts.
- .8 Install multiple cables in duct simultaneously.
- .9 To facilitate matching of colour coded multiconductor control cables, reel off in same direction during installation.
- .10 After installation of cables, seal duct ends with duct sealing compound.

3.4 Field Quality Control

- .1 Perform tests in accordance with Section 26 05 01 - Electrical General Requirements.
- .2 Perform tests using qualified personnel.
- .3 Provide instruments and equipment as required to conduct testing.
- .4 Check phase rotation and identify each phase conductor of each feeder.
- .5 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.
- .6 Pre-acceptance tests.
 - .1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.
 - .2 Check insulation resistance after each splice or termination to ensure that cable system is ready for acceptance testing.
- .7 Acceptance Tests

- .1 Disconnect terminations and accessory equipment.
- .2 Ground shields, ground wires, metallic armour and conductors not under test.
- .3 Leakage Current Testing;
 - (a) Raise voltage in steps from zero to maximum values as specified by ICEA for type of cable being tested,
 - (b) Hold maximum voltage for time period as specified by ICEA,
 - (c) Record leakage current at each step.
- .8 Provide Consultant with list of test results showing location at which each test was made, circuit tested and results of each test.
- .9 Remove and replace entire length of cable if cable fails to meet any of the test criteria.

END OF SECTION

VIBRATION ISOLATION FOR ELECTRICAL SYSTEMS

26 05 48

1 GENERAL

1.1 Scope

- .1 Provide vibration and noise isolation for the following electrical equipment:
 - .1 engine driven equipment,
 - .2 motor driven equipment,
 - .3 transformers,
 - .4 and as shown..

1.2 Design Criteria

- .1 Provide design, selection and provision of materials, installation instructions, installation and inspection of vibration isolation equipment and systems.
- .2 Select vibration isolation equipment to maintain noise levels below the NC levels in the following schedule.

AREA	NOISE CRITERIA (NC level)
Offices - private	32 to 34
-open plan	36 to 38
-business machine areas	40 to 42
-conference/boardrooms	30 to 32
Operating Rooms	25 to 27
Private Bedrooms	26 to 28
Hospital Wards	30 to 32
Public Areas	38 to 40

- .3 The requirements under this Section are in addition to the requirements for supports and vibration isolation specified in other Sections.

1.3 Manufacturer Responsibilities

- .1 Manufacturer of vibration isolation components to:
 - .1 determine vibration isolation sizes and locations,
 - .2 supply suitable vibration isolation as required,
 - .3 supply installation instructions and drawings,
 - .4 provide trained field supervision personnel on site to insure proper installation,
 - .5 conduct site inspections of the Work in progress,
 - .6 conduct a final inspection of the Work,
 - .7 prepare a final inspection report of the installation.

1.4 Submittals

- .1 Submit shop drawings:
 - .1 details of suspension and support for ceiling and wall hung equipment,
 - .2 details of vibration isolation for each piece of equipment hung from the structure or supported from the floor,
 - .3 product data sheets for isolation components,
 - .4 load deflection curves,
 - .5 calculations of the expected deflection and the natural frequency.

2 PRODUCTS

2.1 Resilient Isolator Type 1 (R1)

- .1 Rubber waffle or ribbed pads:
 - .1 of 30 durometer natural rubber, not less than 13 mm ($\frac{1}{2}$ ") thick,
 - .2 suitable for loading up to 350 kPa. (50 psi).
- .2 Rubber-steel-rubber pads:
 - .1 two layers of rubber waffle or ribbed pad, 13 mm ($\frac{1}{2}$ ") thick, as specified above,
 - .2 bonded to 6 mm ($\frac{1}{4}$ ") steel plate with holes sleeved and fitted with isolation washers.
- .3 Neoprene jacketed precompressed moulded fibreglass.

2.2 Resilient Isolator Type 2 (R2)

- .1 Elastomer rubber with:
 - .1 threaded insert,
 - .2 hold down bolts.
- .2 Neoprene, 50 mm (2") free height:
 - .1 natural frequency not to exceed 15 Hz at full load,
 - .2 capable of sustaining a load of 110 kg (250 lb),
 - .3 with deflection not exceeding 5 mm (0.19").

2.3 Elastomeric Mounts

- .1 Neoprene in shear:
 - .1 colour coded,
 - .2 durometer not greater than 60,
 - .3 threaded insert,
 - .4 two bolt down holes,
 - .5 ribbed top and bottom surfaces.

2.4 Spring Mounts – General Requirements

- .1 Isolator springs:
 - .1 designed so that ratio of lateral to axial stiffness is equal to or greater than 1.2 times ratio of static deflection to working height,

- .2 selected for 50% travel beyond rated load,
- .3 cadmium plated,
- .4 colour coded.
- .2 Mounts:
 - .1 zinc or cadmium plated hardware,
 - .2 rubber isolation washers,
 - .3 housings coated with rust resistant paint,
 - .4 levelling devices,
 - .5 6 mm (1/4") thick ribbed rubber sound pad bonded to load plate.
- .3 Clearance between metal parts to be not less than 6 mm (1/4").

2.5 Spring Isolator Type 1 (S1)

- .1 Open spring isolators:
 - .1 extra stiff springs with ratio of lateral to axial stiffness of 1.0.

2.6 Spring Isolator Type 2 (S2)

- .1 Controlled spring isolators:
 - .1 heavy rigid steel base frames,
 - .2 built-in vertical limit stops,
 - .3 removable spacers,
 - .4 extra stiff springs with ratio of lateral to axial stiffness of 1.0.

2.7 Isolation Hangers – General Requirements

- .1 Isolation hangers to have swivel arrangement to permit hanger box or rod to move through 20° arc without metal to metal contact.

2.8 Hanger Type 1 (H1)

- .1 Spring hanger:
 - .1 welded steel housing with one coat anti-rust paint,
 - .2 colour coded spring,
 - .3 retaining cups,
 - .4 elastomeric washers.

2.9 Hanger Type 2 (H2)

- .1 Rubber hanger:
 - .1 welded steel housing with one coat anti-rust paint,
 - .2 25 mm (1") colour coded neoprene in shear with durometer of not more than 60,
 - .3 threaded insert.

2.10 Hanger Type 3 (H3)

- .1 Horizontal thrust restraint:
 - .1 spring and elastomeric element,

- .2 housed in box frame with rods and angle brackets to connect unit between isolated equipment and fixed object,
- .3 fitted with means to adjust start-stop movement to not more than 9 mm (3/8").

2.11 Acoustic Barriers for Anchors and Guides

- .1 Manufactured from 25 mm (1") thick neoprene isolation with duck reinforcing material.

Standard of Acceptance

- Vibron / Kinetics
- BVA
- VMC / Korfund
- Mason
- Tecoustics
- Eaton B-Line

3 EXECUTION

3.1 General

- .1 Install vibration isolation equipment and systems in accordance with the component manufacturer's recommendations. Where a conflict occurs between the requirements of this Section and the manufacturer's recommendations, apply the most stringent requirements.
- .2 Install vibration isolation equipment in accordance with manufacturer's instructions.
- .3 Locate isolation for equipment to provide stable support under saddles, frames and projections of equipment.

3.2 Application

- .1 Provide additional steel in bases and rails to obtain rigidity and uniform load distribution.
- .2 Make flexible connections to isolated equipment so as to maintain isolation system flexibility and to allow full range of movement of the isolated equipment.

3.3 Start-up and Set-up

- .1 After installation of connections to resiliently mounted equipment:
 - .1 remove shims and blocking and adjust mountings to level equipment,
 - .2 adjust connections, hangers, snubbers and restraints,
 - .3 ensure that physical contact between isolated equipment and building structure cannot occur at limits of movement.
- .2 On completion of installation and start-up of equipment:
 - .1 manufacturer/supplier of Vibration Isolation equipment to visit site, check performance of systems, inspect installation and submit written recommendations,
 - .2 make corrections to installation in accordance with manufacturer/suppliers recommendations,
 - .3 provide notice 24 hours in advance of this site visit.

- .3 Provide a final inspection report signed by the manufacturer/supplier's representative, certifying that the vibration isolation equipment is suitable for the application and has been installed in accordance with the manufacturer's recommendations.

3.4 Testing

- .1 Engage and pay for an experienced sound and vibration professional to take measurements of sound and vibration generated by electrical systems.
- .2 Co-operate with manufacturer/supplier of Sound Attenuation equipment in this measurement and testing.
- .3 Sound measurements to extend over full audio frequency range and to be taken in areas adjacent to:
 - .1 main electrical rooms,
 - .2 electrical rooms containing one or more dry type transformers,
 - .3 engine generator (EG: diesel generator) rooms,
 - .4 UPS equipment rooms.
- .4 Submit outline of tests to be performed, details of instrumentation to be used and floor plans showing test locations prior to commencing work.
- .5 Provide notice one week in advance of commencement of tests.
- .6 Submit complete report of tests addressing noise and vibration levels measured in occupied areas and adequacy of Sound Attenuation and Vibration Isolation equipment.

END OF SECTION

SEISMIC RESTRAINT FOR ELECTRICAL SERVICES 26 05 49.20

1 GENERAL

1.1 Scope

- .1 Provide seismic restraint devices to limit movement of electrical equipment, conduit, bus duct, busway, cable, cable tray and wireway under seismic force and movement conditions.
- .2 Provide engineering services for the design, selection of materials, installation instructions, and inspection of seismic restraint devices.
- .3 The requirements under this Section are in addition to the requirements for support of electrical equipment, conduit, bus duct, busway, cable, cable tray and wireway, and vibration isolation specified in other Sections.
- .4 Where specifications of materials of this Section differ from those in other Sections of Division 26, this Section governs.

1.2 Definitions

- .1 The following definitions apply for the purpose of this section.

Conduit – means an electrical raceway that includes rigid galvanized steel conduit, electro-metallic tubing (EMT), PVC conduit, aluminium conduit.

Transverse restraint – means restraint(s) applied to limit motion perpendicular to the centerline of the conduit, bus duct, busway, cable, cable tray or wireway.

Longitudinal restraint – means restraint(s) applied to limit motion parallel to the centerline of the conduit, bus duct, busway, cable, cable tray or wireway.

Restraint: means a device which limits movement of object due to imposed seismic forces acting on the object.

Brace: a restraint directly connected to an object that reacts against both tension and compression seismic loads.

Cable restraint: a restraint consisting of cables that reacts against only tension seismic forces, and that may have a small amount of slack to prevent vibration isolation short-circuiting during normal operation.

Snubber (restraint): a restraint that does not come into contact with the object under normal operating conditions.

Seismically qualify (seismically qualified): means equipment which has been evaluated by testing to withstand defined forces in amplitude and frequency which simulate seismically-induced movement, after which the equipment continues to function for its intended purpose.

- .2 The following abbreviations apply to this section:

"C_p" the horizontal seismic force coefficient as defined in NFPA 13.

"K_s" horizontal seismic force coefficient (equal to 0.3 S (0.2) I_E S_p, as defined in the 2020 National Building Code of Canada and represents a multiple of gravitational acceleration.

"K_v" vertical seismic force coefficient and represents a multiple of gravitational acceleration.

" W_p " the weight of the component subject to a seismic force.

.3 Interpretation:

- .1 In this specification, the parameter " S_s " (spectral response acceleration at 5 Hz) in NFPA 13, ASHRAE, SMACNA and MSS SP-127 used for estimating the horizontal seismic force, has the same meaning as the parameter " $S_a(0.2)$ " for the spectral response acceleration value at 0.2 seconds as defined in the National Building Code of Canada.

1.3 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
1. 26 05 49.23 Seismic Qualifications for Electrical Equipment

1.4 Applicable Codes and Standards

.1 Legislation

- .1 2020 National Building Code of Canada, as adopted in the jurisdiction of the Project.

.2 Installation standards and codes:

- .1 ASHRAE D-90316 Practical Guide to Seismic Restraint
- .2 ANSI/SMACNA Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd edition.

.3 Product standards:

- .1 ACI 355.2 Qualification of Post-Installed Mechanical Anchors in Concrete
- .2 ASTM A492 Standard Specification for Stainless Steel Rope Wire
- .3 ASTM A1023 Standard Specification for Stranded Carbon Steel Wire Ropes for General Purpose
- .4 ICC-ES AC01 Expansion Anchors in Masonry Elements
- .5 ICC-ES AC106 Predrilled Fasteners (Screws) in Masonry
- .6 ICC-ES AC156 Acceptance Criteria for Seismic Certification by Shake-Table Testing of Non-structural Components
- .7 ICC-ES AC193 Mechanical Anchors in Concrete Elements
- .8 ICC-ES AC308 Post-Installed Adhesive Anchors in Concrete Elements

.4 Other documents:

- .1 ASCE 7 American Society of Civil Engineers, Minimum Design Loads and Associated Criteria for Buildings and Other Structures

1.5 Seismic Analysis, Design and Inspection Services

- .1 Provide the services of a professional engineer, licensed in the province or territory of the Work and who specializes in seismic restraint of building services and equipment (the "Seismic Engineer"), for the design of seismic restraints and to provide inspection services of the completed installation.
- .2 Seismic Engineer design services;
- .1 Provide the design of seismic restraint systems, including seismic restraint calculations for all connections of equipment to the structure.

- .2 Provide design drawings showing locations of restraints and details of construction and attachment of restraints. Mark-ups of Consultant drawing or Contractor installation drawings may be used for this purpose.
- .3 Analysis dead loads, seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis to detail anchoring methods, bolt diameter, embedment and/or welded length. Design seismic restraint devices to accept, without failure, the seismic forces acting on the equipment or components and their support and restraint attachments to the building structure.
- .3 Seismic Engineer inspection services;
 - .1 At periods during installation and at completion of the installation of the seismic restraint devices, the Seismic Engineer shall inspect the installation, identify and report deficiencies (if any) which are observed, and re-inspect the installation after deficiencies have been corrected.
 - .2 Seismic Engineer to submit periodic inspection reports and a final inspection report after all work is completed and deficiencies have been corrected, confirming the installation conforms to the seismic design requirements. Prepare and submit any required declarations or similar document to this effect where required by local legislation.
- .4 Shop drawings of custom restraints, supporting calculations, and reports shall be sealed by the Seismic Engineer.
- .5 Prepare and submit reports of inspections of the installation and a final general review report of the completed seismic installation.

1.6 Manufacturer's Services – Seismic Restraints

- .1 Manufacturer of seismic control equipment are responsible for:
 - .1 determining seismic restraint sizes and locations,
 - .2 provide calculations and supply materials for restraint of vibration isolated and non-isolated equipment,
 - .3 provide installation instructions, drawings and trained field supervision to ensure proper installation and performance including welding details,
 - .4 field inspection of manufactured support systems including roof curbs and other rooftop equipment supports at time of installation.

1.7 Design Criteria

- .1 Design seismic restraint systems to conform to the provincial or territorial building code requirements for seismic forces and movement as applicable for the place of the Work. Seismic calculation and restraint methods as described in ASHRAE D-90316, and SMACNA seismic guideline are acceptable as the baseline requirement.
- .2 Base the design of seismic restraints on actual equipment data (dimensions, weight, center of gravity, etc.,) obtained from submittals or the manufacturers of the equipment.
- .3 Testing and calculations of seismic restraints shall include both shear and tensile loads as well as one test or analysis at 45° to the weakest mode.
- .4 Site design parameters:

Item	Description	Abbrev.	Value
1	Site Class	--	C
2	Building Category	---	Post-Disaster
3	Building Importance Factor	I _E	1.5

Item	Description	Abbrev.	Value
4	Design Spectral Response acceleration factor	S(0.2)	0.309
5	Interstorey displacement factor	---	0.01

.5 Building seismic force coefficient data;

- .1 seismic horizontal force coefficients " K_s " and seismic vertical uplift force coefficient " K_v " for building service are listed in Schedule A attached to the end of this Section. These coefficients are the maximum values independent of the type of equipment or service being restrained. It is permitted to calculate a lower K_s coefficient where the C_p , A_r and R_p values, as defined in the building code specific to the actual equipment or service being restrained, are used.

.6 Seismic force;

- .1 the horizontal seismic force " V_p " applied to a component is:

$$V_p = K_s \times W_p,$$

- .2 the vertical seismic force " V_{pv} " applied to a component is:

$$V_{pv} = K_v \times W_p$$

- .7 For suspended equipment, the building elevation height is measured to the level of the floor above the suspended equipment.

- .8 For vibration isolated equipment, where the clearance distance (air gap) between the equipment support frame and the restraint (e.g. snubber or integral limit stop) exceeds 6 mm (1/4 in.), the seismic horizontal force V_p is to be increased by 100%.

- .9 Where adhesive anchors for concrete are used, the seismic force for the restrained equipment is to be increased by multiplying the horizontal seismic force coefficient specified in Schedule A of this Specification section by the " R_p " equipment category as defined in article 4.1.8.18 of the National Building Code of Canada specific to the equipment being restrained.

$$K_{s,adhesives} = K_s \times R_{p,applicable\ equipment}$$

- .10 Where concrete inserts are used, the seismic force for the restrained equipment is to be increased by multiplying the horizontal seismic force coefficient specified in Schedule A of this Specification section by the " R_p " equipment category as defined in article 4.1.8.18 of the National Building Code of Canada specific to the equipment being restrained and divided by the value of 1.5.

$$K_{s,inserts} = K_s \times \frac{R_{p,applicable\ equipment}}{1.5}$$

1.8 Seismic Qualification of Equipment

- .1 Refer to 26 05 49.23 Seismic Qualifications for Electrical Equipment

1.9 Submittals

- .1 Submit shop drawings in accordance with Division 1 and as follows.
- .2 Submittals for design of seismic restraint systems shall be sealed by a Professional Engineer licensed in the province or territory of the jurisdiction of the Project.
- .3 Seismic restraints:

- .1 Provide test certificates for each seismic restraint device, identifying maximum tested load capacities.
- .2 Provide calculations for each piece of restrained equipment, lengths of braced conduit bus duct, busway, cable, cable tray and wireway including seismic forces, restraint selection, and selection data.
- .3 Provide seismic data in spreadsheet format for each piece of equipment, including the following information:
 - (a) Equipment ID,
 - (b) Building floor level,
 - (c) Horizontal seismic force factor,
 - (d) Equipment weight,
 - (e) Horizontal seismic force,-
 - (f) Vertical uplift seismic force (where applicable),
 - (g) Design condition (worst case) overturning moment,
 - (h) Number of restraint fastenings,
 - (i) Pull-out tension for worst case restraint,
 - (j) Compression for worst case restraint (vibration isolated equipment),
 - (k) Horizontal shear per fastener,
 - (l) Worst case simultaneous tension and shear loads at each restraint and snubber,
 - (m) Pull-out tension load rating per fastener,
 - (n) Horizontal shear rating per fastener.
- .4 Provide drawings for each type of restraint assembly, including details for connections to building structure, and associated bill of materials, and (where applicable) full welding details of field welds to structural elements.
- .5 For building connections in concrete, provide concrete anchor sizes and nominal and effective embedment depth.
- .6 Provide floorplan layout drawings indicating location of each restraint, identifying each restraint type in a manner to identify the restraint detail.
- .7 Provide layout and construction details for reinforced housekeeping pads based on actual equipment to be restrained and selected concrete anchors. Shop drawings to include:
 - (a) minimum housekeeping pad plan dimensions and height, including reinforcement,
 - (b) details for securing the housekeeping pad to the structural floor slab,
 - (c) dimensioned position of restraint devices or combination isolator/restraint devices,
 - (d) minimum distance from concrete anchors to edge of housekeeping pad.
- .4 Shop drawings for seismically qualified equipment:
 - .1 Provide seismic test data sheets for seismically qualified equipment. Alternatively, provide seismic qualification listing from HCAI Special Seismic Certification Preapproval (OSP)".
- .5 Calculations and designs shall be sealed by a Professional Engineer licensed in the province or territory of the jurisdiction of the project.
- .6 Electrical distribution riser support system:
 - .1 Provide engineered layout drawings of electrical distribution riser supports including support/restraints, with supporting load calculation including dead loads and static seismic loads, and reaction loads at building connection.

1.10 Quality Assurance

- .1 Without limiting Contractor's responsibility for quality assurance of the Work, the following minimum quality control processes are required.
- .2 Pre-Construction meeting;
 - .1 Request and arrange a meeting with the Seismic Engineer and Consultant to review seismic restraint approach, prior to any restraint installation. Obtain approval from the Consultant before commencing work.
- .3 Initial installation and review;
 - .1 Install the first three transverse and three longitudinal braces for each conduit type, bus duct, busway and cable tray system.
 - .2 Request and arrange for a review of the installation by the Seismic Engineer and Consultant. Obtain approval of the installation before commencing the remainder of the work.
- .4 Provide the services of the manufacturer's technical representative to conduct site inspections of the Work in progress, and to conduct a final inspection of the Work. Provide a copy of the final inspection report to the Consultant for review. For clarity, these inspections are separate from those performed by the Seismic Engineer.
- .5 Provide services by the Seismic Engineer to conduct periodic reviews of the work in progress, and final review of the completed seismic restraint installation before any ceilings are installed or work is otherwise concealed.
- .6 All deficiencies identified by the Seismic Engineer, manufacturer, or Consultant are to be rectified before equipment or services are concealed.

2 PRODUCTS

2.1 General

- .1 Seismic restraint materials are to be provided by manufacturers specializing in the field of seismic restraint.

Standard of Acceptance

- Vibro-Acoustics (Swegon North America)
 - Kinetics Noise Control Inc.
 - B.V.A. Systems
 - Korfund (VMC)
 - Tecoustics
 - Hilti
 - nVent
- .2 Manufactured seismic restraints, anchors, and related materials to be tested in accordance with ICC ES AC156 for loads meeting or exceeding the applied seismic forces of the Work.
 - .3 Demonstrate conformity of seismic restraint products by:
 - .1 approved by a government agency and indicate maximum restraint ratings, or
 - .2 provided with test results verified by an independent testing laboratory which state the maximum restraint ratings.
 - .4 Seismic restraints for equipment supported by vibration isolators to be either:
 - .1 vibration isolators provided with separate seismic snubbers, or
 - .2 combination vibration isolators with integral seismic snubbers.

- .5 The following product articles describe the more common type of restraint devices. Other restraint devices are permissible provided they are qualified by 3rd party testing laboratories for seismic force restraint.

2.2 Seismic Snubbers

- .1 Type "SS1" – Single-Axis/Single Direction Snubbers:
- .1 ASHRAE Type "I", designed to restrict movement in one axis,
 - .2 carbon steel construction with epoxy or electrostatic paint finish, attached to floor or housekeeping pad with minimum of two bolts, faced with minimum 6.4 mm (1/4 in.) thick neoprene pad of compounded to bridge bearing quality,
- .2 Type "SS2 / SS3" – Multi-Axis/Multi-Direction Snubber Assemblies:
- .1 ASHRAE Type "G" and "F", designed to restrict movement in two (2) lateral ("SS2") or three (3) axis ("SS3"),
 - .2 interlocking steel construction, attached to equipment structure and equipment, maximum of 6 mm (1/4 in) seismic movement,
 - .3 minimum 6 mm (1/4 in) thick resilient neoprene pads compounded to bridge bearing specifications, to prevent metal-to-metal impact,
 - .4 minimum two bolt attachments to the floor,

2.3 Seismic Restraint Brackets

- .1 Type "SRB" – Rigid Equipment Restraint Brackets:
- .1 suitable for connection to equipment bases and tank bases,
 - .2 carbon steel "L" sections with epoxy or electrostatic paint finish, for fastening to both the floor structure/housekeeping pad and the equipment base,
 - .3 structure bolt opening equipped with neoprene bushing, compounded to bridge bearing quality,
 - .4 minimum two bolt fastening to equipment base using screws,
 - .5 suitable for equipment direct contact to floor with or without isolation pads,

2.4 Seismic Vibration Isolators

- .1 Type "2-S" – All Direction Neoprene Isolator:
- .1 ASHRAE Type "E", designed to restrict movement in all directions with no metal-to-metal contact.
 - .2 molded, oil resistant neoprene compounded to bridge bearing quality, with encapsulated cast-in-place top steel load plate, and steel base plate with anchor holes,
- .2 Type "3-S" – Restrained Spring Isolator – Constant Load:
- .1 ASHRAE Type "B", designed to restrict movement in all directions,
 - .2 colour coded seismic-controlled spring isolator, single or multiple spring coils, with minimum 6 mm (1/4 in.) neoprene pad,
 - .3 removable coil spring element without having to disturb supported equipment,
 - .4 lateral stiffness greater than 1.2 times rated vertical stiffness,
 - .5 minimum 50% overload capacity,
 - .6 non-welded spring elements: epoxy coated, with a minimum 1000-hour rating when tested in accordance with ASTM B-117,
 - .7 steel housing design to limit lateral and vertical movement of the supported equipment,
 - .8 neoprene snubber, to limit maximum equipment movement in any direction to 6 mm (1/4 in.),

- .9 location of snubbers designed to minimize prying action on floor bolts,
- .10 adaptor base suitable sized for larger anchors, when required to suit anchorage capacity.
- .3 Type "4-S" – Restrained Spring Isolator – Variable Load:
 - .1 colour coded seismic-controlled spring isolator, single or multiple spring coils, with minimum 6 mm (¼ in) neoprene pad mounted under spring(s),
 - .2 removable coil spring element without having to disturb supported equipment,
 - .3 lateral stiffness greater than 1.2 times rated vertical stiffness,
 - .4 minimum 50% overload capacity,
 - .5 non-welded spring elements: epoxy coated, with a minimum 1000-hour rating when tested in accordance with ASTM B-117,
 - .6 steel housing design to limit lateral and vertical movement of the supported equipment,
 - .7 top load plate with adjustable and leveling bolts,
 - .8 adjustable vertical restraints to allow unloading of water-bearing equipment,
 - .9 isolation washers,
 - .10 bottom load plate with anchor holes,
 - .11 hot dipped galvanized for outdoor installations,
 - .12 neoprene snubber compounded to bridge veering quality, to limit maximum equipment movement in any direction to 6 mm (¼ in),
 - .13 adaptor base suitable sized for larger anchors, when required to suit anchorage capacity.

2.5 Restraints and Braces for Distribution Services

- .1 Type "SCR" – Cable Restraints:
 - .1 manufactured system consisting of cable, building attachment, and vertical hanger rod reinforcement assembly,
 - .2 field-built assemblies are not acceptable,
 - .3 steel wire strand cables:
 - (a) galvanized steel aircraft cable to ASTM A1023, or stainless steel to ASTM A492
 - (b) sized for seismic load with a safety factor of 2,
 - (c) arranged for restraint in both longitudinal and transverse directions under tension loads only,
 - (d) connector strength rating equal to 90% of cable breaking strength rating.
 - .4 building and equipment attachment brackets:
 - (a) carbon steel assemblies, designed to permit rotation to the final installation angle, or 45° bent steel plates with holes to allow attachment of cable loops,
 - (b) protective loop thimbles at contact with connectors,
 - (c) rope connections: overlap wire "U" clips with at least two (2) bolt fasteners, or tool-less wedge insert lock connectors,
 - (d) selected to exceed the cable working design load by 50%,
 - (e) single sided "C" beam clamps are not acceptable.
 - (f) fasteners to building structure designed to withstand simultaneous shear and tension loads, including prying action due to the bracket.
- .2 Type "SSB" – Solid Braces:

- .1 factory-built or field assembled solid braces, consisting of structural-shapes, building attachment, and vertical hanger rod reinforcement assembly.
- .2 sized for seismic load with a safety factor of 2,
- .3 arranged for restraint in both longitudinal and transverse directions.
- .4 building and equipment attachment brackets:
 - (a) carbon steel assemblies, designed to permit rotation to the final installation angle, or 45° bent steel plates with holes to allow attachment of cable loops,
 - (b) selected to exceed the working design load by 50%,
 - (c) single sided "C" beam clamps are not acceptable.
 - (d) fasteners to building structure designed to withstand simultaneous shear and tension loads, including prying action due to the bracket.
- .3 Bracing of vertical hanger rods for SCR restraints and SRB braces:
 - .1 hanger rods braced to avoid potential for buckling;
 - (a) structural steel angle or formed channel brace selected to prevent support rod buckling,
 - (b) brace attached to support rod with a series of adjustable clips, without the use of hand-tools.
 - .2 hanger rods are not required where two SRB braces are provided at each seismic restraint location and are installed at 180° opposition to each other.

2.6 Mechanical Anchors

- .1 General:
 - .1 Post-installed mechanical anchors in concrete to be seismically qualified for installation in cracked concrete in accordance with ACI 355.2 by testing for seismic tension and shear loads in cracked concrete in accordance with ICC-EC AC193, and qualified by an ICC-ES seismic evaluation report.
 - .2 Anchors installed in concrete masonry units to be seismically qualified in accordance with TMS 402/602 by testing for seismic tension and shear loads in accordance with ICC-ES AC01 or AC106 and be qualified by an ICC-ES seismic evaluation report.
 - .3 Anchors to be selected for concurrent shear and tension loads with a safety factor not less than 2.0 times estimated load.
- .2 Undercut anchors for post-concrete installation:
 - .1 zinc-plated carbon steel bolt, nut, washer, and cone-shape bearing-bell, with tungsten-tipped cutting radial edges, to create bearing force by keying into concrete,
 - (a) for outdoor use, all materials are to be stainless steel.
 - .2 special undercut stop-drill bit and installation setting tool,
 - .3 marking system to indicate when the anchor is completely installed,
 - .4 designed for pre-setting of anchors and/or fastening of anchors through the equipment attachment opening,

Standard of Acceptance

- ° Hilti - fig. HDA (indoor), HDA-R (outdoor)
- .3 Expansion wedge anchors for post-concrete or masonry unit installation:
 - .1 zinc-plated carbon steel bolt, nut, washer, expanding segments and wedge mandrel, to create restraint force by friction and keying against/into adjacent concrete,
 - (a) for outdoor use, all materials are to be stainless steel.
 - .2 torque- loading to determine complete installation,

Standard of Acceptance

- Hilti - fig. KB-TZ2 (concrete and masonry)
- Hilti - fig. HSL-3 (concrete only)

.4 Screw anchors for masonry units:

- .1 Zine-plated carbon steel masonry screw with hex washer head, to create restraint force by keying into concrete masonry units.
 - (a) for outdoor use, all materials to be stainless steel.

Standard of Acceptance

- Hilti - fig. KH-EZ series.

.5 Housekeeping pad anchors:

- .1 for installation prior to pouring of the housekeeping pad and post-installation of the structural floor,
- .2 tapered ductile iron body, with openings sized for two runs of Ø10mm (#3) reinforcing bar, and body NC threaded receiver for connection to undercut or expanding wedge anchors,
- .3 two pieces of Ø10mm (#3) reinforcing bar, of sufficient length to tie into housekeeping pad reinforcement,
- .4 undercut or expanding wedge anchor for connection to the structural floor slab.

Standard of Acceptance

- Mason Industries - fig. HPA

2.7 Adhesive Anchors

.1 Adhesive anchors for post-concrete installation:

- .1 seismically qualified for installation in cracked concrete in accordance with ACI 355.2 by testing for seismic tension and shear loads in cracked concrete in accordance with ICC-EC AC308.
- .2 to have an ICC-ES seismic evaluation report and be suitable for installation in cracked and uncracked normal- and light-weight concrete.
- .3 anchors to be selected for concurrent shear and tension loads with a safety factor not less than 2.0 times estimated load.
- .4 injectable, two-component hybrid adhesive, matching threaded rod and accessories.

Standard of Acceptance

- Hilti - fig. HIT-HY 200

3 EXECUTION

3.1 General Requirements

- .1 Design and construct seismic restraints to;
 - .1 keep equipment and distribution services in place during and following seismic events,
 - .2 resist vertical loading simultaneously with transverse or longitudinal seismic loading.
- .2 Give special consideration to design for adjacent connections, insulation treatment, thermal movement, vibration isolation, and relation to building seismic joints.
- .3 Select restraint fastening systems so that full restraint will be provided assuming one failed fastener.

- .4 Install seismic restraint devices in accordance with manufacturer's instructions and Seismic Engineer's installation shop drawings.
- .5 Secure each transverse or longitudinal brace to the building structure, and not any other building service.
- .6 Restraint installation;
 - .1 install cable restraints with cables snug.
 - .2 use solid braces only in rigidly supported situations,
 - .3 brace hanger rods forming a part of a seismic restraint to accept resulting compressive loads,
 - .4 install transverse and longitudinal braces at angles between 45 and 60° measured from the horizontal unless the seismic bracing details by the Seismic Engineer states otherwise.
- .7 Trapeze supports may have the trapeze braced (transverse and longitudinally) provided each conduit (of all types) or cable is restrained to the trapeze.

3.2 Use of Pre-Engineered Bracing Details for Electrical Distribution Services

- .1 Use of pre-engineered restraint and bracing details for conduit in accordance with SMACNA is permitted. Where the installation of these services exceeds the limits of the SMACNA guideline, provide specific engineering restraint devices and systems.
 - .1 for SMACNA details, refer to the seismic hazard level ("SHL") by floor level in Schedule A of this Specification Section.
- .2 For the purpose of using SMACNA piping restraints, the following table may be used as a conversion for selected galvanized steel conduit and EMT sizes, where they are 40% filled with copper conductors. Use a similar conversion based on an equivalent weight per linear unit basis for other conduit materials and conductor fill quantity.

Galvanized steel conduit Size, I.D. (mm)	53	63	78	91	103	129	155
EMT Size, I.D. (mm)	63	78	91	103	-	-	-
Reference Pipe Size, Schedule 40, NPS (in)	2½	3	3½	4	5	6	8
Unit Weight of Reference Pipe Size Filled with Water Kg/m	11.7	15.9	19.8	24.2	34.6	46.8	74.6

- .3 Provide cable restraints or bracing for transverse and longitudinal seismic restraints at spacing and locations as specified in the above referenced standards.

3.3 Exemptions from Seismic Restraint

- .1 Except as required in paragraph .2 below, the following electrical distribution services are exempt from seismic restraint:
 - .1 exemption rules in SMACNA for piping apply to the equivalent weight per linear unit of conduit (of all types).
 - .2 conduit Ø60 mm (2.5 in. nominal) and smaller that are suspended, and wireways of similar cross-sectional area.
 - .3 suspended conduit where the length of support from the structure to the conduit does not exceed 305 mm (12 in.) and,

- (a) the connection of the hanger rod to the building structure is fitted with a swivel to prevent bending of the rod,
- (b) the free movement of the conduit will not come into contact with other building services or the building structure.
- .4 conduit and cables fastened directly to the building structure (excluding partitions) using industry standard clips and concrete anchors as specified herein.
- .2 These exemption rules do not apply to:
 - .1 fire alarm cables and conduit,
 - .2 emergency power cables and conduit,

3.4 Building Structural Connections

- .1 Select building connection devices based on seismic loads for actual provided equipment.
- .2 For connection to concrete structures:
 - .1 Select building structure anchors as follows:
 - (a) post-installed undercut anchors or wedge-expansion anchors,
 - (b) concrete inserts may be used in new construction but only where complete seismic design is completed and seismic forces are adjusted to suit,
 - .2 Spacing between anchors: not less than 3 x the effective embedment of the greatest embedment length.
- .3 Where adhesive anchors or concrete inserts are used, the anchors are sized for an increased seismic force as described in article "Design Criteria".
- .4 For connection to steel structures:
 - .1 use double sided beam clamp, loaded to the centerline of the beam web, or
 - .2 were permitted by the building structural engineer, specifically designed welded or bolted connection may be used.
 - .3 the use of single sided "C" type beam clamps is not permitted for the connection to the building steel structure for hanger rods and seismic restraints.

3.5 Construction of Housekeeping Pads

- .1 Do not construct housekeeping pads until equipment restraint and anchors are designed and selected by the Seismic Engineer and/or seismic restraint manufacturer, and housekeeping pads detailed design are provided by the Seismic Engineer.
- .2 Provide housekeeping pads with integral reinforcement and structural anchors to the floor slab to withstand applied shear loads and anchor pull-out tension loads.
 - .1 provide reinforcing bar both directions on equal centers, and interior and perimeter floor anchors,
 - .2 in pre-installation construction, "Z-bar" shapes may only be used when housekeeping pad layouts are known prior to construction of the structural floor slab,
 - .3 in post-installations, use tapered housekeeping pad anchor assemblies,
 - .4 in post-installations, "L-rebar" shapes with adhesive anchors may be used, except the seismic forces in Schedule A of this Specification section must be increased as described above for adhesive anchors.
- .3 Pre-engineered details of construction for housekeeping pads as shown in chapter 6 of ASHRAE *Practical Guide to Seismic Restraint* may be used within its defined limits of application including but not limited to:

- .1 housekeeping pad sizes are limited to 37 m² (400 ft²) or less,
 - .2 equipment center of gravity height does not exceed the width of the housekeeping pad,
 - .3 the ASHRAE maximum load rating includes the weight of the restrained equipment, vibration isolation equipment, support rails and bases, and the housekeeping pads,
 - .4 for values of "Fp" in ASHRAE, substitute the horizontal seismic force "Vp" as defined in the National Building Code of Canada for non-structural components (based on the seismic force coefficient "Ks" in Schedule A of this Specification section).
- .4 Size the housekeeping pad so that the distance from the equipment anchors to the edge of the pad is not less than 1.5 times the effective embedment depth of the equipment anchor unless the anchor manufacturer requires greater separation distance.

3.6 Restraints for Bus Duct, Busway, Cable Tray - General Requirements

- .1 Use braces for restraint of bus ducts and busways.
- .2 Use braces or cable restraints for cable trays.
- .3 Provide reinforcement of hanging rods to prevent buckling of the rod.

3.7 Conduit, Wireway Restraints - General Requirements

- .1 Use cable restraints for suspended conduit and suspended wireway.
- .2 Provide reinforcement of hanging rods to prevent buckling of the rod.
- .3 For trapeze hangers, provide U-bolts over conduit to limit lateral and vertical movement.
- .4 Attach restraints to conduit or conduit hangers, and trapezes.
- .5 Where pre-engineering restraints in accordance with SMACNA are used, the spacing for transverse and longitudinal restraints are to be reduced to 50% of the stated spans for the following conduit materials:
 - .1 PVC conduit.

3.8 Floor Mounted Equipment Restraints

- .1 Anchor floor mounted equipment with anchor bolts, with a minimum of four (4) anchors.
 - .1 friction due to gravity loads shall not be considered to provide resistance to seismic forces.
- .2 Secure equipment directly using equipment base supports or SRB brackets. Alternatively, use type SS1, SS2, SS3 or SRB snubbers where equipment is not subject to overturning moments. Use only type SRB or SS3 snubbers where equipment is subject to overturning moments;
 - .1 for type SS1 snubbers, provide a minimum of eight (8) snubbers for each piece of equipment, with two units placed on each corner of the equipment base frame.
 - .2 for type SRB, SS2 and SS3 snubbers, provide a minimum of four (4) snubbers for each piece of equipment, with one unit placed on each face of the equipment base frame.
- .3 Provide resilient neoprene bushings and washers between equipment and anchor bolts where equipment is secured rigidly to floor or housekeeping pad.
- .4 Install snubber devices only after equipment is installed and operating, to ensure no metal-to-metal contact. Adjust snubbers so that any clearance gaps do not exceed 6 mm (1/4 in.).
- .5 For floor mounted equipment with vibration isolators;
 - .1 select basic vibration isolator in accordance with Section 26 05 48.
 - .2 select seismic restraint for each piece of equipment of either:
 - (a) integrated seismic vibration restraint type 2-S, 3-S or 4-S, or

(b) vibration isolator in accordance with Section 26 05 48 combined with seismic snubbers SS1, SS2 or SS3 as applicable to suit overturning moment.

- .3 Do not mix types of restraint on the same piece of equipment.
- .4 Where the equipment is not provided with a structural base to transfer seismic forces, provide a structural-shape, or formed steel channel base as a complete steel frames suitably cross braced in both horizontal directions to withstand seismic induced shear force and bending moments.

3.9 Suspended Equipment Restraints

- .1 Provide restraints for equipment independent of restraints provided on connecting conduit, bus duct, busway, or cable trays.
- .2 Provide reinforcement of hanger rods to prevent buckling.
- .3 Provide SCR type longitudinal and transverse restraints at each corner of the equipment (total of eight (8) cables). Alternatively, a single SCR cable can be installed at each corner of the equipment, positioned at 45° to both transverse and longitudinal direction and sized for concurrent transverse and longitudinal loads.

3.10 Equipment Restraints - Surface Wall-Mounted Equipment and Panels

- .1 Application: for electrical panels, control panels, motor controllers, and other electrical distribution equipment.
- .2 Attach equipment to horizontal galvanized steel channels and fasten with bolts equipped with neoprene isolation grommet washers. Channels to extend past the side of the equipment to allow anchoring to wall. Select bolts for concurrent shear dead-weight without deduction for uplift load, and tension restraint load.
- .3 Attach channels to concrete or masonry walls with not less than four (4) anchors with each anchor having a not less than a 1.5 safety factor.

3.11 Equipment Restraints - Recessed Wall-Mounted Equipment

- .1 Application: for electrical panels, control panels, motor controllers, and other electrical distribution equipment.
- .2 Mount recessed equipment through the top, bottom and sides of the equipment housing to adjacent block wall or wall studs.

3.12 Inspection, Testing, Adjustment and Reporting

- .1 For equipment supported on vibration isolators, field measure air gaps on each restraint and if necessary, adjust the restraint so that the clearance air gap does not exceed 6 mm (1/4 in.). Provide a written report identifying the results of each test and adjustment, to the Seismic Engineer and Consultant for review.
- .2 Arrange for the seismic restraint manufacturer to inspect and report on the installation at completion of the work. Make corrections of deficiencies identified by the manufacturer. This work is to be performed prior to the final field review by the Seismic Engineer.
- .3 Arrange for Seismic Engineer to conduct a final inspection prior to substantial performance of the Work. Make corrections of deficiencies identified by Seismic Engineer. This work is to be performed prior to the final field review by Consultant.
- .4 Make corrections of deficiencies identified by Consultant.
- .5 Submit the following reports prior to application for substantial performance of the Work, or where applicable, ready-for-takeover of the Work:
 - .1 Seismic Engineer periodic and final inspection reports,

- .2 seismic restraint manufacturer inspection reports,
- .3 Seismic Engineer declaration of general review.

3.13 Schedules

- .1 The following schedules are attached to and form part of this Specification section.
 - .1 Schedule A Seismic Force Coefficients and SMACNA SHL Class
 - (a) Table 1 Horizontal Seismic Force Factor, K_s
 - (b) Table 2 Vertical Seismic Force Factor, K_v

NOT FOR CONSTRUCTION

Schedule A –Seismic Force Coefficients and SMACNA SHL Class

Table 1 – Horizontal Seismic Force Factors		
Building Level	Horizontal Seismic Force Coefficient (except fire protection)	SMACNA SHL Class
	K_s	---
Ground Floor	0.10	D
Basement	0.10	D

Table 2 – Vertical Seismic Force Factors	
Building Level	Vertical Seismic Force Factor
	K_v
All Floors	0.041

END OF SECTION

SEISMIC QUALIFICATION FOR ELECTRICAL EQUIPMENT 26 05 49.23

1 GENERAL

1.1 Scope

- .1 Provide seismic qualification (certification) of select electrical equipment where such requirement and method of qualification is specified in other technical Specification sections of Divisions 26, 27 and 28..

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 26 05 49.20 Seismic Restraint for Electrical Services

1.3 Definitions

- .1 The following definitions apply for the purpose of this section.

Seismic Qualification: equipment which has been evaluated to withstand design lateral and vertical seismic induced forces:

Attachment seismic qualification (Level I qualification) - means the equipment is evaluated at the equipment's attachment point to the building structure to retain the position of the equipment during a design seismic event.

Structural seismic qualification (Level II qualification) - means the equipment's internal structural elements and components have been evaluated to remain in place and not be dislodged during a design seismic event and includes Level I qualification.

Functional seismic qualification (Level III qualification) - means the equipment is evaluated to continue its functional operation after being subjected to a design seismic event and includes a Level I and II qualification.

- .2 For other applicable definitions and abbreviations, refer to:

- .1 26 05 49.20 Seismic Restraint for Electrical Services

- .3 Interpretation:

- .1 In this specification, the parameter " S_{DS} " (5% damped spectral response acceleration parameter at short periods) in ASCE7, AHRI 1271, NFPA 13, ASHRAE, SMACNA and MSS SP-127 used for estimating the horizontal seismic force, has the same meaning as the parameter " $S(0.2)$ " for the Project site-specific design spectral response acceleration value at 0.2 seconds as defined in article 4.1.8.18 of the 2020 National Building Code of Canada.

1.4 Applicable Codes and Standards

- .1 Legislation

- .1 2020 National Building Code of Canada, as adopted in the jurisdiction of the Project.

- .2 Product standards:

- .1 ICC- ES AC156 Acceptance Criteria for Seismic Certification by Shake-Table Testing of Non-structural Components

- .3 Other documents:

- .1 ASCE 7-10 American Society of Civil Engineers: Minimum Design Loads and Associated Criteria for Buildings and Other Structures
- .2 NEMA EESCTG 1-2019: NEMA Seismic Guideline 1 – General Requirements for Seismic Qualification of Electrical Equipment for Commercial Building Loads
- .3 NEMA BI 50010-2024: Seismic Certification Criteria for Nonstructural Electrical Components for Commercial Building Code Applications

1.5 Design Criteria

- .1 For general seismic force design criteria, refer to :
 - .1 26 05 49.20 Seismic Restraint for Electrical Services

1.6 Seismic Qualification of Equipment

- .1 Refer to each applicable equipment Specification section for the equipment-specific seismic qualification level and certification method.
- .2 Where equipment is specified only for Attachment seismic qualification (Level I) or Structural seismic qualification (Level II), certify such equipment in accordance with either of the following:
 - .1 by static analysis or dynamic analysis in accordance with ASCE7 or by shake table test in accordance with ICC ES AC156.
- .3 For equipment which is specified for Functional seismic qualification (Level III), certify such equipment in accordance with the following:
 - .1 by shake table test in accordance with ICC ES AC156.
- .4 Site design parameters:

Item	Description	Abbrev.	Value
1	Site Class	X _s	C
2	Building Category	---	Post-Disaster
3	Building Importance Factor	I _E	1.5
4	Design Spectral Response acceleration factor	S(0.2)	0.309

- .5 Shaker table test parameters in accordance with ICC EC AC156 are to comply with the following:
 - .1 calculate seismic forces in accordance with the building code at the place of the Work, or in its absence the 2020 National Building Code of Canada ("NBC"),

$$V_p = 0.3 S(0.2) I_E C_p \frac{A_r}{R_p} \left(1 + 2 \frac{h_x}{h_n} \right) W_p$$
 - .2 the ASCE7 parameter "S_{DS}" is equivalent to "S(0.2)" where S(0.2) is as defined in the NBC and is the maximum of S(0.2,X) and S(0.5,X),
 - .3 the ASCE7 parameter "a_p" is equivalent to the NBC "A_r" parameter.
 - .4 the ASCE7 parameter "R_p" is equivalent to the NBC "R_p" parameter.
 - .5 the ASCE 7 Component importance factor "I_p" is to be read as the NBC Building Importance Factor "I_E".
 - .6 the ASCE7 parameter "z/h" is to be read as the NBC parameter "h_x/h_n",

- .7 the ASCE7 parameter " Ω_0 " has no equivalent in the NBC and is not to be used,
- .8 the NBC parameter " C_p " has no equivalent in ASCE7 but is to be included in the force calculation,
- .9 the values of parameters " A_r ", " R_p ", and " C_p " are found in each equipment technical specification section.
- .10 unless otherwise specified in the product technical Specification section, the value of " h_x/h_n " ratio is to be 1.0, representing the equipment under test being located anywhere in the building including at the top of a building,
- .11 the test parameters are in accordance with the following table and as follows:
 - (a) parameters for test acceleration values A_{FLX-H} , A_{RIG-H} , A_{FLX-V} , and A_{RIG-V} are as defined in ICC-ES AC156.

Building Code	Test Criteria	Design $S(T,X)$ (g)	S_{DS} (g)	z/h	Horizontal Acceleration		Vertical Acceleration	
					A_{FLX-H}	A_{RIG-H}	A_{FLX-V}	A_{RIG-V}
NBC 2020	ICC-ES AC156	0.309	0.309	0	0.309	0.124	0.207	0.083

- .6 other parameters as specified in accordance with Specification sections:
 - .1 26 05 49.20 Seismic Restraint for Electrical Services
- .7 Where seismic qualification is by shake table test, equipment product line may be qualified by extrapolation or interpolation analysis from a suitable range of tested sample products of the same model by either:
 - .1 in accordance with ICC ES AC156 for equipment within the scope of that standard, or
 - .2 with equipment manufacturer's supporting calculations for such equipment which are prepared by an engineer licensed in the jurisdiction of the Project.
- .8 Alternate compliance path:
 - .1 equipment which conforms with all the following is deemed to be seismically qualified:
 - (a) equipment which is certified and listed on the California Department of Health Care Access and Information "Special Seismic Certification Preapproval (OSP)", and
- .9 the certification horizontal acceleration factor is equal to or greater than the Projects horizontal acceleration factor " K_v " as specified in:
 - .1 26 05 49.20 Seismic Restraint for Electrical Services

1.7 Submittals

- .1 Where equipment is specified to be seismically qualified, submit any of the following test certificates with the shop drawings for each applicable equipment:
 - .1 NEMA BI 500-01
 - .2 California HCAI OSP listing including data for design horizontal seismic forces,
 - .3 test reports by independent laboratories for conformance to ICC ES AC156,
 - .4 manufacturer's sealed calculation reports (seismic qualification Level I and Level II only).

2 PRODUCTS

.1 Not Used

3 EXECUTION

.1 Not used.

END OF SECTION

NOT FOR CONSTRUCTION

IDENTIFICATION FOR ELECTRICAL SYSTEMS

26 05 53

1 GENERAL

1.1 Scope

- .1 Provide identification and warning signs for complete electrical systems as shown.

1.2 Applicable Codes and Standards

- .1 Product standards:
 - .1 CSA C22.2 No. 197 PVC Insulating Tape

1.3 Submittals

- .1 Shop drawings:
 - .1 Submit list of nameplates with proposed wording, prior to engraving.
 - .2 Submit list of labels with proposed wording, prior to printing.
 - .3 Submit representative samples of nameplates, labels and warning signs.

2 PRODUCTS

2.1 Warning Signs

- .1 As required to meet requirements of the Electrical Safety Authority.
- .2 Outdoor signs:
 - .1 fibreglass,
 - .2 minimum size 250 mm x 360 mm (10" x 14").
- .3 Indoor signs;
 - .1 aluminum,
 - .2 baked enamel finish,
 - .3 minimum size 180 mm x 250 mm (7" x 10").

Standard of Acceptance

- Brady
- Seton

2.2 Equipment Identification

- .1 Nameplates for panels and equipment:
 - .1 3 mm ($\frac{1}{8}$ ") thick laminated plastic plates,
 - .2 engraved lettering,
 - (a) first line: 11 mm (7/16 in.) high lettering,
 - (b) second line: 7mm (1/4 in.) high lettering,
 - (c) third line: 5mm (3/16 in.) high lettering,
 - .3 [colour coded as follows:
 - (a) black lettering on white background for panels and equipment on normal power,
 - (b) white lettering on orange background for panels and equipment on emergency power,

- (c) white lettering on light blue background for panels and equipment on UPS power,
- .4 with bevelled edges,
- .5 mechanically attached with self-tapping stainless steel screws.
- .2 Labels for warnings, instructions etc. on panels and equipment:
 - .1 printed on white polyester background,
 - .2 7 mm (1/4") high letters unless specified otherwise,
 - .3 UV resistant inks,
 - .4 clear polyester over lamination,
 - .5 pressure sensitive adhesive.

Standard of Acceptance

- Brady
- Ideal Industries
- Safety Sign

- .3 Do not commence manufacture of nameplates and labels until wording has been reviewed by the Consultant.

2.3 Wiring Identification

- .1 Colour coded phasing tapes:
 - .1 7 mil poly vinyl chloride,
 - .2 pressure sensitive adhesive,
 - .3 compatible with wire insulation,
 - .4 permanent colour,
 - .5 electrically insulating,
 - .6 UV and moisture resistant,
 - .7 to CSA C22.2 No. 197

Standard of Acceptance

- 3M Scotch 35
- Electro Tape Specialties 103/103C Series

- .2 Wire markers:
 - .1 adhesive
 - .2 self laminating,
 - .3 white vinyl print area,
 - .4 permanent thermal transfer printing.

Standard of Acceptance

- Brady
- Panduit

3 EXECUTION

3.1 Equipment Identification

- .1 Identify electrical equipment with nameplates, directories and labels.
- .2 Provide nameplates:
 - .1 secure to top exterior of equipment except where indicated otherwise,
 - .2 switchboards: indicate name, voltage and ampacity,
 - .3 rear of switchboard cubicles or cells: indicate name of cell or cubicle,
 - .4 panelboards: indicate name, voltage and source of power,
 - .5 terminal cabinets: indicate name, system and voltage,
 - .6 circuit breakers with fixed trip units: indicate load supplied, voltage and maximum allowable ampere rating of the breaker,
 - .7 circuit breakers with replaceable trip units: indicate load supplied, voltage and maximum allowable ampere rating of the trip unit,
 - .8 circuit breakers with adjustable trip units: indicate load supplied, voltage and maximum allowable ampere setting of the long time pick up,
 - .9 disconnects: indicate load supplied, voltage, type of fuses and maximum allowable ampere rating of fuses,
 - .10 starters: indicate equipment being controlled, voltage and maximum allowable setting of the overload device,
 - .11 contactors: indicate equipment being controlled and voltage,
 - .12 transformers: indicate name, capacity, primary and secondary voltages,
 - .13 pull boxes and junction boxes: indicate system, circuit numbers and voltage,
 - .14 cabinets for low voltage systems, such as signals and communications: indicate name and system,
 - .15 equipment not listed above, such as, instruments, fire alarm, clock and program equipment and control panels: identify in a similar manner showing name and number of the equipment, voltage and load information.
- .16 typical identification standards:
 - (a) Lighting, Receptacle and Power Panels: each identified with an engraved lamicoid nameplate secured to top interior trim as follows:

LP-4NW-1EA	11 mm (7/16") high lettering
120/208 volts	7 mm (1/4") high lettering
Fed from PP-SBSW-EAA	5 mm (3/16") high lettering

- .3 Directories:
 - .1 Supply each panelboard with a directory card holder welded to inside of door, complete with a neatly typewritten list showing information as follows:

Panelboard Name LP-4NW-1EA		
Panel Voltage 120/208 Volts		
Circuit Number	Description	Maximum Allowable Rating

1	Lighting Room #34	20 Amps
2	Receptacles Room #34	15 Amps
3	Ice Machine Room #17	30 Amps
4/6	Split Receptacle Room #26	20 Amps
5/7/9	Sub Feed to Receptacle Panel RP-4NW-1EA	60 Amps

- .2 Cabinets for low voltage systems, such as signals and communications: as for panelboards with a directory showing circuit numbers and room locations plus a blank column for "Remarks".
- .3 Cover directory list with a 0.8mm (1/32") minimum thick clear plastic sheet to protect it.
- .4 Warning Labels:
 - .1 circuit breakers where the allowable maximum continuous load is less than the breaker rating or the breaker is not marked with a continuous load rating: provide a label stating:
Caution: maximum continuous load not to exceed XXX Amperes.
 - .2 disconnects where the allowable maximum continuous load is less than the switch rating or the switch is not marked with a continuous load rating: provide a label stating:
Caution: maximum continuous load not to exceed XXX Amperes.
- .5 Pull Boxes and Junction Boxes
 - .1 Identify feeder pull boxes and junction boxes:
 - (a) lettering stamped on brass or aluminum tags,
 - (b) showing the name of the feeder or system,
 - (c) voltage involved,
 - (d) data for both termination points whether equipment or panel,
 - (e) secure tag under box lid screws using steel wire.

3.2 Service Rough-in Identification

- .1 Apply a small dab of paint to inside of each outlet box, pull box and panel as it is installed, using colour code as follows:

Red	Fire Alarm System and Emergency Voice Communication System
Dark Blue	Intercom and Public Address
Dark Green	Telephone and Data Systems
Black	Annunciator and Buzzer System
Grey	Clock System
White	Central Dictation
Orange	Nurse Call
Yellow	Alarm Systems

Pink	Computer Systems
Light Green	TV Systems

- .2 Junction boxes in furred ceilings to have colour identification on both inside and outside.
- .3 As an alternative to applying paint dabs, prepainted conduit/EMT may be used where applicable.
- .4 Colour coding is not required for lighting and power circuits.

3.3 Wiring Identification

- .1 Identify feeders and branch circuit wiring with wire markers;
 - .1 at each end of run,
 - .2 in each junction box,
 - .3 wherever they are introduced into ducts or equipment.
- .2 Identify incoming utility service lines by Red - Phase "A", Black - Phase "B", Blue - Phase "C", with colour coded phasing tape.
- .3 Band buswork in each;
 - .1 switchboard,
 - .2 unit substation cubicle,
 - .3 power panel,
 - .4 lighting and receptacle panel,

with colour coded phasing tape as follows:

Red	Phase A
Black	Phase B
Blue	Phase C
White	Neutral
Green	Bond/Ground

- .4 Band feeder and sub-feeder bus and conductors as above.
- .5 Maintain phase sequence and colour coding throughout.
- .6 Connections in equipment to be Phase A, B, C from left to right when viewing from front or accessible direction.
- .7 For control conductors for motors and equipment, schedule and chart marker numbers with corresponding machine numbers and locations and include with Record Drawings and Operation and Maintenance Data.
- .8 Use colour coded wires in communication cables, matched throughout system. Schedule and chart, marker numbers and wire colours with corresponding equipment and include with Record Drawings and Operation and Maintenance Data.

3.4 Conduit and Cable Identification

- .1 Label;
 - .1 incoming service cables,
 - .2 bus ducts,
 - .3 feeder conduits/EMT,

- .4 feeder cables,
- .5 communications cables.
- .2 Locate labels as follows;
 - .1 at every end of every conduit, duct or cable run, adjacent to item of equipment serviced,
 - .2 on each exposed conduit, duct or cable passing through a wall, partition or floor (one on each side of such wall, partition or floor),
 - .3 at intervals of not more than 15 m (50') along every exposed conduit, EMT, duct or cable run exceeding 23 m (75') in length,
 - .4 at every access point on concealed conduit, EMT, duct or cable runs,
 - .1 visible from 1.5 m (5') above adjacent floor or platform.

3.5 Fire Stopping Identification

- .1 Provide a warning card adjacent to each opening exceeding 25mm (1") in diameter, indicating the following;
 - .1 a warning that the opening is protected by a fire stopping material,
 - .2 the fire stop system used, ULC or cUL,
 - .3 F rating or FT rating,
 - .4 specific fire stop product(s) used,
 - .5 name and telephone number of the contact person should any changes to the fire stopping be required.
- .2 Provide warning labels for each fire stopped penetration as follows;
 - .1 permanently attached to walls, floors, underside of slabs, adjacent to the penetration,
 - .2 on each side of the penetration,
 - .3 vinyl panel, white and red background with black lettering,
 - .4 self adhesive with permanent pressure sensitive adhesive,
 - .5 stating:

WARNING
THROUGH PENETRATION FIRESTOP SYSTEM - DO NOT DISTURB
NOTIFY BUILDING MANAGEMENT OF ANY DAMAGE

3.6 Single Line Electrical Diagrams

- .1 Provide a single line schematic diagram in each Electrical room to illustrate every component including;
 - .1 main service,
 - .2 transformers,
 - .3 grounding,
 - .4 switchgear,
 - .5 unit substations,
 - .6 generators,
 - .7 circuit breakers,
 - .8 fuses,
 - .9 capacitor banks,

- .10 surge protective devices,
 - .11 disconnect switches,
 - .12 transfer switches,
 - .13 panelboards,
 - .14 major items of equipment such as chillers,
 - .15 feeders,
 - .16 key interlocks,
 - .17 interlocking schemes,
 - .18 protective relays,
 - .19 metering,
 - .20 transformer winding arrangements,
 - .21 voltage levels, including number of phases and wires,
 - .22 equipment ratings such as: Amperes, kW, kVA, kVAR.
- .2 Diagram:
- .1 print of an AutoCAD drawing using the latest version of AutoCAD,
 - .2 not less than 600 mm x 600 mm (2' x 2'),
 - .3 in a wood frame,
 - .4 plexiglass covered.
- .3 Submit diagram to Electrical Inspection Authority and incorporate all requirements indicated in their comments.
- .4 Submit diagram as shop drawing for review.
- .5 Provide an electronic version of the drawing file to the Owner for the Owner's future use.

END OF SECTION

INDEPENDENT POWER SYSTEM TESTING

26 05 73.15

1 GENERAL

1.1 Scope

- .1 The Division 26 contractor shall retain and pay for the services of an Independent Testing Organization ("ITO") to provide Factory Acceptance Testing (FAT), Site Acceptance Testing (AT) and On-Site Commissioning Service in accordance with the details specified herein.
- .2 The Division 26 Contractor shall include in the Bid Amount the cost for the services of tradesmen to handle equipment, make temporary connections, operate equipment and make repairs and adjustments and assist the testing organization's on-site specialists during the site acceptance testing and supplementary Commissioning phase of the work and as required by the [Engineer][Consultant] until the equipment and systems are accepted by the Owner.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections. Refer to these sections for additional requirements for factory witness testing and for site acceptance testing:
 - .1 26 08 06 Electrical Systems Studies and Reports
 - .2 26 08 15 Electrical Commissioning
 - .3 26 05 13 High Voltage Cables
 - .4 26 05 26.13 Primary Grounding and Bonding for Electrical Systems
 - .5 26 05 26.16 Secondary Grounding and Bonding for Electrical Systems
 - .6 26 12 16 Dry-Type Medium-Voltage Transformers
 - .7 26 32 13 Power Generation Diesel

1.3 Installation Codes and Standards

- .1 ANSI/NETA ATS Standard for Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

1.4 Independent Testing Organization

- .1 In order to ensure the requirement for independence, the ITO must be retained directly by the Division 26 contractor. The ITO must not be retained by an equipment manufacturer or their distributor as part of an equipment package.

1.5 Bidding Instructions to Vendors

- .1 The Bidders for Division 26 work shall advise all equipment suppliers bidding for the equipment supply for this project prior to Tender close of the requirement for comprehensive factory and on-site testing and commissioning and the requirement for on-site services of technical representatives during the testing and extensive commissioning phase and ensure the services and associated costs are included in the suppliers' quotations for the equipment for the project and in the Bidder's Tender Price.

2 PRODUCTS

2.1 Not Used

3 EXECUTION.

3.1 Substation Ground Resistivity Study

- .1 Immediately upon award of Contract conduct ground resistivity measurements at the proposed location of the outdoor high voltage substation. In conjunction with the substation drawings, prepare a report for submission to the ESA indicating station ground resistance, ground potential rise, mesh voltage, step voltage, and touch voltage inside and outside the station area. Make recommendations on modifying the substation grounding design where necessary to achieve acceptable grounding system characteristics.
- .2 Verify completed installation as follows:
- .3 Dynamic ground resistance measurements at the high voltage substation using the drop of potential method as described in ANSI/IEEE 81, using a three point (or four point) Fall of Potential multi function tester.
- .4 Dynamic bonding verification of the high voltage switchgear, power transformers, substation enclosure, and associated apparatus using 60 Hz AC excitation current method.
- .5 Buried Grounding System Test

3.2 Building Grounding System Testing

- .1 Buried Grounding System Test
 - .1 Perform electrical measurement testing of the installed electrical protection system buried grounding grid installation to verify the effectiveness of the installation.
 - .2 Test using the fall of potential method as described in ANSI/IEEE 81, using a three point (or four point) Fall of Potential multi function tester.
 - .3 Inject AC current of non standard (non 60 Hz and non 60Hz harmonics) frequency into the grounding system via an accessible ground lead connection.
 - .4 Insert current probe into soil at 10 foot intervals ranging from 0 - 400 feet away from the building, and record resistance.
- .2 Connections to Buried Grid
 - .1 Throughout the perimeter of the ground floor electrical/mechanical plant area, grounding connections between the perimeter copper ground buses and the below grade buried grounding grid are in place.
 - .2 Measure the effective resistance connections between the buried grid and the above grade portion by utilizing a two clamp on current transformer measurement technique. One current transformer when clamped around the stub up conductor is to induce a 128 Hz voltage on the conductor, while the second current transformer measures the actual current flowing through the conductor, in order to determine the effective resistance of the connection to the buried grid. The recommended testing instrument for this test is the Fluke / LEM GEO Earth Ground Tester.

3.3 Factory Acceptance Testing

- .1 Provide in-plant inspection and factory witness testing at various manufacturing plants where the equipment and materials are made and/or assembled prior to shipment to the jobsite. Testing to suit delivery schedule of manufacturers.

- .2 Include a contingency allowance in the cost to re-visit the manufacturers' plants and re-witness Factory Witness tests, should the initial tests fail and repairs and modifications cannot be done to correct deficiencies during the initial testing program.
- .3 Certification shall be made that all required tests have been completed and that equipment conforms to standards, specifications and shop drawings and is suitable for shipment.
- .4 Factory witness tests of equipment and HV cables shall be done after equipment have passed standard production tests and is free and clear of deficiencies and in the opinion of the manufacturers, the equipment is deemed suitable for shipment to the job-site.
- .5 The supplementary factory witness tests by the Independent Testing Organization are required to certify on behalf of the contractor and owner that the equipment is compliant and free and clear of deficiencies and suitable for shipment to the job-site.
- .6 Detailed testing requirements are identified in equipment specification sections.
- .7 The following is list of equipment for the factory witness tests.
 - .1 Main power transformers
 - .2 Diesel generators
- .8 Provide a test report for each equipment item in each of above sections.

3.4 Site Acceptance Testing (SAT)

- .1 Upon Completion of the installation and prior to energization of components and systems, perform a complete inspection and testing to verify phase and polarity match of feeders with equipment and the tightness of power wiring terminations.
- .2 Detailed testing requirements are identified in equipment specification sections.
- .3 In addition, perform site acceptance testing for the following equipment:
 - .1 High voltage cables
 - .2 Power Transformers
 - .3 Emergency Power System including ATS's
 - .4 Power Feeders
 - .5 Potential transformers (throughout all components and systems)
 - (a) Ratio, polarity and phase angle tests
 - (b) Insulation resistance tests
 - .6 Current transformers (throughout all components and systems)
 - (a) AC excitation test, (produce saturation curves)
 - (b) Polarity ratio and insulation resistance tests
 - .7 Metering and Instruments throughout all components and systems
 - (a) Verify correctness of wiring and operation
 - .8 Key Interlocking schemes
 - (a) Verify proper operation and identification of all key interlocking systems throughout all switchboards and panelboards

3.5 Testing, Adjusting and Verification

- .1 Provide necessary test equipment, material, labour and miscellaneous services during the testing, adjusting, verification and commissioning procedure.

- .2 Work normal to the electrical trade such as providing temporary feeders, jumpers and connections, and handling equipment shall be done by the contractor under Division 26.
- .3 Work and technical supervision by manufacturers' technical representatives in the verification, testing and commissioning phase shall be provided and all costs for tradesmen and representatives shall be included in the tender price.
- .4 Verify that all protective device schemes function properly. Conduct circuit breaker trip tests. Apply correct voltage and current to protective devices.
- .5 Verify the performance of the ground fault alarm and protection systems
- .6 Provide cross wattmeter readings or equivalent or any differential and/or directional relay schemes. Verify metering schemes.
- .7 During the testing and verification procedure, conduct supplementary spot checks on selected protective devices in company with representative of the Owner and/or [Engineer][Consultant] to adjust and re-test protective devices so that final settings will result in performance in accordance with approved issue of respective co-ordination curve.

3.6 Performance Verification of the Entire System

- .1 After the energization of the electrical systems have been satisfactorily completed and all testing and calibration work have been done and all reports submitted as shop drawings to the Consultant and all deficiencies noted to-dated have been corrected, the systems shall be subjected to supplementary dynamic simulation and verification of their operating performance characteristics in accordance with the Consultant Test Plans and in the presence of the Consultant and Owner's representative.
- .2 The Contractor's forces and manufacturer's technicians shall also be present to start, stop and operate equipment and make adjustments as directed by the [Engineer][Consultant].
- .3 The following is an abbreviated outline of the tasks to be undertaken:
 - .1 Dynamic phasing and polarity verification of HV & LV switchboards, automatic transfer switches, and APS systems.
 - .2 Verify the start signal from each ATS is received at the respective diesel generator control panels and that the DG's start and supply power to the ATS's in the prescribed sequence.
 - .3 Verify that APS system will operate automatically. Tripping of incoming power supplies will be required
 - .4 Verify operation of APS automatic load management system by removing generating units from the system and simulating other malfunctions in the system.
 - .5 Verify operation of all manual controls on APS system
- .4 Upon completion of the Commissioning phase, prepare a comprehensive report summarizing the findings.

3.7 Reports

- .1 Prepare and submit the following reports. Simultaneously submit one copy directly to the Consultant and one copy to the contractor to be processed as a shop drawing:
 - .1 Factory Witness test report for each item of equipment within 5 working days of the factory visit. Where deficiencies in the factory test have been noted, inform the engineer and contractor immediately to permit a decision to be made whether remedial action is required of the manufacturer prior to the equipment being accepted for shipment to site.
 - .2 Site Testing Report for each item of equipment within 5 working days of completion of site test.
 - .3 Site Performance verification report(s) to reflect each significant phase of system completion.

- .4 Upon completion of the Commissioning phase, prepare a comprehensive report summarizing the findings.
- .2 The final report and study shall include assurance for the following items:
 - .1 That the protective devices on the high voltage equipment co-ordinate with the Utility protective devices.
 - .2 That the protective devices within the parameters of the study conform to the results of the study.
 - .3 That the equipment has been tested and performs as per the settings of the approved co-ordination curves.
 - .4 That the "as left" condition of the protective devices corresponds to the record documents.
- .3 Completed studies and reports shall be submitted simultaneously to the Consultant as well as part of the requirements of the Maintenance Manuals. Provide PDF of final reports plus one hard copy.

END OF SECTION

WIRING FOR MECHANICAL SERVICES 26 07 03

1 GENERAL

1.1 Scope

- .1 Provide wiring for mechanical services and equipment which forms part of the Work under Divisions 20 to 25.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 20 05 12 Wiring Requirements for Mechanical Systems
 - .2 20 05 14.13 Constant Speed Motor Controllers
 - .3 20 05 14.16 Variable Frequency Drive Motor Controllers

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 **Control panels** – an electrical device that controls or monitors mechanical equipment, or that interfaces with instrumentation devices.
 - .2 **Control wiring** - wiring for the purpose of communication or control of mechanical equipment and instrumentation.
 - .3 **Mechanical breaker panel (MBP)** - 120/208 V mechanical power panel with overcurrent protection circuit breakers provided as part of an MCC.
 - .4 **Mechanical Services Panel (MSP)** – panelboard with branch circuit overcurrent protection devices, provided by Division 26, and dedicated to supply power for equipment provided by mechanical trades work.
 - .5 **Mechanical trades work** - equipment and systems provided under Divisions 20 to 25.
 - .6 **Motor controllers** - constant speed motor controllers of the manual, magnetic or solid-state type in accordance with specification section 20 05 14.13.
 - .7 **Motor Control Center (MCC)** – has the meaning as specified in section 20 05 14.13.
 - .8 **Packaged equipment** – mechanical trades equipment containing some or all of: motor(s), controls and/or other electrically powered equipment, such as but not limited to: electric heating equipment, water treatment equipment, packaged HVAC equipment, electric boiler, electric domestic water heaters, etc.)
 - .9 **Power Panel (PP)**: 208 up to 600 V, 3 phase, panelboard with branch circuit overcurrent protection devices, provided by Division 26, which serves general building loads and may also serve equipment provided by mechanical trades work.
 - .10 **Power wiring** means wiring that provides electrical power to mechanical equipment.
 - .11 **Receptacle panel (RP)** - a 120/208 V panelboard with branch circuit breakers, provided by Division 26.
 - .12 **VFD**: variable frequency drives in accordance with specification section 20 05 14.16.
 - .13 **Wiring** means conductors, cable, conduit, fittings, supports and accessories.
- .2 For clarity, any reference herein to Division 20 means Divisions 20 to 25 inclusive.

2 PRODUCTS

2.1 Not used

3 EXECUTION

3.1 Wiring of Mechanical Trades Motors and Equipment

- .1 To limit responsibility and to specifically define the Work under this Division, use the following procedure with regard to motors and equipment provided under mechanical trades work.
- .2 The contractor for the mechanical trades work will be responsible for installing equipment which they supply including motors, motor controllers, VFDs, disconnect switch, Motor Control Centres, mechanical breaker panels (MBP) and miscellaneous controls.
- .3 For motorized equipment forming part of the mechanical trades work, wire to line side of the Motor Control Centre, motor controllers, VFDs, , or disconnect switch provided under the mechanical trades work, in reasonable proximity to equipment being controlled.
- .4 From this point, unless otherwise shown, the cost of electrical material and labour will be borne by the particular trade whose work is involved. That trade will mount the motor controller or VFD and wire from it to the motor being controlled, together with control wiring, remote switches, and pilot lights.
- .5 Except where a panelboard is shown to be provided by Division 26, where individual starters and controls are grouped together, provide a feeder, main fused disconnect switch, a splitter of adequate size and capacity, individual fused disconnect switches, and wire to line side of the Division 20 motor controllers.
- .6 In the case of packaged equipment and control panels, provide a junction box adjacent to motor or device being electrically powered, and pull wire through with sufficient length to allow direct termination to the end device or equipment.
- .7 Provide branch circuit wiring and an junction box for each motorized damper or heating control, with sufficient length to terminate at the motorized damper or heating control.
 - .1 Provision of conduit from these junction boxes to the mechanical equipment will be done under Mechanical Division 20.
- .8 Ascertain locations of starters, Motor Control Centres, and motors from Mechanical Drawings.

3.2 Coordination and Division of Responsibility – Division 20 and Division 26

- .1 Schedule A at the end of this Specification section specifies the division of responsibility between Division 20 and Division 26 for provision of electrical work for mechanical equipment, including termination of conductors.
- .2 For clarity;
 - .1 the Division 20 electrical Work may be performed by the Division 26 contractor, but the work is managed and paid for by the Division 20 contractor.
- .3 Coordinate with the Division 20 contractor to manage the Division 26 work. Coordination to include but is not limited to:
 - .1 reviewing a list of all planned and ordered mechanical trades equipment for motor horsepower ratings and electrical power requirements, prior to procuring power distribution equipment,
 - .2 periodically review this power requirements list as mechanical trades equipment is ordered, and revise and update branch circuit feeders and breaker ratings in a timely manner.

Schedule A – Coordination of Division 20 and 26 Scope of Work

Schedule A – Coordination of Division 20 and 26 Scope of Work			
Reference	Work Element	Div. 20	Div. 26
All	Motor Control Centers, motor controller racks, motor controllers, VFDs, Mechanical Breaker Panels (MBP), and disconnect switches	●	
Mechanical Equipment at voltage > 600 VAC	Power wiring from Division 26 switchgear to: - motor controller, - between motor controller and the mechanical equipment (where motor controller is free-standing separate from the mechanical equipment) - field-installed disconnect switches, and wiring between the disconnect switch and the mechanical equipment		●
	Field-installed disconnect switches.		●
General Mechanical Equipment fed from Non-dedicated Power Panels (Note 2)	Non-dedicated Power Panels (PP) and receptacle panels (RP), including branch overcurrent protection devices.		●
	Distribution splitters		●
	Power wiring from PPs and/or distribution splitters to: - motor controller, - disconnect switch ahead of VFD, - disconnect switch for package equipment, - packaged equipment (with integral disconnect switch) - equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc.)		●
	Power wiring from RP to: - motor controller or disconnect switch, - disconnect switch for package equipment, - packaged equipment (with integral disconnect switch), - equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc.)		●
	Power wiring from: - disconnect switch to a VFD, - motor controller or VFD to the motor, - disconnect switch to packaged equipment	●	
Terminal Units BAS Controllers	Power wiring for controllers at 120 V, single phase terminating at each terminal box controller		●
	Power wiring for controllers at 120 or 24 VAC, from junction box provided by Division 26 to each terminal unit controller.	●	
	Power wiring for controllers at 24 VAC/DC, from building automation system control panels to terminal unit box controller.	●	
	3 phase, 208 V and higher voltage wiring direct to terminal unit box.		●

Schedule A – Coordination of Division 20 and 26 Scope of Work			
Reference	Work Element	Div. 20	Div. 26
BAS Controls and OEM Controls			
	Power wiring for controls in service rooms: wiring from MSP or BP to the BAS and OEM control equipment.	●	
	Other than service rooms: Dedicated 120V 15A normal and emergency branch circuit breakers as indicated on the receptacle panel schedules.		●
	Power wiring for controls other than in service rooms: wiring from dedicated circuits in receptacle panels to control equipment.	●	
	120 V, single phase power supply with a junction box at specific control devices as shown.		●
	Breaker tamper-protection locks.	●	
	Instrumentation and actuator power and control wiring, for both BAS controls and OEM controls.	●	
	Control wiring to interlock motor controllers and to connect safety and operating controls.	●	

Notes:

[1] MPP and MBP will be located in mechanical services rooms.

[2] PP and RP are not dedicated for mechanical equipment and may be located in any type of service room or space.

End of Section

ELECTRICAL SYSTEM STUDIES AND REPORTS

26 08 06

1 GENERAL

1.1 Scope

- .1 The Division 26 contractor shall retain and pay for the services of a contractor to do the electrical systems studies and reports to provide a complete building Short Circuit Study, System Coordination Study, and Arc-Flash Study in accordance with the details specified herein.
- .2 System analysis to be completed with one of the recommended software packages of EasyPower, ETAP, or SKM. Other software packages may be used but must be approved by consultant prior to use.
- .3 The systems studies contractor doing the system studies may be the same company as the independent testing organization (ITO) but is not required to be.
- .4 The systems studies contractor doing the studies to complete a systematic review of all existing building information where required. Including, with the assistance of the Division 26 contractor, site verification of the following:
 - .1 equipment ratings,
 - .2 existing protective device specifications and settings,
 - .3 conductor characteristics.
- .5 The systems studies contractor shall obtain all information on the existing electrical equipment as part of the study and the Div 26 contractor shall provide all new information.
- .6 Systems studies contractor to coordinate with relevant equipment manufacturers to obtain specific information pertaining to protection and coordination of the system prior to equipment release for production.
- .7 Systems studies contractor to update coordination settings and arc flash labelling per Owner and Consultant approved study recommendations.
- .8 Division 26 contractor to coordinate with systems study contractor, Owner, and Consultant and prepare specific methods of procedure for any site investigations, system adjustments, and related testing plans that may impact site operation.
- .9 Division 26 contractor is responsible to coordinate with equipment manufacturers and project commissioning personnel regarding the implementation of the Owner and Consultant approved system studies findings and recommendations resulting from the studies.
- .10 ITO, which may be the same contractor as the systems studies contractor, is responsible for setting, testing, validation, and reporting of all protective device setting adjustments.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 26 08 11 Testing of Integrated Electrical Life Safety and Fire Protection Systems]
 - .2 [26 08 15 Electrical Commissioning]

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section;
 - .1 PCC – point of common coupling,

- .2 LVPCB – low voltage power circuit breaker,
- .3 MRM - Maintenance Reduction Mod
- .4 High Voltage System – electrical distribution system with nominal voltages above 1000V,
- .5 Low Voltage System – electrical distribution system with nominal voltages below or equal to 1000V.

1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 OESC Ontario Electrical Safety Code,
 - .2 CSA Z32 Electrical safety and essential electrical systems in health care facilities,
 - .3 CSA Z462 Standard for electrical safety in the workplace,
 - .4 CSA Z460 Control of hazardous energy – lockout and other methods,
 - .5 IEEE Standard 242 Recommended practice for protection and coordination of industrial and commercial power systems.
 - .6 IEEE Standard 1584 Guide for performing arc-flash hazard calculations,

1.5 Qualified Tradesperson

- .1 Work to be performed by a qualified, licensed, and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.

1.6 Submittals

- .1 Distinct report submissions must include:
 - .1 Preliminary Short Circuit and Coordination Study Report
 - (a) submission and approval of this report is a prerequisite for related equipment's shop drawing approval and release for production,
 - (b) submission of this report is required for review by the Consultant within 4 weeks of Contract award.
 - .2 Short Circuit and Coordination Study Report (review)
 - (a) proposed coordination settings for review,
 - (b) submission schedule must align with Contract commissioning and testing requirements.
 - .3 Preliminary Arc Flash Study Report,
 - (a) preliminary arc flash study report, intended to inform approval of coordination settings,
 - (b) submitted with Short Circuit and Coordination Study Report (review).
 - .4 Arc Flash Study Report (review)
 - (a) updated arc flash report with approved coordination settings,
 - (b) report must include all proposed labels,
 - (c) submission schedule must align with Contract commissioning and testing requirements.
 - .5 Short Circuit and Coordination Study Report (final)
 - .6 Arc Flash Study Report (final)
 - (a) report must include documentation of all labels, as installed.
- .2 Each report, including final versions, must be submitted as a formal shop drawing for review and approval.
- .3 Preliminary and review study submissions are permitted in PDF only.

- .4 Final report submissions to be issued in PDF and hardcopy upon shop drawing approval.
- .5 Single line and schematic diagrams included with reports must adhere to the following;
 - .1 acceptable paper sizes: ANSI A, ANSI B, or a standard US architectural size,
 - .2 project specific title blocks indicating project, drawing title, date, and revision number,
 - .3 include reference to a legend defining all symbols,
 - .4 text height must be scaled no less than 2mm.
- .6 In addition to system study reports, the Division 26 contractor is responsible for preparing and submitting formal specific methods of procedure for review and approval a minimum of two weeks prior to any activities that may impact facility operation.
- .7 An unlocked final soft copy of the master file from the systems studies analysis software must be submitted to the Owner upon final approval of all report submissions.

1.7 Approved Independent Testing Organizations

- .1 To ensure the requirement for independence, the systems studies contractor must be retained directly by the Division 26 contractor. The systems studies contractor must not be retained by an equipment manufacturer or their distributor as part of an equipment package.

Standard of Acceptance

- AC Tesla
- Brosz and Associates
- Enkompass
- G.T. Woods
- Haronitis & Associates Ltd.
- KRKA

2 PRODUCTS

2.1 Preliminary Short Circuit and Coordination Study

- .1 Immediately upon award of Contract liaison with the Supply Authority to obtain;
 - .1 incident utility fault energy at PCC,
 - .2 information pertaining to relays and other protective devices installed on Supply Authority system and substations which affect the co-ordination of the new equipment provided under this contract.
- .2 Immediately upon award of Contract liaison with the equipment manufacturers to obtain;
 - .1 manufacturer specific information pertaining to protection and coordination of the system.
- .3 Immediately upon award of Contract review existing and new building single line diagrams. Verify all relevant site conditions and identify all proposed equipment locations and routing as necessary to complete the preliminary report.
- .4 Identify worst case short circuit energy levels at each new bus/device to identify minimum equipment/bus device interruption ratings and equipment withstand ratings.
- .5 For high voltage systems:
 - .1 prepare preliminary high voltage phase and ground curves,
 - .2 recommend fuse and/or sensor sizes for protection devices,
 - .3 identify minimum short circuit interruption and withstand ratings.
- .6 For low voltage systems:

- .1 confirm long-time overcurrent settings,
- .2 where applicable determine CT (sensor) sizes. If multitap CTs are available for LVPCBs, select CTs where the long-time setting is middle of the range.
- .3 identify minimum short circuit interruption and withstand ratings.
- .7 The recommended minimum short circuit interruption and withstand ratings, fuse ratings, relays, sensors and CTs should be documented in a report titled "Preliminary Short Circuit and Coordination Study Report".
- .8 Attend all necessary meetings as required by the Supply Authority, Consultant and manufacturer to resolve co-ordination details.

2.2 Short Circuit and Coordination Study

- .1 Prepare a complete building model using approved software to facilitate short circuit and coordination and preliminary arc flash studies.
- .2 All information included in the model should be site verified and include the entire building's electrical distribution down to 120V/208V branch panel buses. Note: information related, but not limited to, motor, generator, photo-voltaic, DC system (telecom, UPS) ratings and contributions should be included in the analysis, and associated rating and settings site verified.
- .3 When relevant equipment rating information is not verifiable on-site or in existing documentation the ITO is responsible for coordinating directly with equipment manufacturers for both new and existing equipment. Any assumptions must be explicitly identified and highlighted in the submitted reports.
- .4 Short Circuit Study
 - .1 Prepare a complete building short circuit study using software.
 - .2 Short circuit study shall include segregated single line diagrams with appropriate information so that the Consultant's single line diagrams can be updated with calculated symmetrical fault current data and submitted to the Electrical Safety Authority for review and approval.
 - .3 Short-circuit study should identify, at a minimum, the following for all distribution equipment/buses;
 - (a) Device/Bus ID,
 - (b) Voltage,
 - (c) Bus/Device Interruption and Withstand Ratings,
 - (d) Peak Three Phase Symmetrical and Asymmetrical Fault Levels,
 - (e) Peak Single Phase Symmetrical and Asymmetrical Fault Levels,
 - (f) X/R ratio.
 - .4 Scrutinize short circuit currents and fault levels under diverse operating scenarios, including but not limited to:
 - (a) various source configurations, where multiple sources are connected to the system,
 - (b) equipment and distribution maintenance bypass and tie configurations,
 - (c) peak non-generative equipment contributions.
 - .5 Any assumptions on operating configurations must be identified and confirmed prior to award of Contract.
 - .6 Verify onsite and with Div 20 contractor if motor starters have VFDs.
- .5 Coordination Study
 - .1 Prepare a detailed co-ordination study of the complete building electrical system.
 - .2 The co-ordination study shall include the preparation of time-current characteristic curves of the protective devices in the system. Curves represented graphically with log-log axes; .01 to 10,000

seconds on the 'time' co-ordinate (vertical axis) and 5 ranges on the 'current' co-ordinate (horizontal axis). The system shall be sub-divided into portions so that the curve for each device clearly shows its relationship to associated upstream and downstream devices. Each set of curves on a single graph, for the portion of the system involved, shall include the following:

- (a) appropriate section of single line diagram,
 - (b) electrical equipment and conductor damage curves,
 - (c) transformer inrush, damage, and overload curves,
 - (d) phase and ground time current curves characteristics on different graphs,
 - (e) three phase and ground fault levels when operating with normal utility power,
 - (f) generator decrement curves for the main emergency switchboard,
 - (g) protective devices identified with a unique label matching the Contract Drawings or alternatively, matching the single line diagram prepared for the study. Ambiguous names will not be accepted.
- .3 Separate sets of time-current curves should be provided for each protective device feeding a specific bus. For example, double ended switchboards or switchboard/panelboards fed through a transfer-switch will have multiple time-current curve plots.
- .4 Separate instances of a specific device's protection settings on multiple time-current curves must be consistent with each other.
- .5 The coordination study must be comprehensive and include time-current curves identifying all adjustable device settings for the entire building and the largest associated downstream non-adjustable device (e.g. molded-case breaker or fuse). The coordination study should also include:
- (a) Protective devices on the Supply Authority system,
 - (b) Distribution equipment at all voltage levels, their largest protective device, and all upstream devices feeding the equipment.
 - (c) Protection equipment on motors 75kW (100 HP) and larger.
- .6 The coordination study must propose optimal device settings per the codes and standards referenced herein.
- .7 All proposed protective device settings that deviate from the recommended practice of the codes and standards referenced herein must be explicitly identified and highlighted in the associated report submission labelled "Short Circuit and Coordination Study Report".

2.3 Arc Flash Study

- .1 Prepare a detailed arc-flash study of the complete building electrical system using an incident energy analysis method.
- .2 The study shall identify potential arc flash hazard sites, calculate incident energy levels (cal/cm²) during arc-flash events, calculate arc flash boundaries and specify PPE requirements per the relevant standards referenced herein. Calculations shall take into consideration the characteristics of the overcurrent protective devices and their fault clearing time, including its condition of maintenance.
- .3 The preliminary study should propose mitigative strategies for review and consider any specified arc reduction systems.
- .4 Incident energy levels and PPE requirements should be calculated and reported with and without the activation of any arc reduction systems.
- .5 The report should include detailed arc flash and shock hazard information for each electrical enclosure and propose an associated detailed label identifying:
- .1 Arc Flash Protection
 - Working Distance: xx mm (yy in)
 - Incident Energy: xx cal/cm²
 - Arc Flash Boundary: xx m (yy in)

.2 Shock Protection

Nominal Voltage: xx V
Limited Approach Boundary: xx m (yy in)
Restricted Approach Boundary: xx mm (yy in)

.3 Recommend Personal Protective Equipment

When an employee is working within the Arc Flash Boundary, they shall wear protective clothing and other personal protective equipment (PPE).

Refer to CSA Z462 for PPE Requirements
Glove Class: xx

.4 Equipment Name: xxx

.5 Analysis Details

Report Name/Version: xxx.pdf
Report Date: yyyy/mm/dd
Arc Flash Analysis by: Company Name
Analysis Standard: IEEE 1584-xxxx

- .6 A schedule of Arc flash labels with this information shall be submitted for application by the manufacturer and/or contractor to all electrical enclosures in accordance with the study.

2.4 Model Data

- .1 An output of the model data shall be provided in pdf as part of the shop drawing process in order to review the correctness of breaker types, cable types, cable lengths, and any other inputs into the system studies.

3 EXECUTION

3.1 Existing Electrical Site Data

- .1 Division 26 contractor is ultimately responsible to perform and facilitate site investigations of all existing electrical distribution equipment as required for systems studies to verify:
- .1 equipment ratings,
 - .2 existing protective device specifications and settings,
 - .3 conductor characteristics including length.

3.2 Equipment Manufacturer Coordination

- .1 Systems Studies Contractor to coordinate with equipment manufacturers to obtain specific information pertaining to protection and coordination of the system prior to their release for production.

3.3 Commissioning Program

- .1 Systems Studies contractor and Div 26 contractor to comply with the project commissioning requirements in accordance with specification section 26 08 15.
- .2 The verification and testing requirements specified in this section may be concurrent with, or conducted separately from, the commissioning program, as coordinated with the Contractor and the commissioning agent.

3.4 Testing, Adjusting and Verification of Protective Devices

Issued For

- .1 Provide necessary test equipment, material, labor, and miscellaneous services during the testing, adjusting, verification and commissioning procedure.
- .2 All modified settings are to be verified by secondary injection.
- .3 Systems studies contractor to set all devices noted in the coordination study and apply all labels.

3.5 Methods of Procedure

- .1 Division 26 contractor to coordinate with systems studies contractor, Owner, and Consultant and prepare specific methods of procedure for any site investigations, system adjustments, and related testing plans that may impact site operation.
- .2 Specific methods of procedure must be submitted a minimum of two (2) weeks prior to the activity for review and approval by Owner and/or Consultant.

End of Section

TESTING OF INTEGRATED FIRE PROTECTION AND LIFE SAFETY SYSTEMS 26 08 11

1 GENERAL

1.1 Scope

- .1 Provide testing of integrated fire protection and life safety systems and related equipment provided under Divisions 26 to 28 with those provided under other Divisions of the Work, in accordance with specification section 01 75 11.
- .2 This specification is limited to testing of the interconnections between life safety and/or fire protection systems. Refer to separate technical specification sections for the individual testing and commissioning requirements for those systems.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 Section 01 75 11 Testing of Integrated Fire Protection and Life Safety Systems

1.3 Definitions and Abbreviations

- .1 Refer to section 01 75 11.

1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 CAN/ULC-S1001 Integrated Systems Testing of Fire Protection and Life Safety Systems

1.5 Qualified Tradesperson

- .1 Refer to section 01 75 11.

2 PRODUCTS

- .1 Not used.

3 EXECUTION

3.1 General Requirements

- .1 Conduct complete and thorough testing and documentation of the systems interface and integration between various FPLS systems provided under Divisions 26 to 28 and those provided under other Divisions of the Work.
- .2 Include all labor and material as required to participate in and implement the integrated FPLS testing process for equipment and systems provided under Division 26 to 28.

3.2 Integrated Test Plan and Procedures - Development

- .1 Participate in the development of the integrated FPLS test plan and procedures in accordance with the requirements of specification section 01 75 11.
- .2 Supply manufacturer's operating and testing instructions to the ITC prior to the development of the integration FPLS test plan.

3.3 Integration Test Plan – Implementation

- .1 Complete related FPLS system testing in accordance with the applicable technical specification sections of Divisions 26 to 28, prior to implementation of integrated FPLS testing. Where testing of such systems inherently test the FPLS system interconnection(s), such testing is not required to be duplicated for the integrated FPLS testing provided the results of the integration test are recorded in accordance with the requirements of the integrated FPLS test plan.
- .2 Prior to implementing any integrated FPLS test,
 - .1 provide written confirmation from each trade contractor under Divisions 26 to 28 of the Work, that their respective FPLS related equipment or systems, or parts thereof, have been installed in accordance with the design and are ready for integrated FPLS testing,
 - .2 where applicable, provide test verification reports from the organization that verified the installation of any FPLS system as required by referenced codes or standards, such as NFPA or ULC.
 - .3 provide a copy of inspection reports from an authority having jurisdiction governing a FPLS system.
- .3 Coordinate with the ITC and provide all necessary resources to implement the integrated FPLS test plan.

3.4 Final Test Results Report

- .1 The final test report will be prepared by the ITC.

END OF SECTION

ELECTRICAL COMMISSIONING

26 08 15

1 GENERAL

1.1 Scope

- .1 Provide commissioning of electrical systems provided under Division 26.
- .2 Electrical system installation, start-up, testing, preparation of O&M manuals and operator training are the responsibility of the Division 26 Contractors, with the coordination of the commissioning process the responsibility of the General Contractor/ Construction Manager.
- .3 Include all labor and material as required to participate in the commissioning process, as outlined in this section, for equipment installed under Division 26.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 Section 01 91 13 General Commissioning Requirements
 - .2 Section 26 05 73.05 Independent Power Testing
 - .3 Section 26 08 06 Electrical System Studies and Reports
 - .4 Section 26 08 13 Testing of Hospital Wiring
 - .5 and as shown.

1.3 Commissioning Process

- .1 Commissioning Mandate for Electrical Systems : to ensure that all project systems perform interactively and in strict accordance with the design intent and Owner's operational needs as set forth in the Contract Documents.
- .2 Commissioning procedures are in accordance with this Section [and the Owner's Commissioning Plan and Procedures]].
- .3 The Commissioning process develops, coordinates, and documents the following:
 - .1 Equipment start-up
 - .2 Control system calibration
 - .3 Testing
 - .4 Verification and Performance Testing
 - .5 Operation documentation
 - .6 Operator training
- .4 The Commissioning Program is divided into the following parts:
 - .1 Part 1 : Pre-Start and Start-Up testing
 - .2 Part 2 : Installation Verification testing
 - .3 Part 3 : Performance Validation testing
 - .4 Part 4 : Systems Operating Manuals
 - .5 Part 5 : Operator Training

1.4 Work Included

- .1 Commissioning work of Division 16 includes, but is not limited to:
 - .1 Participation in regular construction meetings as well as separate Commissioning Meetings during the construction period associated with the scheduling, coordination, and implementation of the various commissioning activities within the overall construction program.
 - .2 Factory Testing of equipment as described under various equipment specifications
 - .3 Site Testing and start-up of equipment.
 - .4 Detailed acceptance testing as described under various equipment specifications including supplementary testing required by Commissioning Authority
 - .5 Cooperation with the Commissioning Authority in developing and implementation of the commissioning plan.
 - .6 Providing qualified personnel for participation in implementing commissioning test procedures.
 - .7 Providing equipment, materials, and labor as necessary to correct construction and/or equipment deficiencies found during the commissioning process.
 - .8 Providing operation and maintenance manuals, and as-built drawings to the Commissioning Authority for verification in a timely manner.
 - .9 Providing training and demonstrations for the systems specified in this Division prior to turnover to Owner.
- .2 Conduct complete and thorough evaluation and documentation of the operation and performance of all components, systems, and sub-systems, including the following equipment and systems:
 - .1 Power Generation Diesel
 - .2 Dry Type Transformers Primary +1000 V
- .3 Commission equipment supplied by the electrical contractor, as well as equipment which has been pre-tendered, pre-purchased, or pre-ordered by the Owner or their Agent, and the value of which has been assigned to the Electrical Contractor or their sub-trades and is included in the value of the Work. Provide skilled tradespeople to operate various related electrical equipment in support of the commissioning program.
- .4 Commission services to equipment, but not the equipment itself, where the supply of the equipment does not form part of the electrical Work. Provide skilled tradespeople to operate various related electrical equipment in support of the commissioning activities of other trades.
- .5 Provide the following commissioning documentation:
 - .1 recording completed Pre-start and Start-up procedures test results,
 - .2 recording completed Installation Verification and Performance Validation test results,
 - .3 As-built records.
 - .4 Operation and maintenance manuals
- .6 The final commissioning report will be prepared by the Commissioning Consultant.

1.5 Excluded Work

- .1 Unless otherwise specified, equipment which is not supplied by the electrical contractor or their sub-trades, where the value for the supply of equipment is not included as part of the Work, such as:
 - .1 Supplied by Owner (SBO) equipment,
 - .2 Equipment marked Not in Contract (NIC) or Not in Electrical Contract (NIEC).

1.6 Required Information and Commissioning Prerequisites Information:

.1 Provide:

- .1 A complete set of accurate "as built" drawings must be transmitted to commissioning consultant a minimum of one (1) month prior to Substantial Performance.
- .2 A copy of all equipment specifications must be transmitted to commissioning consultant a minimum of one (1) month prior to Substantial Performance.
- .3 All "sequence of operation" narratives must be submitted to the commissioning consultant a minimum of one (1) month prior to Substantial Performance. Include all set points and timing sequences.
- .4 A copy of all Factory Acceptance Test (FAT) reports must be completed, reviewed by the Consultant, and transmitted to commissioning consultant a minimum of one (1) month prior to Substantial Performance.
- .5 A copy of all site startup reports must be transmitted to the commissioning consultant a minimum of five (5) business days prior to Substantial Performance.

1.7 Definitions

- .1 **Major deficiency** – an item which if not corrected renders the equipment or system unsuitable or unsafe for use by the Owner. Major deficiencies must be corrected as a condition for achieving Substantial Performance.
- .2 **Minor deficiency** – an item which does not impact on the operation of the equipment or system and will allow the Owner to use the system safely. Minor deficiencies may be corrected before or after Substantial Performance, but will not prevent certification of Substantial Performance of the Work.

1.8 Commissioning Schedule

- .1 Provide a detailed commissioning schedule for consolidation into the main construction schedule.
- .2 Include:
 - .1 equipment and systems start-up predecessors
 - .2 time periods for pre-start and start up testing, verification and validation testing for each equipment and system.

1.9 Documentation Deliverables

- .1 Identify documents including test documents, binder covers, etc. using equipment ID numbers provided on equipment schedules.
- .2 Scan original signed test reports, including verification and performance test reports, manufacturers service reports, etc. in Adobe Acrobat *.pdf version 8 format. For original document chapters, provide Adobe chapter referencing.
- .3 Submit three (3) copies of each completed and accepted Verification and Functional Performance Test reports, both preliminary and final issues.
- .4 Collate final, accepted and signed test results in separate binders as follows:
 - .1 Electrical Systems
 - .2 Communications Systems
 - .3 Fire Alarm and Security Systems
- .5 Provide three (3) CD-R or DVD-R copies of commissioning documentation.

1.10 Substantial Performance

- .1 Refer to Section 01 91 13 General Commissioning Requirements.

1.11 Test Equipment

- .1 Furnish tools and equipment required during the various stages of pretesting, startup, and commissioning processes.
- .2 Utilities (water, gas, fuel oil, electrical power) are provided by the Owner or as provided in the Contract documents.
- .3 Provide any test equipment and software required for pretesting and start-up, whether specified or not.
- .4 Manufacturer provides test equipment and personnel as required for the startup and testing of their equipment and assists in the commissioning process as needed.
- .5 Manufacturer provides test equipment, demonstrate its use, and assists in the commissioning process as needed.

2 ORGANIZATION

2.1 General

- .1 Complete all phases of work so that the systems can be started, tested, and verified for alarm or status monitoring by the BAS system and fire alarm systems as applicable, and the Commissioning procedures can be undertaken in a timely manner such that only one acceptance test is conducted at any one time. Provide supplementary testing as required to ensure all BAS and fire alarm system monitoring of electrical equipment status points are verified to demonstrate all operating status and alarm conditions.
- .2 Participate and assist in the development of the Commissioning Schedule by the General Contractor, by providing necessary information pertaining to the equipment and installation. Provide commissioning schedule information to be incorporated into the overall Construction Plan schedule.
- .3 Acceptance procedures may begin prior to completion of a system and/or sub-system. Start of acceptance procedures before system completion does not relieve the Contractor from completing those systems in accordance with the commissioning and construction schedule.

2.2 Participants

- .1 Commissioning Team consists of multiple parties with separate responsibilities.
- .2 Owner:
 - .1 establishes acceptance criteria,
 - .2 provides operations staff to receive training, and to witness any or all tests at their discretion,
 - .3 final acceptance of commissioning results.
- .3 Design Consultant:
 - .1 responsible for the construction review activities in accordance with local building code requirements,
 - .2 may participate in development and / or review of commissioning procedures,
 - .3 reviews pre-startup, testing, and commissioning test results,
- .4 Commissioning Authority:
 - .1 develops and/or approves the commissioning plan and procedures,
 - .2 coordinates Owner's commissioning team members who witnesses tests,
 - .3 accepts the commissioning test results on behalf of the Owner.
- .5 Commissioning Consultant:

- .1 develops or assists the Commissioning Authority to develop the commissioning plan and procedures,
- .2 selectively witnesses commissioning tests on an audit basis to confirm compliance by the Contractor to the Commissioning Plan,
- .3 reviews commissioning test results and makes recommendations to the Owner and/or Acceptance Authority for acceptance.
- .4 monitors the progress of the commissioning work and reports to the Owner.
- .6 General Contractor / Construction Manager:
 - .1 coordinates and manages commissioning activities,
 - .2 develops and integrates commissioning activities into the construction schedule,
 - .3 ensures commissioning procedures are completed and documented, and commissioning records including any required attachments are submitted.
- .7 Electrical trades Contractors ("Commissioning Agent") :
 - .1 Provide the services of qualified technician(s) who are familiar with the construction and operation of the system, to start-up and debug equipment and systems within the Division 16 scope of Work. Includes work of Independent Testing Agent subcontractor. Include for labour, materials, and subsistence costs for these same technicians to assist the Commissioning Authority in completing the commissioning program.
 - .2 Provide access to the contract plans, shop drawings, and equipment cut sheets of all installed equipment.
 - .3 Ensure the qualified technician(s) are available and present during commissioning testing to complete the tests, make adjustments and to assist in problem resolutions.
 - .4 Should any equipment or system experience performance problems and/or reconstruction or replacement of components is required, include for additional technician time for subsequent retesting of systems until required system performance is achieved.
 - .5 The Commissioning Authority reserves the right to approve proposed technicians with regard to the technical skill level required for each type of equipment and/or system, and a willingness by the individual(s) to work within the Commissioning Group.
 - .6 provide a foreman electrician familiar with the electrical interlocks, interfaces with emergency power supply, and interfaces with BAS, alarm, and life-safety systems. Provide access to the contract plans, and all as-built schematics of sub-systems, interfaces and interlocks.
- .8 Equipment suppliers ("Commissioning Agent") :
 - .1 provide the services of manufacturers' service personnel to provide assistance with pre-start and initial start-up of the equipment, and to undertake operation of equipment as part of the acceptance and commissioning testing program as required

3 EXECUTION

3.1 Commissioning Meetings

- .1 Participate in periodic commissioning team meetings, and trade commissioning meetings.
- .2 Pre-construction:
 - .1 participate in a pre-construction meeting of commissioning team members, to familiarize parties with the commissioning process, and to ensure that the responsibilities of each party are clearly understood.
- .3 Construction and Post-Construction:
 - .1 participate in commissioning meetings as scheduled by the General Contractor.

- .2 participate in trade commissioning meetings as required, in addition to the regular commissioning team meetings,
- .3 identify to the commissioning group problems relating to the commissioning schedule, identification of start-up issues, etc, and participate in the resolution of these problems.

3.2 Commissioning Procedures

- .1 The Owner's designated Commissioning Authority provides the commissioning procedures (checklists, etc) for use by the contractor.
- .2 Each commissioning procedure tests the equipment and systems, and consists of the following elements:
 - .1 Document sign-off
 - .2 Pre-start and Initial test
 - .3 Installation Verification - Equipment
 - .4 Installation Verification - Systems
 - .5 Performance Validation
 - .6 Appendices.
- .3 Document Sign-Off:
 - .1 each completed procedure is signed off by the following parties:
 - (a) Contractor, for testing,
 - (b) Commissioning Consultant, for review and witnessing,
 - (c) Owner, for test acceptance.
- .4 Pre-Start and Initial Test:
 - .1 Checklists included: confirmation of authorities inspections, pre-start safety checks (where applicable), system cleaning and pressure testing, and confirmation of availability of supporting systems.
- .5 Installation Verification - Equipment
 - .1 Checklists to verify the installation of equipment, including: design specification requirements, drawing requirements, manufacturer installation requirements, and other experience-related items.
 - .2 Use of pre-printed manufacturer installation and start-up checklists are permitted and encouraged; however, the commissioning procedure checklists may contain supplemental items.
- .6 Installation Verification - System:
 - .1 Checklists to verify the installation of the system associated with the equipment.
- .7 Performance Validation:
 - .1 Specific test procedures and record documentation requirements for performance measurements of the various systems.
- .8 Appendices:
 - .1 Collate test reports from authorities having jurisdiction, manufacturer start-up and test reports, balancing reports, etc.

3.3 Commissioning test methodology

- .1 Step 1 : Notify the Commissioning Consultant in accordance with an agreed schedule and notification period when testing will begin on each procedure type. The Commissioning Consultant will witness

- the testing on an audit basis, including the first instance, the last instance, and at random during other times.
- .2 Step 2 : complete the commissioning procedures including recording results, and sign-off and date separately the completion of Part "A" Verification, and Part "B" Validation. Any deficiencies discovered during this testing are to be corrected prior to sign-off of the test.
 - .3 Step 3 : on completion of systems which do not require witness demonstration, finalize the report and submit to the Commissioning Consultant and the Consultant for review.
 - .4 Step 4 : on completion of systems which have been witnessed by the Commissioning Consultant, the Commissioning Consultant is to sign-off the completed procedure document as being witnessed.

3.4 Commissioning implementation

- .1 Conduct operating tests and checks to verify that all components, equipment, systems, and interfaces between systems, operate in accordance with contract documents.
- .2 Demonstrate and verify operating modes, interlocks, specified control sequences, specific responses to abnormal or emergency conditions, and verification of the proper response to the Building Automation System, security system, and fire alarm system as applicable.
- .3 Roles and Responsibilities:

Organized by:	General Contractor
Test sheets provided by:	Commissioning Authority
Testing Conducted by:	Div 16 Contractors Equipment Suppliers Technical Personnel as appropriate Independent Testing Agent as specified
Testing recorded by:	Div 16 Contractors Equipment Suppliers Technical Personnel as appropriate Independent Testing Agent as specified Commissioning Authority
Tests witnessed by:	Commissioning Consultant Owner (selected tests)
Reports reviewed by:	General Contractor Commissioning Consultant Design Consultant Owner / Commissioning Authority
Reports Accepted by:	Owner

3.5 Operating checks

- .1 The Commissioning Consultant witnesses selected equipment and system tests on an audit basis.
- .2 Set the system equipment into operating mode to be tested including but not limited to:
 - .1 Normal start up, operation, and shut-down
 - .2 Normal auto position
 - .3 Normal manual position
 - .4 Unoccupied cycle
 - .5 Emergency power operation, including transition states.

- .6 Status and Alarm conditions
- .3 Inspect and verify the position of each device and interlock identified on the checklist.
- .4 Repeat the above tests for each operating mode that applies to the system being tested.
- .5 For failed test items, provide appropriate comments to the checklist data sheet and classify whether it is a "Major" or "Minor" deficiency.
 - .1 The Consultant retains the right to make the final decision regarding classifications of deficiencies.
- .6 Test failure is defined as:
 - .1 Refer to relevant specification sections.
- .7 Acceptance
 - .1 The final reports will be reviewed by the Commissioning Consultant and the Consultant, to determine if verification is complete and the operating systems are functioning in accordance with the contract documents.
 - .2 The Commissioning Consultant, in conjunction with the Consultant, reviews and makes final classification of all noted deficiencies. Correct deficiencies classified as "Major" before acceptance of the Verification stage.
 - .3 The Owner will make the final acceptance of test results.

3.6 Performance Validation Testing

- .1 Conduct performance tests and checks to validate that equipment and system components are providing the required performance (capacity) for each equipment and system.
- .2 Special testing requirements:
 - .1 Conduct acoustic measurement tests outside the building when generators are running, in accordance with local noise by-law procedures.
 - .2 Conduct acoustic measurement tests inside of generator room when generators are running.

3.7 Problem Resolution

- .1 In the event that additional work is required to either correct systems, misapplied or improperly installed equipment, and/or deficient performance under varying load conditions, assist the Owner and Commissioning Consultant in developing an acceptable resolution to the problem, including the resources of equipment suppliers.
- .2 The Owner has final approval over any additional work required to achieve the required level of performance.
- .3 Complete corrective work in a timely fashion to permit the completion of the commissioning process.

3.8 Acceptance

- .1 Any identified deficiencies will be reviewed by the Consultant in conjunction with the General Contractor/Construction Manager to determine if correction of the deficiency is as a result of a defect in the equipment or installation.
- .2 If it is determined the performance deficiency is as a result of a defect in the equipment or its installation, rectify the deficiency and repeat the performance test until the required performance levels are achieved.
- .3 If it is determined the equipment or system has been constructed in accordance with the contract documents, the Owner will decide whether to accept the performance as is, or, direct the installation

contractor to make changes to the system as required to obtain performance levels which meet the design intent, and retest the system.

3.9 Post-Substantial Performance Commissioning

- .1 Provide commissioning after Substantial Performance:
 - .1 Performance testing which is weather or live-load dependent;
 - .2 For out-of-season system performance testing, conduct initial performance tests to demonstrate off-peak load performance. Schedule peak load performance testing over the succeeding nine (9) months to ensure all equipment is tested at peak load prior to the expiry of the warranty period.
 - .3 Infra-red thermal imaging of equipment under peak building live-load conditions,
 - .4 90 day security system testing,
 - .5 Alternatively, provide temporary equipment (load banks, etc) to simulate full load conditions. Submit proposed methodology for review by the Commissioning Authority and Consultant.

3.10 Additional Commissioning

- .1 Additional commissioning activities may be required after completion of system performance testing. Include in the tender cost a reasonable reserve to complete this work, including assistance from manufacturers' service technicians.

3.11 Systems Operating Manuals

- .1 Provide Operating and Maintenance Manuals in accordance with the requirements of section 16010.
- .2 The Systems Operating Manuals (SOM) are in addition to the Operating and Maintenance Manuals (OMM) required under Section 16010.
 - .1 Provided by Commissioning Authority and/or Consultant.

3.12 Training

- .1 Equipment Training:
 - .1 Provide equipment training in accordance with Section 26 05 01 and the relevant equipment specification sections. The manufacturer's representative training will emphasize operating instructions and preventative maintenance.[]
- .2 Systems Training:
 - .1 In addition to the equipment training described above, provide additional training to describe the operational requirements and design intent of each system.
 - .2 Include classroom instruction, delivered by competent instructors. Place emphasis on overall systems diagrams and descriptions, and design criteria and conditions.
 - .3 If required, obtain and pay for the services of the Design Consultant to provide the instructor services and to provide lecture material for inclusion in the training manual.
 - .4 Training topics to include:
 - (a) Types of installed systems
 - (b) Design intent and design criteria
 - (c) Design constraints
 - (d) Different operating modes – occupied, unoccupied, emergency conditions, etc.
 - (e) Seasonal operating modes
 - (f) Energy efficiency
 - (g) System operation

- (h) Automatic controls
 - (i) Service, maintenance, diagnostics and repairs
 - (j) Use of reports and logs
 - (k) Troubleshooting
-
- .5 Structure each session to start with the classroom instruction for the overall system, followed by hands-on instruction for each equipment, with the services of the manufacturers' representative as required. Demonstrate the start-up and shut-down of each system.
 - .6 Organize and schedule each training session to deliver the required instruction in an efficient and effective manner on a schedule agreed upon with the Owner. Allow for two (2) training sessions for each topic, separated by approximately one week each, to allow for shift coverage.
 - .7 Structure each training session based on type of maintenance personnel attending the training session, ie. Plumbers, fitters, general maintenance, controls technicians, etc. Develop the proposed training plan and obtain approval from the Owner before commencing the training.
 - .8 Complete the training as close to Substantial Performance as possible, so that the Owner's operations staff are prepared to operate the system after Substantial Performance is certified.
-
- .3 Training Manuals
 - .1 Provide training material hand-outs for each session.
 - .2 Collect training material and bind into separate binders.]

END OF SECTION

OUTDOOR SUBSTATION 26 11 11

1 GENERAL

1.1 Scope

- .1 Provide outdoor substations as shown, including:
 - .1 fenced enclosure,
 - .2 signage, and
 - .3 accessories.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 26 05 53 Identification for Electrical Systems.
 - .2 26 12 16 Dry Type, Medium-Voltage Transformers.
 - .3 26 32 13 Power Generation Diesel

1.3 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 ASCE Substation Structure Design Guide,
- .2 Product standards:
 - .1 ANSI C29.5 Wet-Process Porcelain Insulators – Low and Medium Voltage Types,
 - .2 ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless,
 - .3 ASTM A90 Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings,
 - .4 ASTM A121 Standard Specification for Metallic-Coated Carbon Steel Barbed Wire,
 - .5 ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process,
 - .6 ASTM A924/A924M Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot Dip Process,
 - .7 CAN/CGSB-138.1 Fabric for Chain Link Fence,
 - .8 CAN/CGSB-138.2 Steel Framework for Chain Link Fence,
 - .9 CAN/CGSB-138.3 Installation of Chain Link Fence,
 - .10 CAN/CGSB-138.4 Gates for Chain Link Fence,
 - .11 CAN/CSA A3000 Cementitious Materials Compendium,
 - .12 CSA-A23.1 Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete,
 - .13 CSA C22.2 No 41 Grounding and Bonding Equipment,
 - .14 CSA-G40.20/CSA-G40.21 General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel,

- | | |
|-----------------|---|
| .15 CSA-S16 | Design of Steel Structures, |
| .16 IEEE C37.42 | IEEE Standard Specifications for High-Voltage (>1000V) Expulsion-Type Distribution-Class Fuses, Fuse and Disconnecting Cutouts, Fuse Disconnecting Switches, and Fuse Links, and Accessories Used |
| with | These Devices, |
| .17 IEEE 693 | IEEE Recommended Practices for Seismic Design of Substations, |
| .18 IEEE 837 | IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding. |

1.4 Qualified Tradesperson

- .1 The detailed design, supply and installation of the Outdoor Substation to be provided by a specialist high voltage electrical contractor.

Standard of Acceptance

- Carleton Electric Limited
- Black & McDonald Ltd.
- BG High Voltage
- K-Line
- MS High Voltage
- PBW High Voltage
- Powerline Plus
- acceptable alternative

1.5 Design Criteria

- .1 Substation to be in accordance with the electrical safety code requirements for a heavy snow area.
- .2 Provide electrical safety authority field evaluation for any components that are not certified to Canadian product standards adopted under the applicable electrical safety code. .

1.6 Submittals

- .1 Shop Drawings:
- .1 Submit detailed dimensioned (construction) drawings, shop drawings, material lists and product data in accordance with Section 26 01 01 Electrical General Requirements.
 - .2 Submit detailed dimensioned (construction) drawings, shop drawings, material lists and product data as required, to the Electrical Safety Authority and to the Supply Authority and obtain approval.
 - .3 Detailed dimensioned (construction) drawings of the substation to include:
 - (a) station fence; indicating fence construction, gates and grounding,
 - (b) warning signs.
 - .4 Nameplates: in accordance with Section 26 05 53.
- .2 Operation and Maintenance Data
- .1 Provide operation and maintenance data for incorporation into operating and maintenance manuals.

2 PRODUCTS

2.1 Cast-in-Place Fence Footings

- .1 Concrete: compressive strength not less than 32 MPa at twenty-eight (28) days.
- .2 Reinforced with steel bars.

2.2 Concrete and Reinforcing

- .1 28 day compressive strength and exposure classifications: not less than 32 MPa, C-1.
- .2 Portland cement: to CAN/CSA-A3000, Type 10.
- .3 Water: to CAN/CSA-A23.1.
- .4 Nominal size of coarse aggregate: to clause 14 of CAN/CSA-A23.1, size not to exceed 20mm.
- .5 Fine aggregate: size not to exceed the limits of Table 2 of CAN/CSA-A23.1.
- .6 Reinforcing bars: to CAN/CSA-G30.18, Grade 400.
- .7 Admixtures: to Clause 6 of CAN/CSA-A23.1.
- .8 Air content: category 1, 5-8% in accordance with Table 10 of CAN/CSA-A23.1.
- .9 Slump: to Table 6 of CAN/CSA-A23.1.
- .10 Cure and protect concrete in accordance with CAN/CSA-A23.1.
- .11 Dowels for pinning concrete to bedrock: not less than 19mm x 300mm ($\frac{3}{4}$ " x 12") deformed steel bar, hot dipped galvanized after fabrication.

2.3 Fence

- .1 Chain-link fence fabric:
 - .1 to CAN/CGSB-138.1,
 - .2 Type 1, Class A, heavy style,
 - .3 mesh: not more than 50 mm,
 - .4 wire diameter; not less than 3.6 mm,
 - .5 height of fabric: not less than 1.8 m (6'), (not including barbed wire),
 - .6 material: steel wire,
 - .7 coating: zinc, hot dipped galvanizing - Grade 2.
- .2 Posts, braces and rails:
 - .1 to CAN/CGSB-138.2,
 - .2 material: steel pipe,
 - .3 coating: hot dipped galvanizing, zinc not less than 550 g/m²,
 - .4 corner, end, and gate posts: not less than 89 mm ($3\frac{1}{2}$ ") nominal external diameter,
 - .5 line posts: not less than 60 mm (2.4") nominal external diameter,
 - .6 rails: not less than 42 mm (1.7") nominal external diameter.
- .3 Tension bars:
 - .1 to ASTM A653,
 - .2 not less than 5 mm x 20 mm ($\frac{1}{4}$ " x $\frac{3}{4}$ "),
 - .3 material: steel,
 - .4 coating: hot dipped galvanizing, zinc not less than 550 g/m².
- .4 Tension bar bands, not less than:
 - .1 3 mm x 20 mm (0.12" x $\frac{3}{4}$ ") hot dipped galvanized steel or,
 - .2 5 mm x 20 mm ($\frac{1}{4}$ " x $\frac{3}{4}$ ") aluminium.
- .5 Tie wire fasteners:

- .1 to CAN/CGSB-138.1, Table 2,
- .2 material: steel wire, single strand,
- .3 coating: zinc, hot dipped galvanizing.
- .6 Bottom tension wire:
 - .1 to CAN/CGSB-138.1, Table 2,
 - .2 material: steel wire, single strand, not less than 5 mm (0.2") diameter,
 - .3 coating: zinc, hot dipped galvanizing.
- .7 Gates:
 - .1 to CAN/CGSB-138.4,
 - .2 electrically welded joints,
 - .3 outside frame: not less than 60 mm (2.4") nominal outside diameter,
 - .4 interior bracing: not less than 34 mm (1.3") nominal outside diameter,
 - .5 material: steel pipe, thick wall,
 - .6 coating: hot dipped galvanizing after welding, zinc not less than 550 g/m²,
 - .7 fence fabric secured to frame with twisted selvage at top,
 - .8 hinges:
 - (a) hot dipped galvanized malleable iron,
 - (b) designed to prevent the gate from being lifted off the hinges when in the closed position,
 - .9 latch:
 - (a) hot dipped galvanized malleable iron,
 - (b) with provision for padlocking,
 - (c) padlocking to be attachable and removable from either side of installed gate,
 - (d) latch to be operable from either side of installed gate.
 - .10 double gates:
 - (a) with center rest,
 - (b) drop bolt to secure the closed position,
 - (c) drop bolt to be fixed in position when the gate is locked or to have provision for padlocking in the closed position,
 - (d) drop bolt to have a support to hold the bolt in the open position.
- .8 Fittings and hardware:
 - .1 to CAN/CGSB-138.2,
 - .2 hot dipped galvanized steel, zinc not less than 550 g/m².
- .9 Post caps:
 - .1 to provide waterproof fit,
 - .2 to fasten securely over posts,
 - .3 to carry top rail,
 - .4 outward projection:
 - (a) approximately 300 mm (12") long, to project from fence at 45° above horizontal,
 - (b) with clips or recesses to hold 3 strands of barbed wire,
 - (c) barbed wire strands to be spaced 100 mm (4") apart.

- .10 Barbed wire:
 - .1 to ASTM A121,
 - .2 not less than 2.5 mm (1/10") diameter galvanized steel wire,
 - .3 4 point barbs on 125 mm (5") spacing.
- .11 Turnbuckles:
 - .1 drop forged.

2.4 Grounding

- .1 Connections for conductor to fence posts:
 - (a) exothermic welded connections:

Standard of Acceptance:

- Thomas & Betts - Furseweld
- Erico -Cadweld
- Burndy - BURNDYWeld

3 EXECUTION

3.1 General

- .1 Co-ordinate connections with supply authority, ESA and Owner.
- .2 Remove debris and level the area for the substation.
- .3 Excavate the entire area within the substation and to a distance of two meters outside the fence enclosure and beyond the swing area of gates, to a depth of 300mm (12").

3.2 Fence

- .1 Correct ground undulations along fence line to obtain smooth uniform gradient between posts.
- .2 Provide clearance between bottom of fence and finished grade of 25 mm (1").
- .3 Erect fence along lines as indicated and in accordance with CAN/CGSB-138.3.
- .4 Excavate post holes to 1500 mm depth x 300 mm diameter (60" depth x 12" diameter).
- .5 Where bedrock is encountered within 600mm (24") of finished grade, drill bedrock not less than 600mm (24") and grout the fence post into the bedrock.
- .6 Where bedrock is encountered deeper than 600mm (24") of finished grade, drill and pin the bedrock using waterproof epoxy to secure the pins.
- .7 Space posts not more than 3 m (10') apart, measured parallel to ground surface.
- .8 Provide:
 - .1 straining posts at sharp changes in grade and where directed by the Consultant,
 - .2 corner posts where change in alignment exceeds 10°,
 - .3 end posts at end of fence and at buildings,
 - .4 gate posts on both sides of gate openings.
- .9 Place forms in post holes, pour concrete then embed posts into concrete to [1000mm (39")][1500 mm (60")] depth.
- .10 Extend concrete 25 mm (1") above finished grade and slope to drain away from posts.

- .11 Brace posts in plumb position and true to alignment and elevation until concrete has set.
- .12 Do not install fence fabric until concrete has cured for at least 7 days.
- .13 Install braces in center of panel and parallel to ground surface:
 - .1 between end posts and nearest line post,
 - .2 between gate posts and nearest line post,
 - .3 on both sides of corner and straining posts.
- .14 Install:
 - .1 overhang tops and caps,
 - .2 top rail between posts.
- .15 Install bottom tension wire, stretch tightly and fasten securely to end, corner, gate and straining posts with turnbuckles and tension bar bands.
- .16 Install fence fabric:
 - .1 with twisted selvage at top,
 - .2 knuckled selvage at bottom,
 - .3 stretch tightly to tension recommended by manufacturer,
 - .4 fasten to end, corner, gate and straining posts with tension bar secured to post with tension bar bands spaced at 300 mm (12") intervals,
 - .5 secure fabric to top rails, line posts and bottom tension wire with tie wires at 300 mm (12") intervals,
 - .6 twist tie wires at least twice.
- .17 Install barbed wire strands, clip securely to lugs of each projection and tighten with turnbuckles.
- .18 Install gates in locations as indicated.
- .19 Level ground between gate posts and set gate bottom approximately 40 mm (1.5") above finished grade.
- .20 Determine position of center gate rest for double gate. Cast gate rest into concrete. Dome concrete above ground level to shed water.
- .21 Install gate stops and latches.

3.3 Fence Bonding

- .1 Bond each post (corner, end, line and gate posts) to the grounding grid with not less than a 2/0 AWG tinned copper tap conductor.
- .2 Bond the following to the grounding grid, with tinned copper tap conductors, not less than 2/0 AWG:
 - .1 bottom tension wires (each unbroken length and at least every 12m),
 - .2 fence fabric(at least two locations for each section and at least every 12m),
 - .3 top rails (at not less than four locations and at least every 12m) and
 - .4 each strand of barbed wire (each unbroken length and at least every 12m).
- .3 Bond each gate frame to the post tap conductor with an extra flexible tinned copper braid, not less than #2/0 AWG.
- .4 Provide a #2/0 AWG tinned copper bonding jumper across each joint of the top rail.

END OF SECTION

DRY-TYPE MEDIUM-VOLTAGE TRANSFORMERS

26 12 16

1 GENERAL

1.1 Scope

- .1 Provide dry-type medium-voltage transformers as shown.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the BAS system is further described in the following the work under this section directly integrates with or refers to the following specification sections:
 - .1 26 05 49.20 Seismic Restraint for Electrical Service
 - .2 26 05 49.23 Seismic Qualification for Electrical Equipment

1.3 Applicable Codes and Standards

- .1 Product standards:
 - .1 CSA C22.2 No. 47 Air-Cooled Transformers (Dry-Type)
 - .2 CSA C9 Dry-Type Transformers
 - .3 CSA C802.2 Test Method and Minimum Efficiency Values for Dry-Type Transformers

1.4 Seismic Qualification

- .1 Seismically qualify (certify) the following equipment specified herein:
 - .1 Transformer assemblies.
- .2 The seismic qualification of the above-listed equipment is to conform to Specification section 26 05 49.23 for the following seismic qualification level and certification method:
 - .1 Functional seismic qualification (Level III): by shake table testing,
- .3 The following equipment specific seismic force parameters are to be used:

C _p	A _r	R _p	h _x /h _n
1.00	1.00	1.25	1.0

1.5 Submittals

- .1 Submit shop drawings and product data for materials specified herein.

1.6 Quality Control

- .1 Manufacturer Production Test and Records:
 - .1 Submit certified copies of reports of manufacturer's production testing for the products specified herein prior to shipping.
- .2 Manufacturer Factory Acceptance Testing ("FAT"):
 - .1 Conduct FAT to be performed in the presence of contractor's representative(s), Consultant and independent testing organization for each tested equipment or system.
 - .2 FAT are in addition to manufacturer's standard production tests.
 - .3 Deficiencies discovered during FAT will be corrected prior to shipping of product.

.4 FAT to include:

- (a) heat run,
- (b) BIL test,
- (c) applied potential,
- (d) induced potential,
- (e) ratio, polarity and phase angle,
- (f) resistance,
- (g) excitation losses,
- (h) iron losses,
- (i) load losses,
- (j) impedance,
- (k) review of efficiency curves from no load to full load, kW & KVAR,
- (l) verification of tap voltage ratios including voltmeter recording at the various tap positions,
- (m) visual inspection of fan controls and fans,
- (n) verification of operation of all alarm and protective devices.

.5 All test results and report data to be factory certified and provided to the Consultant in report format. Correct deficiencies noted during FAT prior to shipment.

2 PRODUCTS

2.1 General

- .1 Transformers shall have voltage and kVA rating indicated.
- .2 Transformer windings and all current carrying parts shall be copper.
- .3 Transformers shall be self-contained, free-standing units suitable for floor mounting.
- .4 Core constructed of high quality non ageing cold rolled grain orientated silicon steel lamination.
- .5 Coil to be disc wound construction designed to minimize eddy losses and provide high short circuit strength
- .6 Primary and secondary windings to utilize a vacuum cast fibreglass reinforced solid epoxy resin dielectric for both the primary and secondary windings] [equal to Square D Power-Cast.
- .7 For all transformers of 500 kVA and above, transformer core shall either be manufactured with insulated through bolts through laminations or be provided with perimeter external clamping arrangement to support the core and provide strength to withstand stresses due to short circuits. Core shall be fully insulated from the frame and enclosure with high strength, high temperature glastic (NEMA GPO-3 or better) of minimum 3mm (1/8") thickness to minimize the possibility of a magnetic short circuit. Ground core in one location only.
- .8 Transformers shall have provisions for incoming and outgoing conductor entry shown on Drawings.
- .9 Front accessible connections, unless indicated otherwise.
- .10 Transformers shall be equipped with grounding provision specified in Table 3 of CSA Standard C9.
- .11 Transformers to have 4-2½% full capacity primary taps, two above and two below nominal voltage.
- .12 Three phase transformers shall have delta connected primary and WYE secondary unless otherwise noted.

Standard of Acceptance

- Square D.
- Hammond Manufacturing Co. Ltd.
- STI Power
- Delta
- ABB

2.2 Ratings

- .1 KVA capacity indicated to be based on Class 220 degree C insulation, 150 degree C rise.
- .2 Transformers shall be type ANN/ANF.
- .3 Efficiency to meet or exceed CSA C802.2.
- .4 Transformer impedance shall not exceed 6%.
- .5 Transformer full load voltage regulation not more than 5% at 80% power factor
- .6 Transformer noise level to be as per Table 8 of CSA Standard.
- .7 Transformers rated 300 kVA and larger to have a noise level 3 dB below that shown on Table 8 of CSA Standard C9.
- .8 Transformer BIL as follows:
 - .1 5 kV Class: 60 kV BIL

2.3 Surge Arrestors

- .1 Three 2.55kV Ohio Brass Dynavar MCOV porcelain station intermediate class surge arrestors shall be connected to the primary terminals with a 4 hole NEMA pad.
- .2 Provide 4/0 AWG copper ground jumper to ground bus. Keep jumper length to a minimum.

2.4 Monitoring and Alarms

- .1 Transformers rated 500 kVA and larger shall be equipped with an external dial type thermometer, indicating average coil temperature, with 2 stage alarm contacts. Contacts shall be wired to a terminal block in a suitable enclosure mounted on transformer.

2.5 Control Cabinet

- .1 A weatherproof control cabinet with hinged, gasketed doors to be supplied on the front of the transformer enclosure at a height readily accessible to an operator standing at ground level.
- .2 Control cabinet to house the following equipment:
 - .1 Phoenix contact terminal blocks UK 2.5 with all accessories for termination of wiring from alarm leads (#12 AWG); UK 5 series for current transformer leads (#10 AWG),
 - .2 combination disconnect switch and magnetic starters and other control equipment necessary for control of forced air cooling fans resilient mounted for protection against vibration. A selector switch to permit manual or automatic operation of fans and to be located in the control cabinet;
 - (a) [power supply for fans is to be directly from the secondary windings of the transformer, via an dead front HRC fused circuit. Wire leads from transformer winding to dead front HRC fuse block shall be as short as feasible, and comprise minimum 2500 V rated 200 degree C high temperature wiring,]
 - .3 heaters of sufficient capacity to prevent harmful moisture condensation, supplied with thermostat and humidistat connected in parallel,
 - .4 heaters to operate from a single phase, 120 volt, 60 Hz, from external Owner's power supply. Control cabinet to have removable bottom plate of sufficient size for entrance of conduits. All alarm

devices to have electrically separate, normally open contacts suitable for 125 V DC brought out to a terminal block in the control cabinet for remote annunciations,

- .5 leads from control devices to be wired in rigid steel or flexible watertight conduit to control cabinet terminal blocks. All conduit fittings and connectors to be waterproof,
 - .6 all wiring to be 1000 V identified at both ends with permanent plastic sleeve type wire markers,
 - .7 all wiring and connections to be vibration proof with all terminations and splices made in accessible cabinets and boxes.
- .3 The control cabinet to be used to terminate all leads to circuits external to the transformer.
 - .4 Fan motors to be three phase 600V60 Hz with fans mounted on cooler radiators;
 - .1 power supply shall be self-contained within the transformer and shall not rely on an external power source. Circuit is to be protected with dead front HRC fuses,
 - .2 if different fan voltage will be used, a control transformer shall be provided of sufficient capacity to operate all fans, complete with necessary protective devices,
 - .3 a weatherproof plug disconnect shall be provided in power supply lead to each fan motor,
 - .4 fan starter circuits shall be complete with fan failure alarm contacts to indicate: loss of power; motor failure during forced cooling stage.

2.6 Support and Isolation

- .1 Support transformers core and coil assembly on in-shear vibration isolation mounting. Installed mountings to provide a uniform deflection underweight and weight distribution of supported equipment. Pads to provide a minimum of 6mm static deflection.
- .2 In addition, each transformer is to be set on 2 layers of 9mm ribbed or waffle pattern neoprene pads of not more than 50 durometer. A stainless steel plate of not less than 16 gauge for full size of each pad shall be provided on top of and between pad isolator plates. Pads shall be similar to Peabody Noise Control Model "NP". Installed mountings shall provide a uniform deflection under weight and weight distribution of supported equipment.

2.7 Enclosure and Finish

- .1 Enclosure: Type 4]
- .2 Transformer enclosure to have primary metal treatment and to be finished with 2 coats of [UL50 3R rated] powder coat finishing paint.
- .3 Finish equipment as follows:
 - .1 basic rust-inhibiting metal process
 - .2 Interior in white
 - .3 Exterior shall be finished with paint equal to Sherwin Williams, as follows:
 - .4 [ASA 61 Grey
- .4 Manufacturer to provide quart of touch-up paint or several pressurized spray cans to touch-up small areas marred during installation.

2.8 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 01 - Electrical General Requirements.
- .2 Label size: 7. Submit nameplate wording.

3 EXECUTION

3.1 Installation

- .1 Provide dry type transformers as shown and as specified.
- .2 Provide a {100mm} {4"} reinforced concrete pad with bevelled edges for all floor mounted transformers. Seal with paint or concrete sealer to prevent concrete dust from entering equipment. Pads to be provided by others.
- .3 Position transformers to provide:
 - .1 adequate clearance for ventilation,
 - .2 adequate clearance to access connections,
 - .3 adequate clearance to access taps.
- .4 Install transformers in level upright position.
- .5 Provide suitable mounting hardware complete with vibration isolation pads.
- .6 Provide wiring from alarm contacts to BAS complete with pilot light, buzzer and silencing switch
- .7 Remove shipping supports only after transformer is installed and just before putting into service.
- .8 Loosen isolation pad bolts until no compression is visible.
- .9 Make primary and secondary connections in accordance with wiring diagram.
- .10 Ground transformer casing with 3/0 AWG green insulated copper grounding conductor installed in conduit to the grounding system.
- .11 Connect transformer secondary wye point to the electrical grounding system with minimum 3/0 AWG green insulated copper installed in conduit.
- .12 Energize transformers after installation is complete.
- .13 Adjust transformer taps as required to achieve suitable secondary voltage at loads.
- .14 Touch up small areas marred in transit or during installation with touch up paint. Repaint entire transformer using electrostatic process where large areas of significant damage to factory finish has occurred.
- .15 Provide ground fault detector on transformer secondary side. Provide control wiring between ground fault detector and generator output breaker to trip on ground fault.

END OF SECTION

LOW-VOLTAGE DISTRIBUTION TRANSFORMERS 26 22 13

1 GENERAL

1.1 Scope

- .1 Provide dry type transformers with primary voltages up to 600 V, as shown.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
- .1 26 05 48 Vibration Isolation for Electrical Systems
 - .2 26 05 49.20 Seismic Restraint for Electrical Services
 - .3 26 05 09.23 Seismic Qualification for Electrical Equipment

1.3 Seismic Qualification

- .1 Seismically qualify (certify) the following equipment specified herein:
- .1 <<<item>>>.
- .2 The seismic qualification of the above-listed equipment is to conform to Specification section 26 05 49.23 for the following seismic qualification level and certification method:
- .1 Functional seismic qualification (Level III): by shake table testing,
- .3 The following equipment specific seismic force parameters are to be used:

C_p	A_r	R_p	h_x/h_n
1.00	1.00	1.25	1.0

1.4 Applicable Codes and Standards

- .1 Legislation:
- .1 NRCan 2019 Natural Resources Canada Energy Efficiency Regulations (Dry-Type Transformers)
- .2 Product Standards:
- .1 CAN/CSA C22.2 No. 47 Air-Cooled Transformers (Dry Type),
 - .2 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Non-environmental Considerations,
 - .3 CSA C22.2 No. 94.2 Enclosures for Electrical Equipment, Environmental Considerations,
 - .4 CSA C9 Dry-Type Transformers,
 - .5 CAN/CSA C802.2-18 Test Method and Minimum Efficiency Values for Dry-Type Transformers.
 - .6 UL 1561 Standard for Dry-Type General Purpose and Power Transformers

1.5 Submittals

- .1 Shop drawings:

- .1 Submit shop drawings and product data for each type and rating of transformer.
- .2 Operation and Maintenance Data:
 - .1 Provide operation and maintenance data for incorporation into the Operating and Maintenance Manual.
 - .2 Provide operating and maintenance instructions.

2 PRODUCTS

2.1 General

- .1 Listed to CSA C22.2 No. 47 and UL 1561.
- .2 Transformers constructed in accordance with the referenced standards except where indicated otherwise.
- .3 Self-contained, free-standing units suitable for floor mounting.
- .4 Up to and including 75 kVA to also be suitable for wall mounting.
- .5 Supply wall mounting brackets for transformers shown to be wall mounted.
- .6 Vacuum impregnated epoxy or polyester resin construction.
- .7 Type ANN.
- .8 Efficiency to meet or exceed CSA C802.2-18 and NRCan 2019.
- .9 Windings: copper
- .10 Buswork and all current carrying parts, other than the windings: copper
- .11 Primary and secondary voltages and kVA ratings as indicated on drawings.
- .12 Delta connected primary and 120/208 volt wye or, where indicated, a Zigzag connected secondary.
- .13 Secondary neutral terminals, suitable for the connection of:
 - .1 the neutral conductor
 - .2 #6 AWG copper grounding conductor and
 - .3 bonding conductor.
- .14 Primary-to-secondary phase shift of -30 degrees, except where indicated otherwise.
- .15 Where indicated, primary-to-secondary phase shift of zero degrees.
- .16 Taps: four (4) @ 2.5% full capacity primary taps, two above and two below nominal voltage.
- .17 Provisions for incoming and outgoing conductor entry of sizes shown.
- .18 Front accessible connections, unless indicated otherwise.
- .19 System bonding lugs, connected to the enclosure for:
 - .1 primary feeder bonding conductor,
 - .2 secondary feeder bonding conductor and
 - .3 bonding conductor to the secondary neutral terminal.
- .20 System bonding lugs sized to accommodate cables sizes in accordance with Table 16 of the electrical code.
- .21 Core bonded to the enclosure, either inherently by design or by a bonding strap.

.22 Seismic certified to withstand the ground acceleration criteria and seismic demand requirements for non-structural equipment as specified in the Building Code for the geographic location of the installation.

.23 Labelled to warn of an arc flash potential in accordance with the electrical code.

Standard of Acceptance

- ABB
- Atlas Transformer Inc.
- Bemag
- Delta Transformers Inc.
- Hammond Power Solutions Inc.
- STI Power
- Rex Power Magnetics

2.2 Ratings

.1 kVA capacity based on Class 220] degree C insulation, with 150degree C rise.

.2 Impedance:

- .1 per Table 7 of CSA C9, except where indicated otherwise,
- .2 not less than 3% up to and including 225kVA,
- .3 not less than 4% for 226-500kVA,
- .4 not less than 5% for 501kVA and above,
- .5 not to exceed 6%.

.3 Full load voltage regulation at 80% power factor:

- .1 ≤ 45 kVA: ≤3.4%,
- .2 ≤ 225 kVA: ≤3.2%,
- .3 300 kVA: ≤3.3%,
- .4 > 300 kVA, ≤ 1000 kVA: ≤4%.

.4 Noise levels:

- .1 Per Table 8 of CSA C9 for ratings ≤300 kVA, unless noted otherwise.
- .2 3 dB below the values shown in Table 8 of CSA C9 for ratings > 300 kVA.

2.3 Support and Isolation

.1 Support core and coil assemblies on in-shear vibration isolation mounting pads. Pads to:

- .1 provide a uniform deflection underweight and weight distribution of supported equipment,
- .2 consist of 2 layers of 9mm (3/8") ribbed or waffle pattern neoprene pads of not more than 50 durometer,
- .3 include a galvanized steel plate separating and bonded to the layers of elastomer,
- .4 [equal to Kinetics Noise Control Model "NGD", with a static deflection ≥ 4.5mm,]
- .5 include a thru bolt with extra thick extra-large washers, tightened for shipping purposes.

.2 In addition to the vibration isolation mounting pads, provide external vibration isolation mounts in accordance with Specification section 26 05 48 [on each of the following transformers:

- .1 floor and bracket mounted transformers: neoprene floor mounts.

Standard of Acceptance

- Kinetics - fig. RD Series.

.2 suspended transformers: steel spring isolation hangers.

Standard of Acceptance

- Kinetics - fig. SH Series.]]

.3 Vibration isolation mounts to be seismically rated in accordance with Specification section and 26 05 49.

2.4 Enclosure and Finish

.1 Electrical enclosure: to CSA C22.2 No. 94.1 Type 3R]], except where indicated otherwise.

.2 Finish:

- .1 rust-inhibiting metal treatment process,
- .2 powder coat finish to UL50 3R,
- .3 colour: [ANSI #49 or ANSI #61 grey].

.3 Provide 2 pressurized spray cans of matching paint to touch-up small areas marred during installation.

2.5 Equipment Identification

.1 Provide equipment identification in accordance with Section 26 05 53 – Identification for Electrical Systems.

.2 Label size: 7.

.3 In addition, provide a nameplate on the transformer bearing the following:

- .1 markings per electrical code clause 26-262,
- .2 markings per CSA C9, section 6.1,
- .3 "Efficiency per CSA C802.2-18 / NRCAN 2019" or equivalent wording for transformers meeting these efficiency requirements.

.4 Submit nameplate wording.

3 EXECUTION

3.1 Installation

.1 Mount transformers:

- .1 ≤ 75 kVA suspended, on wall brackets or on floor as indicated,
- .2 > 75 kVA on floor.

.2 Provide, under this division, a 100mm (4") reinforced concrete pad with beveled edges for each floor mounted transformer. Seal with paint or concrete sealer to prevent concrete dust from entering equipment.

.3 Anchor the concrete pad to the building structure in accordance with Section 26 05 48 and 26 05 49.

.4 Install transformers in level upright position.

.5 Provide suitable mounting hardware.

.6 Where specified, install the external vibration isolation mounts for both floor mounted (between enclosure and pad) and bracket (wall) mounted transformers (between enclosure and brackets).

- .7 Where specified, install the external spring isolation hangers in the support rods of suspended transformers.
- .8 Install seismically rated vibration isolation mountings in accordance with Section 26 05 48 and 26 05 49.
- .9 Position transformers to provide:
 - .1 adequate clearance for ventilation,
 - .2 adequate clearance to access connections,
 - .3 adequate clearance to access taps.
- .10 Remove shipping supports only after transformer is installed and just before putting into service.
- .11 Loosen isolation pad bolts until no compression is visible.
- .12 Make final primary and secondary connections using flexible steel conduits.
- .13 Make primary and secondary connections in accordance with wiring diagram.
- .14 Provide a #6 AWG green insulated copper ground conductor in rigid PVC conduit from transformer secondary neutral to the building grounding system.
- .15 Connect the bonding conductors from the primary and secondary feeders to the transformer bonding lugs.
- .16 Provide a bonding conductor, sized not less than the secondary feeder bonding conductor, from the transformer bonding lugs to the transformer secondary neutral terminal.
- .17 Provide 4#12 control wiring in EMT from each pair of alarm contacts to the BMS.
- .18 Provide a compatible communications cable in EMT between each temperature monitoring device and the BMS.
- .19 Program the temperature monitoring devices for correct operation.
- .20 Provide nameplates in accordance with Article "Equipment Identification".
- .21 Energize transformers after installation is complete.
- .22 Adjust transformer taps as required to achieve suitable secondary voltage at loads, with the transformer operating under its typical load.
- .23 Touch up small areas marred in transit or during installation with touch up paint.
- .24 Repaint entire enclosure using electrostatic process where significant damage to factory finish has occurred.

END OF SECTION

GROUND FAULT EQUIPMENT PROTECTION 26 26 13

1 GENERAL

1.1 Scope

- .1 Provide ground fault equipment protection as shown.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 26 24 16.13 Power Panels
 - .2 26 28 16.13 Enclosed Circuit Breakers

1.3 Submittals

- .1 Submit shop drawings and product data in accordance with Section 26 05 01 Electrical General Requirements.
- .2 Ground fault protective equipment: product of one manufacturer.

2 PRODUCTS

2.1 Equipment

- .1 Provide ground fault protection on 1200 A, 347/600 V, 4 wire, 3 phase service.
- .2 Ground fault unit to contain:
 - .1 ground sensing relay suitable for operation at 1200 A factory set. Control voltage: 120 V.
 - .2 three-position sensitivity control switch to select value of leakage current at which relay will operate.
 - .3 indicating lamp illuminated when no ground fault exists, extinguished on ground fault or test.
 - .4 switches:
 - (a) SPDT contacts for alarm and trip,
 - (b) mechanical target indication,
 - (c) manually reset,
 - (d) reset button for contacts and target.
- .3 Zero sequence transformer toroidal type with 1200 A to 5 amps range.
- .4 System to operate on time delay of 0 to 1 second adjustable at ground current setting.

2.2 Fabrication

- .1 Install the following components in equipment specified in other Sections and as indicated:
 - .1 zero sequence transformer.
 - .2 ground fault relay.

2.3 Related Equipment

- .1 Shunt trip generator main output breaker.

3 EXECUTION

3.1 Installation

- .1 Do not ground neutral on load side of sensor.
- .2 Install phase conductors including neutral through zero sequence transformer.
- .3 Install ground fault protection system.
- .4 Make connections as indicated and in accordance with manufacturer's recommendations.

3.2 Field Quality Control

- .1 Perform tests in accordance with Section 26 05 01 - Electrical General Requirements.
- .2 Arrange and pay for field testing of ground fault equipment by independent testing agency laboratory, ground fault equipment manufacturer and contractor before commissioning service.
- .3 Submit report of tests to Engineer and certificate that system as installed meets criteria specified.
- .4 Demonstrate simulated ground fault tests.

END OF SECTION

WIRING DEVICES

26 27 26

1 GENERAL

1.1 Scope

- .1 Provide wiring devices as shown.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 26 05 53 Identification for Electrical Systems.

1.3 Applicable Codes and Standards

- .1 Product standards:
 - .1 CSA C22.2 No. 111 Switches.
 - .2 CSA C22.2 No. 42 Receptacles.

1.4 Submittals

- .1 Submit shop drawings for each type and size of device.

2 PRODUCTS

2.1 Nameplates

- .1 Wall mounted:
 - .1 engraved laminated plastic to Section 26 05 53.
 - .2 7 mm (1/4") high letters unless indicated otherwise.
- .2 Receptacle mounted:
 - .1 permanently printed on white polyester background,
 - .2 7 mm (1/4") high letters unless indicated otherwise,
 - .3 UV resistant inks,
 - .4 clear polyester over lamination,
 - .5 pressure sensitive adhesive.
- .3 Colours:
 - .1 normal power: black lettering on white background,
 - .2 emergency power: red lettering on a white background,
 - .3 "NOT FOR PATIENT CARE": white lettering on green background.

2.2 Switches

- .1 Features:
 - .1 20 A, 120 V, general purpose AC type,
 - .2 higher ratings where indicated,
 - .3 listed to CSA 22.2 No. 111.

- .4 fully rated for:
 - (a) tungsten filament lamps,
 - (b) fluorescent lamps,
 - (c) inductive loads,
- .5 HP rated where used in motor circuits, with rating not less than the motor HP,
- .6 industrial/specification grade for toggle switches, specification grade for Decora style switches
- .7 Decora style in finished areas, toggle handle type in unfinished areas
- .8 silent operation,
- .9 terminals rated for No. 10 AWG wire,
- .10 suitable for back and side wiring,
- .11 silver alloy contacts,
- .12 single pole, double pole, three-way, four-way switches as indicated.
- .2 Toggle colours:
 - .1 Normal power: white.
 - .2 Emergency power: clear.
- .3 Decora rocker colour: white.
- .4 Switches of one manufacturer throughout project, unless accepted otherwise.

Standard of Acceptance

- Pass & Seymour (Legrand)
- Hubbell
- Bryant Electric
- Eaton Wiring Devices (Arrow Hart)
- Leviton

- .5 Switches controlling lights on 120 volt power circuits:

Standard of Acceptance

Type	Catalogue Numbers				
	Hubbell (Toggle) / (Decora)	Bryant (Toggle) / (Decora)	P & S (Toggle) / (Decora)	Eaton (Toggle) / (Decora)	Leviton (Toggle) / (Decora)
Single Pole	1221 / DS120	4901 / -	PS20AC1 / 2621	AH1221 / -	1221-2 / 5621-2
Double Pole	1222 / DS220	4902 / -	PS20AC2 / 2622	AH1222 / -	1222-2 / 5622-2
Three-Way	1223 / DS320	4903 / -	PS20AC3 / 2623	AH1223 / -	1223-2 / 5623-2
Four-Way	1224 / DS420	4904 / -	PS20AC4 / 2624	AH1224 / -	1224-2 / 5624-2

- .6 Switches controlling lights on 120 volt emergency power circuits: lighted handle, light to be on when load is off:

Standard of Acceptance

Type	Catalogue Numbers				
	Hubbell	Bryant	P & S	Eaton	Leviton
Single Pole (Toggle) (Decora)	HBL1221IL DS120IL	4901GL -	PS20AC1-SL 2625	AH1221LT -	1221-LH 5631-2
Three-Way (Toggle) (Decora)	HBL223IL DS320IL	4903GB -	PS20AC3-SL 2626	AH1223LT -	1223-LH 5633-2

- .7 Pilot light switches: red pilot light to be on when the load is on:

Standard of Acceptance

Type	Catalogue Numbers				
	Hubbell	Bryant	P & S	Eaton	Leviton
Single Pole (Toggle) (Decora)	HBL1221PL DSL120PL	4901PL-120 -	PS20AC1-PL 2629	AH1221PL -	1221-PL 5628-2

- .8 Weatherproof switches: equal to those above, complete with:

- .1 weatherproof box,
- .2 "While-In-Use" weather protective cover:
 - (a) polycarbonate material,
 - (b) clear lockable cover,
 - (c) attached gasket,
 - (d) stainless steel hardware,
 - (e) [extra duty].

Standard of Acceptance

- Pass & Seymour No. WIUCED10DCL
- Hubbell Taymac No. MM410CCN

2.3 Receptacles

- .1 Listed to CSA C22.2 No. 42.
- .2 [Decora style in finished areas, standard duplex style in unfinished areas.
- .3 Heavy duty industrial/specification grade.
- .4 With the following features:
 - .1 eight back wired entrances, four side wiring screws,
 - .2 suitable for no. 10 AWG for back and side wiring,
 - .3 break-off links for use as split receptacles,
 - .4 triple wipe contacts,
 - .5 riveted or integral ground contacts.
- .5 Colour coded as follows:
 - .1 Normal power: [white][ivory][brown],
 - .2 Emergency power: red.
- .6 One manufacturer throughout the project.

Standard of Acceptance

- Pass & Seymour (Legrand)
- Hubbell
- Bryant Electric
- Eaton Wiring Devices (Arrow Hart)
- Leviton

- .7 Weatherproof: complete with:
- .1 15 ampere, 120 volt receptacle as listed below,
 - .2 weatherproof box,
 - .3 "While-In-Use" weather protective cover:
 - (a) polycarbonate material,
 - (b) clear lockable cover,
 - (c) deep cover,
 - (d) attached gasket,
 - (e) stainless steel hardware,
 - (f) marked "extra duty".

Standard of Acceptance

- Pass & Seymour No. WIUCED10DCL
- Hubbell Taymac No. MM410CCN

- .8 The receptacles listed below represent the most common configurations and are not necessarily used on this project. Refer to drawings for types used.
- .1 Duplex receptacle: 15 ampere, 120 volt, grounded CSA Configuration 5-15R:

Standard of Acceptance

Type	Catalogue Numbers				
	P & S	Hubbell	Bryant	Leviton	Eaton
Non-decora (Hospital grade)	5262	5262	5262	5262	AH5262
	8200	8200	BRY8200	8200	8200
Decora (Hospital grade)	26252	HBL2152	9252	16262	6262
	26262HG	2172	9200	16262-HG	8262

2.4 Cover Plates

- .1 Compatible with wiring device.
- .2 Stainless steel 18-8 chrome metal alloy, Type 302, vertically brushed, 1 mm (1/32") thick cover plates for wiring devices in flush-mounted outlet boxes
- .3 Cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .4 Engraving, where indicated:
 - .1 6 mm (¼") high letters filled with red paint,
 - .2 parallel to finished floor level.
- .5 One manufacturer throughout the project.

Standard of Acceptance

- Pass & Seymour (Legrand)
- Hubbell
- Bryant Electric
- Eaton
- Leviton

2.5 Ground Fault Circuit Interrupters (GFCI's)

- .1 CSA approved Type A.
- .2 Complete with suitable outlet box.
- .3 15A grounded duplex Decora receptacle type 5-15R.
- .4 15A/20A grounded duplex Decora receptacle type 5-20R where indicated.
- .5 Auto-monitoring (self-test), manual test feature and reset switch.
- .6 Units to include current transformer and sensing mechanism.
- .7 GFCI's in patient care areas: hospital grade.
- .8 Unless noted otherwise, unit to trip at 6 mA.
- .9 No power at device face if reversed wired.
- .10 Colour coded as follows:
 - .1 Normal power: [white][ivory],
 - .2 Emergency power: red.
- .11 Where shown in outdoor locations, units to be enclosed in "While-In-Use" weatherproof surface-mounted enclosures. In other locations units to be furnished with stainless steel cover plate.

Standard of Acceptance

Type	Catalogue Numbers				
	P & S	Hubbell	Bryant	Leviton	Eaton
15A:					
Decora	1597	GFR5262SG	GFRST15	7599	SGF15
(Hospital grade)	1597HG	GFR8200SG	GFST82	N7599-H	SGFH15
15/20A:					
Decora	2097	GFR5362SG	GFRST20	7899	SGF20
(Hospital grade)	2097HG	GFR8300SG	GFST83	N7899-H	SGFH20

3 EXECUTION

3.1 Identification

- .1 Label receptacles with circuit identification using a lamacoid label with colour coding for normal, emergency and UPS source with label attached to the receptacle or the wall above the receptacle.
- .2 Label receptacles in patient care areas in accordance with the latest version of CSA standard Z32:
 - .1 lamacoid label secured to the wall above the receptacle,

- .2 engraved with the panel name and circuit number from which the receptacle is fed,
- .3 lettering not less than 6 mm (¼") high,
- .4 normal power: black lettering on white lamacoid,
- .5 emergency power: red lettering on a white lamacoid.
- .3 Provide an additional lamacoid, of matching colour, for receptacles on dedicated circuits, stating: "Dedicated Circuit".
- .4 Identify receptacles, located within a patient care area but not intended for patient care use, with a nameplate stating "NOT FOR PATIENT CARE".
- .5 Label pilot light switches:
 - .1 lamacoid label secured to the wall above the switch,
 - .2 engraved with the name of the load controlled,
 - .3 black lettering on white background.

3.2 Installation

- .1 Switches;
 - .1 Mount switches vertically so that the switch contacts are closed when the toggle is up or, in the case of Decora switches, when the top part of the rocker is depressed.
 - .2 Install switches in gang type outlet box when more than one switch is required in one location.
 - .3 Provide separate boxes where switches are supplied from different power systems (normal and emergency).
 - .4 Mount switches at heights specified in Section 26 05 01 - Electrical Basic Materials & Methods unless indicated otherwise.
 - .5 Verify the door swing and ensure easy access before installing switches.
 - .6 Switches installed adjacent to dimmers: provide switches that match appearance of dimmers.
 - .7 Pilot light switches: run a neutral conductor to the switch.
- .2 Timer Switches;
 - .1 Provide timer switches for heat lamps in therapeutic washrooms, and other locations where indicated.
 - .2 Run a neutral conductor to timer switches.
- .3 Dimmers;
 - .1 Where more than one dimmer is shown in the same location, mount dimmers in individual backboxes.
 - .2 Where remote dimmers are utilized, install associated components in accordance with the manufacturer's recommendations.
- .4 Receptacles;
 - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
 - .2 Provide separate boxes where receptacles are supplied from different power systems (normal and emergency).
 - .3 Mount receptacles at heights specified in Section 26 05 01 - Electrical Basic Materials & Methods unless indicated otherwise.
 - .4 For each type of receptacle 20 ampere or larger, supply and hand to Owner two heavy duty caps.

- .5 Connect receptacle grounding terminal to the outlet box with an insulated green bonding conductor.
- .6 Verify exact position of service fittings to suit furniture layout.
- .7 Do not mount receptacles directly on a column, unless column has been appropriately furred, to avoid breaking fire barrier.
- .8 Where equipment is located on a rooftop, provide receptacle(s) for maintenance purposes:
 - (a) 15/20A weather resistant GFCI receptacle, type 5-20R,
 - (b) weatherproof while-in-use housing,
 - (c) located within 7.5 m of the equipment,
 - (d) mounted at least 750mm above the finished roof,
 - (e) supplied from a dedicated circuit,
 - (f) provide additional receptacles as required so that a receptacle is located within 7.5 m of each item of equipment.
- .5 Cover Plates;
 - .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
 - .2 Install suitable common cover plates where wiring devices are grouped.
 - .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.
- .6 Install explosion proof wiring and devices in hazardous locations of Class, Division and Group as indicated on Drawings.
- .7 Ground fault circuit interrupters;
 - .1 Mount receptacles at height indicated in Section 26 05 01 - Electrical Basic Materials & Methods unless indicated otherwise.
 - .2 Do not connect GFCI receptacles to provide protection to downstream receptacles, unless specifically indicated.
- .8 Outlets in movable partitions;
 - .1 Co-ordinate installation of outlet boxes and conduits with the particular trade involved.

3.3 Testing

- .1 Verify the operation of illuminated handles in switches.
- .2 Verify the operation of lights on pilot light switches.
- .3 Test each receptacle for correct polarity and ground continuity.
- .4 Test the manual trip and reset functions of each GFCI.

END OF SECTION

WIRE AND BOX CONNECTORS 0-1000 V 26 27 28

1 GENERAL

1.1 Scope

- .1 Provide wire and box connectors for wiring 1000 V and less, as shown.

1.2 Applicable Codes and Standards

- .1 Product standards:
 - .1 CSA C22.2 No.65 Wire Connectors.
 - .2 CSA C22.2 No.188 Splicing Wire Connectors.

2 PRODUCTS

2.1 Materials

- .1 Mechanical pressure type wire connectors:
 - .1 for copper conductors: current carrying parts of copper or tin plated aluminum,
 - .2 for aluminum conductors: current carrying parts of aluminum.

Standard of Acceptance

- Burndy
- IlSCO
- Thomas & Betts

- .2 Compression type pressure wire connectors:
 - .1 long barrel
 - .2 tin plated copper for copper conductors
 - .3 aluminum for aluminum conductors

Standard of Acceptance

- Burndy
- IlSCO
- Thomas & Betts

- .3 Twist on wire connectors:
 - .1 for copper wire up to and including #6 AWG,
 - .2 "live" spring construction,
 - .3 corrosion resistant spring,
 - .4 square wire spring construction,
 - .5 polypropylene cap rated for 105°C

Standard of Acceptance

- T&B Murette
- Ideal
- 3M

- .6 For damp, wet, outdoor and submersible locations: filled with silicone gel.
- .4 Fixture type splicing connectors:
 - .1 current carrying parts of copper,
 - .2 sized to fit copper conductors 10 AWG or less,
 - .3 temperature rating of not less than 105°C

Standard of Acceptance

- Burndy
- Hubbell
- Thomas & Betts

3 EXECUTION

3.1 Installation

- .1 Provide connectors in accordance with the manufacturer's recommendation for the size, quantity and type of wires.
- .2 Install connectors in accordance with the manufacturer's recommendations.
- .3 Remove insulation carefully from ends of conductors:
 - .1 where the conductor is damaged, remove the damaged portion and strip the insulation back further as necessary,
 - .2 where the conductor is too short, replace the conductor.
- .4 For aluminum conductors, clean the conductors and immediately coat with electrical joint compound.
- .5 Tighten screws of mechanical pressure type connectors in accordance with the manufacturer's recommendations. Installation to meet secureness tests in accordance with CSA C22.2 No.65.
- .6 Install compression type connectors using the appropriate compression tool and die as recommended by the manufacturer. Make two crimps on each wire. Installation to meet secureness tests in accordance with CSA C22.2 No.65.
- .7 Remove all traces of electrical joint compound after each connection has been made.
- .8 Install fixture type connectors and tighten. Replace insulating cap.

END OF SECTION

DISCONNECT SWITCHES UP TO 1000 V

26 28 16.16

1 GENERAL

1.1 Scope

- .1 Provide enclosed disconnect switches for wiring systems of 1000 V or less, as shown.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 26 28 13 Fuses
 - .2 26 05 49.13 Seismic Restraint for Electrical Service
 - .3 26 05 49.23 Seismic Qualification for Electrical Equipment

1.3 Applicable Codes and Standards

- .1 Product standards:
 - .1 CSA C22.2 No. 4 Enclosed and Dead Front Switches.
 - .2 CSA C22.2 No. 39 Fuseholder Assemblies.

1.4 Submittals

- .1 Submit shop drawings for each type and size of switch.

2 PRODUCTS

2.1 Disconnect Switches

- .1 Listed to CSA C22. 2 No. 4.
- .2 Electrical enclosure: fusible and non-fusible disconnect switch in CSA C22.2 No. 94.1 Type 1 sprinkler proof or Type 3R enclosure, sizes as indicated.
- .3 2 pole or 3 pole as required for single phase or three phase circuits.
- .4 2 pole with solid neutral for three wire circuits with neutral.
- .5 3 pole with solid neutral for four wire circuits with neutral.
- .6 6 pole for two speed motor applications.
- .7 HP rated where used in motor circuits, with rating not less than the largest motor in the circuit.
- .8 Provision for padlocking switch in OFF position.
- .9 Mechanically interlocked door to prevent opening when handle in ON position.
- .10 Fuses: size as indicated, and to conform to Specification section 26 28 13.
- .11 Fuse holders:
 - .1 listed to CSA C22. 2 No. 39.,
 - .2 suitable without adaptors, for type and size of fuse indicated.
- .12 Heavy Duty, quick-make, quick-break action, rated for load breaking operation.
- .13 ON-OFF switch position indication on switch enclosure cover.
- .14 [Compression lugs for switches over [100A][225A][400A]].

- .15 Auxiliary NO/NC contact in switches used for hydraulic elevator motors.
- .16 Rust inhibiting process to enclosures prior to finishing.
- .17 Finish enclosures using manufacturer's standard process, colour to be grey ASA No.49 or 61.

3 EXECUTION

3.1 Installation

- .1 For sprinklerproof and CSA Type 3R enclosures use watertight connectors complete with O rings for conduit connections.
- .2 For switches used for hydraulic elevator motors run 3#12 in conduit from the auxiliary NO/NC contacts in the disconnect to the elevator control cabinet and terminate as per the elevator supplier's instructions.
- .3 Provide fuses in disconnect switches, sizes as shown.

END OF SECTION

POWER GENERATION DIESEL 26 32 13

1 GENERAL

1.1 General Requirements

- .1 Conform to Section 26 01 01, Electrical General Requirements.
- .2 Conform to Section 26 05 01, Electrical Basic Materials and Methods.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 26 05 49.20 Seismic Restraint for Electrical Service
 - .2 26 05 49.23 Seismic Qualification for Electrical Equipment

1.3 Work Included

- .1 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.
- .2 General Schedule of equipment pre-purchased by the owner to be tested by Division 26:
 - .1 1120 kW, 1400 kVA, 4160 volt, 3 phase, 4 wire
 - .2 Generator enclosure
 - .3 Engine generator control panel with monitor alarm and control system.
 - .4 Starting battery and charger.
 - .5 [Control battery and charger.]
 - .6 Generator Control Panel complete with generator output circuit breaker, generator controls, monitoring, alarms and metering.
- .3 Work undertaken by the Contractor under Division 20, but included as part of the overall project requirements include the following:
 - .1 installation of the expansion joint and silencer.
 - .2 supply and installation of balance of exhaust system including support sleeves, rain caps and drains.
 - .3 insulating the entire exhaust system.
 - .4 supply and installation of the fuel system up to the engine [fuel filter assembly].

1.4 References

- .1 Diesel-generator performance and accessories shall conform to latest CAN/CSA Standard C282.

1.5 [Seismic Qualification]

- .1 Seismically qualify (certify) the following equipment specified herein:
 - .1 Power generators.

- .2 Control panels, both generator mounted and free-standing.
- .2 The seismic qualification of the above-listed equipment is to conform to Specification section 26 05 49.23 for the following seismic qualification level and certification method:
 - .1 Functional seismic qualification (Level III) for electrical control equipment: by shake table testing,
 - .2 Functional seismic qualification (Level III) for vibration isolated equipment: by shake table testing.
- .3 The following equipment specific seismic force parameters are to be used:
- .4

Equipment	C _p	A _r	R _p	h _x /h _n
Generators, included generator mounted control panels	1.00	2.50	2.50	1.0
Control Panels - freestanding	1.00	1.00	1.25	1.0

1.6 Source Quality Control

- .1 Test generator set including engine, alternator, control panels, and accessories in presence of Engineer
- .2 Notify Engineer 10 days in advance of date of test.
- .3 Prepare blank forms and check sheet with spaces to record data. At top of first sheet record:
 - .1 Date
 - .2 Generator set serial no.
 - .3 Engine, make, model, serial no.
 - .4 Alternator, make, model, serial no.
 - .5 Voltage regulator, make and model.
 - .6 Rating of generator set, kW, kVA, V, A, r/min, Hz.
- .4 Mark check sheet and record data on forms in duplicate as test proceeds.
- .5 Demonstration of automatic start system
- .6 With 100% site rated full load, operate set for 4 h, taking readings at 30 min intervals, and record following:
 - .1 Time of reading.
 - .2 Running time.
 - .3 Ambient temp in °C.
 - .4 Fuel consumption
 - .5 Lube oil pressure in kPa.
 - .6 Lube oil temp in °C.
 - .7 Engine coolant temp in °C.
 - .8 Exhaust stack temp in °C.
 - .9 Alternator voltage:

- .10 Alternator current:
- .11 Power in kW.
- .12 Frequency in Hz.
- .13 Power Factor.
- .14 Battery charger current in A.
- .15 Battery charger current in A.
- .16 Alternator cooling air outlet temp.
- .7 After completion of 4 h run, demonstrate following features, shut down devices and alarms:
Demonstrate low oil pressure and high engine temperature shutdown devices operation without
subjecting engine to these excesses.
 - .1 Cycle crank test
 - .2 Over cranking.
 - .3 Over speed.
 - .4 High engine temp.
 - .5 Low lube oil pressure.
 - .6 Short circuit.
 - .7 Alternator over voltage.
 - .8 Low battery voltage, or no battery charge.
 - .9 Manual remote emergency stop.
 - .10 High alternator temperature.
 - .11 All other safety features
- .8 Next install continuous strip chart recorders to record frequency and voltage variations during load
switching procedures. Each load change delayed until steady state conditions exist. Switching
increments to include:
 - .1 No load to full load to no load.
 - .2 No load to 75% load to no load.
 - .3 No load to 50% load to no load.
 - .4 25% load to 100% load to 25%.
 - .5 50% load to 100% load to 50%.
- .9 Demonstrate
 - .1 Automatic starting of set and automatic transfer of load on failure of normal power.
 - .2 Operation of manual control switch.
 - .3 That battery charger reverts to high rate charge after cranking.
- .10 .

1.7 Temporary and Trial Usage

- .1 Temporary and trial usage by Owner of equipment or any other work or materials supplied before
final completion and written acceptance shall not be construed as evidence of acceptance by
Engineer.

- .2 Engineer shall have the privilege of such temporary and trial usage, as soon as supplier shall claim that said work is completed and in accordance with specifications, for such reasonable length of time as is deemed to be sufficient for making a complete and thorough test of same.
- .3 Claims for damage shall not be made by supplier for the injury to or breaking of any parts of such work which may be used, whether caused by weakness or inaccuracy of structural parts or by defective materials or workmanship of any kind whatsoever.

1.8 Final Acceptance

- .1 Request for acceptance shall be submitted in writing. Written request shall not be submitted until:
 - .1 Deficiencies noted during job inspections have been completed.
 - .2 Systems have been pre-commissioned and tested and are ready for on-line operation.
 - .3 Completed data books have been submitted and approved.
 - .4 Diagrams have been submitted and approved, and equipment identification is completed.
 - .5 The cleaning up is finished in every respect.
 - .6 Spare parts and replacement parts specified have been provided and receipt of same acknowledged.
 - .7 Record drawings are completed and approved.
 - .8 Owner's operating personnel have been instructed in operation of systems.
 - .9 Operating manual shall include fully detailed software program, documentation including descriptive sequence of operations and referenced to accompanying ladder logic diagrams. This material shall be used in training Owner's staff in the system operation, maintenance and diagnostics. Include the cost of the services of a technical representative for instructing the commissioning team in the system operation.

1.9 Operation of Emergency Power System

- .1 If any one or all phases of normal supply to one or all of automatic transfer switches should fail, a contact in the transfer switch shall close and initiate automatic starting of the Diesel-generator unit.
- .2 Certain lighting loads, motors and pumps, supplied through transfer switches, shall be automatically reconnected to emergency power supply by operation of the automatic transfer switches after the generator reaches rated voltage and speed, so that these items will continue to operate as required.
- .3 Automatic transfer switches will transfer their loads back to normal source when normal power service is restored, and elevators will restart and return to normal operation.
- .4 Diesel generator shall continue to operate until shut down automatically after an adjustable cool down period of up to 30 minutes.

2 (NOT USED)

2.1 Test Procedure

- .1 Contractor shall conduct performance and full load tests, to be witnessed by Engineer upon completion of assembly to prove that unit will start automatically, pick up load and operate as required, in accordance with the article "Source Quality Control" at the beginning of this specification.

- .2 Notification of factory test shall be given a minimum of 10 working days in advance. Dismantling and shipment from factory test bay shall not occur until deficiencies have been corrected and the system retested to the satisfaction of the Engineer and certified as being acceptable for shipment.
- .3 The test shall include:
 - .1 Demonstration of automatic start system
 - .2 A 4-hour full load test, utilizing an adjustable load at unity power factor
 - .3 Demonstration of safety features
 - .4 Demonstration of cycle crank tests.
 - .5 Block loading tests from cold start: 0%-25%, 0%-50%, 50%-100% and 0%-100%
- .4 During test, the following parameters shall be recorded at 30 minute intervals:
 - .1 Speed and frequency at steady state and step load changes
 - .2 Phase volts and amps at steady state and step load changes
 - .3 Load
 - .4 Coolant temperature
 - .5 Lubricating oil pressure
 - .6 Exhaust temperature
- .5 Fuel consumption for duration of test shall be stated.
- .6 Provide a photograph of an oscilloscope trace of the sine wave generator output 60 cycle.

3 EXECUTION

3.1 Installation General

- .1 Provide a complete Diesel-generator set and emergency power system.
- .2 Take delivery of the diesel generator and related equipment. Provide necessary cranes and hoisting equipment and labour to unload equipment from transport and place in designated location.
- .3 Prior to project completion, revise all wiring diagrams submitted as Shop Drawings to "As-Built" condition, prepare photo reductions of same and include them in the Operation and Maintenance Manual.
- .4 Touch up small areas marred in transit or during installation with touch up paint.

3.2 Installation of Engine Generator Set

- .1 Mount Diesel-generator package on structural steel base with suitable adjustable steel spring vibration isolators with sound pads mounted between steel base and concrete base pad. Touch-up areas marred in transit or installation.
- .2 Ground generator frame to building ground and/or perimeter ground system.

3.3 Installation of Miscellaneous Components

- .1 Provide 8 conductor #12 MICC cable from each Automatic Transfer Switch to the diesel generator control panel for engine start contact, ATS in normal position status, ATS in emergency position status, and ATS in bypass position status.

- .2 Provide 4 conductor #12 MICC cable from each Fire Pump ATS/Control Panel, and each Sprinkler Pump ATS/Control panel to the engine generator control panel for engine start contact and ATS in emergency position status.
- .3 Provide connection from control panel to fire alarm panel to indicate engine running and trouble condition on fire alarm annunciator.
- .4 Provide power and control wiring between engine control panel and the diesel fuel tank level controller to obtain "Fuel Low Level" alarm contact.
- .5 Provide control wiring connection between engine control panel and fuel leakage detection system panel.

3.4 Testing

- .1 Unload, handle, install and provide temporary cables from generator control panel to temporary load bank for on-site testing. Note that engine-generator assembler shall supply the load bank for site testing.
- .2 Remove the load bank and temporary connections after on-site witness tests have been completed successfully.
- .3 Provide all fuel for testing. Provide initial filling of day tank. Provide initial filling of main storage tank.
- .4 Provide pre-service inspection, testing and calibration of control panel as per Section 26 08 05 requirements for switchboards, panelboards, and protective schemes prior to energization.
- .5 Conduct an acceptance test of the complete emergency power system after preliminary runs and test have been made. Conduct this test on site after completion of installation. This acceptance test shall be as described under the article Site Testing in Section 2 above. In the event of equipment or component failures interrupting completion of test, correct the deficiency and repeat test until satisfactorily completed without failure.
- .6 Demonstrate functioning of safety devices, pilot lights, controls, remote monitoring on the Building Automation System and Fire Alarm system, and operation of all interconnections and alarms to battery charger, fuel system, leak detection panel, dampers, Automatic Transfer switches, etc...
- .7 Immediately following the load test a sample of lubricating oil shall be taken for lab analysis.
- .8 After completion of tests replace all air, fuel and lubricating oil filters with new elements and change the lube oil
- .9 Verify power and control wiring connections between engine generator, engine control panel and diesel combustion air dampers and ventilation dampers, battery charger and automatic transfer switches
- .10 Provide temporary cables and temporary load bank for on-site testing, complete with terminal lugs on cables.
- .11 Conduct an acceptance test after preliminary runs and set up / calibration tests have been made. Conduct this test on site after completion of installation. This acceptance test shall be a minimum of four hours duration with full rated load plus verification of the system performance. In the event of equipment or component failures interrupting completion of test, correct the deficiency and repeat test until satisfactorily completed without failure.

- .12 After completion of above test, perform tests to demonstrate overheat protection, low oil pressure protection and over-speed protection. Demonstrate functioning of safety devices.
- .13 After completion of tests replace all air, fuel and lubricating oil filters with new elements and change the lube oil.
- .14 Revise all wiring diagrams submitted as Shop Drawings to "As-Built" condition, prepare photo reductions of same and include them in the Operation and Maintenance Manual.

3.5 Acceptance Test (Final On-site Testing)

- .1 A competent Diesel-generator expert shall be supplied for as long as is necessary for commissioning and witness testing and for two working days, at a time convenient to Owners, to instruct Owners' staff in maintenance and operation, and in addition shall be present during on-site commissioning and acceptance test.
- .2 Engine manufacturer shall provide an electric resistor load bank of approximately 120% of full rated load for use during factory and on-site test.

3.6 Site Tests

- .1 General
 - .1 Upon completion of the installation of the emergency power supply system, the installation shall be tested to ensure conformity to the requirements of Standard C282. Provide Engineer of with a minimum of 10 days written notification of the proposed test date
 - .2 Generator enclosure to be thoroughly cleaned prior to starting the engine for the first time.
 - .3 Provide a portable test load bank and cables of the required capacity to perform the following tests at site.
- .2 Operational Test
 - .1 With the engine in a "cold start" condition and the emergency load at normal operating level, a power failure shall be simulated by opening all switches or breakers supplying the normal power to the building or facility. The test load is to be [a portable test load bank supplied by the engine generator supplier] [that load which is normally served by the emergency power system].
 - .2 The operational test shall be continued for one hour after which normal power shall be restored to the building or facility and satisfactory transfer of the load and shutdown of the emergency generating set shall be demonstrated.
 - .3 The following data shall be observed and recorded:
 - (a) time delay on start
 - (b) cranking time until the engine starts and runs
 - (c) time required to come up to operating speed
 - (d) time required to achieve steady-state condition with all switches transferred to the emergency position
 - (e) voltage, frequency, and amperes at start-up and at any observed change in load
 - (f) Engine oil pressure, water temperature where applicable, and battery charge rate at 5 min intervals for the first 15 minutes, and at 15 minute intervals thereafter
 - (g) time delay on retransfer for each transfer switch
 - (h) time delay on engine cooldown and shutdown.
 - .4 Following the test prescribed above the emergency generator set shall be subjected to a 4 h 100% load test, using a test load bank to be provided by the engine generator supplier and connected by the Division 26 contractor.

- .5 The building load shall not be used as part of the test load. Full load shall equal the nameplate kW rating of the emergency generator set less applicable derating factors for site conditions. Unity power factor is acceptable for on-site testing, provided that rated load tests at rated power factor have been performed by the manufacturer of the emergency generator set prior to shipment.
- .6 The full load test shall be initiated from automatic transfer switches that will start the engine and, immediately upon reaching rated speed, pick up the full load.
- .7 Synchronization and Load Management Tests
 - (a) Demonstrate the emergency start and synchronizing features of all generators as a system

END OF SECTION

WALK-IN GENERATOR ENCLOSURES

26 32 13.53

1 GENERAL

1.1 Scope

- .1 Install factory fabricated walk-in equipment enclosures for facility power generation equipment complete with internal equipment, line equipment and accessories.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 26 05 01 Electrical General Requirements
 - .2 26 32 13.13 Diesel-Engine-Driven Generator Sets
 - .3 26 32 13.43 Engine Exhaust Silencer Equipment
 - .4 26 32 13.59 Fuel Oil Systems for Packaged Generator Equipment

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 **Equipment enclosure** – a housing that can provide structural support, sound attenuation, security, and weather protection for equipment contained therein.
Walk-in equipment enclosure – an enclosure requiring personnel to be inside the enclosure to perform maintenance or operations work.
 - .2 **Electrical enclosure** – has the same meaning as “cabinet” in CSA C22.1 and conforms to CSA C22.1 No. 94.1 or No. 94.2.
 - .3 **Engine exhaust system** – means the equipment used to convey combustion gases to the outdoors, and can include a dedicated or non-dedicated chimney.
 - .4 **Packaged equipment** – means equipment enclosures and associated equipment contained therein constructed as a factory-built unit, and includes any field installed equipment, components or accessories supplied as part of the unit.
 - .5 **Place of the Work** – means the location of the installation of the equipment.
 - .6 **Shore services** – electrical and mechanical services supplied by one or more building service to the equipment enclosure for operation of equipment inside the enclosure.
 - .7 **Shore power** – a shore service consisting of electrical power supplies
- .2 Abbreviations:
 - .1 EGSA Engine Generating Systems Association

1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 CSA B138.1 Portable Oil-burning Equipment – Packaged Equipment Requirements
 - .2 CSA B138.2 Portable Oil-burning Equipment – Installation Requirements
 - .3 CSA B139 Installation Code for Oil Burning Equipment
 - .4 CSA C22.1 Canadian Electrical Code, Part 1, as amended by the AHJ for electrical safety at the place of installation of the packaged equipment.

- .5 CSA C282-15 and CSA C282-19 Emergency Electrical Power Supply for Buildings
- .6 EGSA 200W Recommended Practice for Seismic and Wind Certification for Compliance to the International Building Code (IBC)
- .2 Product standards:
 - .1 CSA C22.2 No. 141 Emergency Lighting Equipment
 - .2 CSA C860 Performance of Internally Lighted Exit Signs
 - .3 ANSI/CAN/UL/ULC 2200 Standard for Safety Stationary Engine Generator Assemblies
 - .4 CAN/ULC S601 Standard for Shop Fabricated Steel Aboveground Horizontal Tanks for Flammable and Combustible Liquids,
 - .5 CAN/ULC S602 Standard for Aboveground Steel Tanks for Fuel Oil and Lubricating Oil,
 - .6 CAN/ULC-S629 Standard for 650°C Factory-Built Chimneys
 - .7 ULC/ULC-S657 540°C and 760°C Industrial Chimneys
- .1 [Other documents:
 - .1 CAN 2-1708A State of California, Code Application Notice, Certification of Equipment and Nonstructural Components]

1.5 Registration and Inspection

- .1 Arrange and pay for all compliance variance approvals and follow-up inspections by the AHJ for fuel safety where the design and construction of the packaged equipment differs from the requirements of CSA B139, including but not limited to:
 - .1 valves listed to UL 842, including valves larger than NPS 2 and motorized control valves,
 - .2 auxiliary supply tank venting to atmosphere,
 - .3 anti-siphon protection of engine supply fuel tanks other than by use of anti-siphon valves,
 - .4 venting of combustion gases other than by a vertical chimney,
 - .5 where the packaged equipment is constructed to CSA B138.1 but not certified to that standard, for any item that conforms to CSA B138.1 but does not conform to CSA B139.
- .2 Arrange and pay for regulatory inspections and any other variances by the applicable AHJ where the enclosure and applicable equipment are not certified as a complete assembled product:
 - .1 electrical safety,
 - .2 fuel safety.

1.6 Design Criteria

- .1 General:
 - .1 Foundation condition or support: outdoor concrete pad at grade level.
- .2 Electrical safety design criteria:
 - .1 Electrical systems to conform to the electrical safety code at the place of installation of the packaged equipment, or in its absence conform to CSA C22.1 of the published edition at the time of manufacture.
- .3 Fuel safety design criteria:

- .1 Installation of oil-burning equipment to conform to the requirements of CSA B139.1.0 and CSA B139.1.1 as adopted in the place of installation of the packaged equipment at the time of manufacture.
- .2 Alternative: packaged equipment certified to CSA B138.1.

1.7 [[Seismic performance criteria:

- .1 Packaged equipment to be certified in accordance with EGSA 200W for seismic forces except as specified herein.
- .2 Design and construct packaged equipment to withstand seismic forces in accordance with the following criteria: (to provide clarity with reference to IBC criteria and ASCE 7):
 - .1 seismic forces calculated in accordance with the building code at the place of the Work, or in its absence the National Building Code of Canada,
 - .2 ASCE 7: " S_{DS} " is equivalent to NBCC: " $2/3 \cdot F_a(0.2) \cdot S_a(0.2)$ "
 - .3 ASCE 7 Component importance factor is to be read as the Building Importance Factor in accordance with the National Building Code of Canada,
 - .4 and other factors in conformance with Specification section 26 05 49.]

2 (NOT USED)

3 EXECUTION

3.1 Installation

- .1 Place enclosure unit on structural supports or foundation slab, and level the units with steel shims as necessary. When installed on concrete pad, after leveling fill void spaces underneath base frame with non-shrink grout.
- .2 Anchor base frame to support structure with mechanical fasteners selected to withstand wind loads when installed outdoors.
- .3 Provide and connect shore services as shown and in accordance with applicable Specification sections.

3.2 Cleaning

- .1 Prior to starting the generator for the first time, thoroughly clean inside the equipment enclosure to remove loose debris and packaging materials, and clean all surfaces by vacuuming.

3.3 Start-Up and Testing

- .1 Start-up and test generators in accordance with Specification section 26 32 13.13.
- .2 Test diesel fuel systems in accordance the Specification section 23 11 13.
- .3 Test enclosure ventilation system to verify control sequence of operation under as-tested ambient site conditions. Maintain a record of outdoor air temperature during test. Where the testing requirements for the generator require additional tests at other outdoor conditions, conduct additional tests of the ventilation system under those conditions as well.

3.4 Acoustic (Noise) Testing

- .1 Conduct noise testing of engine(s) at maximum rated capacity in accordance with the requirements of the local municipality, but not less than as stated in Specification section 26 32 13.13 and as follows:
- .2 Take noise measurements in the following locations:
 - (a) at 7 m (23 ft) from and centered on each exterior face of the equipment enclosure,
 - (b) within 3 m (10 ft) of the building roof edge (for rooftop installations),

- (c) at the property line for installations other than on the building roof.
- .3 Record straight-line distances between points of measurement and the closest external face of the unit enclosure.
- .4 Take noise measurements of the background noise condition with the generators not operating over a one hour averaged time period at 12 noon and either 07:00 hrs or 23:00 hours.
- .5 Take two sets of measurements while the generator(s) are operating at their maximum rated capacity:
 - (a) first set: between 07:00 and 23:00 hrs
 - (b) second set: between 23:00 and 07:00 hrs.
- .6 Make noise levels readings on the dBA weighting scale over eight bandwidths.
- .7 Report results in tabular and graphical plots, including distances between source and test receptors.
- .8 Report any objectionable noise and be prepared to locate cause by instrumentation and analysis.

3.5 Site Acceptance Testing

- .1 Conduct Site Acceptance Testing (SAT) of the generator(s) in accordance with Specification section 26 32 13.13 and in the presence of and to the satisfaction of the Owner's representative(s).

3.6 Commissioning Program

- .1 In addition to the generator manufacturer Site Acceptance Testing, installation contractor and manufacturer to provide field service personnel to participate in the system integration commissioning of the equipment and/or system including:
 - .1 review of equipment and system commissioning procedures provided by Owner in addition to the manufacturers own testing procedures,
 - .2 to have control of and operation of equipment during testing,
 - .3 adjusting of equipment controls as required to simulate load and/or fault conditions, and
 - .4 assist with record keeping of test results.

3.7 Demonstration and Training

- .1 Demonstrate the operation of, and providing training on, the system in accordance with Specification section 26 05 01 and Division 01.

3.8 Test and installation records

- .1 Provide an installation record for the following elements of the work and submit the original to the Owner and a copy to the Engineer. Provide an additional copy when required or requested by the Authority-having-Jurisdiction.
 - .1 equipment start-up and testing reports,
 - .2 noise testing reports,
 - .3 test reports or inspection reports from applicable AHJ's,
 - .4 test reports required by other Specification sections referenced herein.

End of Section

CLOSEOUT REQUIREMENTS FOR ELECTRICAL WORK 26 77 19.20

1 GENERAL

1.1 Scope

- .1 Provide documentation deliverables at completion of the Work for the following milestone events:
 - .1 Occupancy permit (where applicable) (Form OP1E),
 - .2 Substantial Performance of the Work (Form SP1E),
 - .3 Ready for take-over by Owner (Form RFT1E),
 - .4 Total Performance of the Work (Form TP1E).

1.2 Definitions

- .1 The following definitions apply to this section.
 - .1 **Occupancy permit** – means either: (i) a permit issued by a regulatory authority to allow the Owner to occupy the building subject to the building permit, or (ii) a building permit close-out procedure where documentation must be submitted to the building authority for that purpose.

1.3 General

- .1 The prerequisites and submittal of supporting documentation for the aforementioned milestone events may be combined as a single submission at one point in time for the following combination of events:
 - .1 Occupancy Permit, and Substantial Performance.
- .2 Where a prerequisite is listed in more than one milestone event, it shall be included in the earliest-occurring milestone event unless expressly specified otherwise.

1.4 Occupancy Permit

- .1 Submit the reviewed final record of the Testing of Integrated Life Safety and Fire Protection Commissioning report two weeks prior to application for occupancy permit, where such a report is required.
- .2 Complete the Occupancy Permit Checklist and submit with required documentation to support the Owner's application for occupancy.

1.5 Substantial Performance

- .1 Complete the Substantial Performance Checklist and submit with required documentation when applying for Substantial Performance of the Work.
- .2 Where the work is sub-divided into separate scopes of Work, each requiring a separate Substantial Performance application, provide a separate checklist for each application.
- .3 Within five working days of the Consultant's review report which indicates that Substantial Performance of the Work has been achieved, provide a detailed schedule for completion and/or correction of the Work of all items described in the Contractors' and the Consultants' deficiency list.

1.6 Ready-for-Takeover by Owner

- .1 The basic prerequisites to attaining Ready-for-Takeover of the Work are described in the General Conditions and Supplementary General Conditions of the Contract.
- .2 Complete the Ready-for-Takeover Checklist and submit with required documentation when applying for Ready-For Takeover of the Work.

1.7 Total Performance

- .1 Complete the Total Performance Checklist and submit with required documentation when applying for Total Performance of the Work.

Form OP1E: OCCUPANCY PERMIT CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

The following requirements are completed and documentation included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.

- ☐ Building department inspection reports.
- ☐ AHJ electrical systems inspection reports.
- ☐ Fire Alarm Installation and Verification certificate to CAN/ULC-S524,
- ☐ Independent testing company, coordination study and testing reports submitted.
- ☐ Integrated Fire Protection and Life Safety test report to ULC-S1001.
- ☐ Equipment start-up reports (Interim).
- ☐ Electrical system testing reports.

Consultant Review	
Status:	☐ Reviewed ☐ Incomplete or deficient - resubmit
Signed:	
Date:	

Form SP1E: SUBSTANTIAL PERFORMANCE APPLICATION CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

The following requirements are completed and documentation included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.

- ☐ Occupancy permit has been issued by the AHJ (where applicable).
- ☐ Systems have been started-up, tested, and demonstrated to Owner or Consultant (final)
- ☐ Equipment and wiring identification completed
- ☐ Spare parts and replacement parts turned over to Owner, transmittal attached.

Consultant Review	
Status:	☐ Reviewed ☐ Incomplete or deficient - resubmit
Signed:	
Date:	

Form RFT1E: READY-FOR-TAKEOVER APPLICATION CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

The following requirements are completed and documentation included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.

- ☐ Substantial Performance has been certified or verified.
- ☐ Occupancy permit has been issued by the AHJ (where applicable).
- ☐ Final cleaning and waste removal completed.
- ☐ Delivery to Owner of Operating and Maintenance documents for systems being taken-over by Owner.
- ☐ Submit copies of up-to-date as-built drawings.
- ☐ Final start-up, testing and balancing reports completed and submitted to Owner, including any items requiring corrections identified by Consultant.
- ☐ The portions of the building being turned over to the Owner can be secured by Owner.
- ☐ Demonstration and training are completed, or Contractor and Owner has agreed to a schedule to provide such training to be completed within one month after the date of Ready-for-Takeover.
- ☐ All commissioning activities except for those activities that are identified or otherwise agreed by the Owner to be deferred commission activities which may be completed after Ready-for-Takeover of the Work.
- ☐ Integrated systems testing of fire protection and life safety systems.
- ☐ All warranties have been submitted to the Owner.
- ☐ A comprehensive list of items to be completed or corrected is provided to Owner and Consultant and included in the application for Ready-for-Takeover, and includes a schedule of when such work will be completed.

Consultant Review	
Status:	☐ Reviewed ☐ Incomplete or deficient - resubmit
Signed:	
Date:	

Form TP1M: TOTAL PERFORMANCE APPLICATION CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

The following requirements are completed and included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.

- ☐ All final Operating and Maintenance documents have been delivered to Owner.
- ☐ All final up-to-date as-built drawings have been delivered to Owner.
- ☐ All demonstration and training are completed.
- ☐ All commissioning activities are completed, including deferred alternate season commissioning activities.
- ☐ All known deficiencies have been corrected, including latent deficiencies reported by the Owner.
- ☐ All inspections and tests required to be performed by Contractor or manufacturer's prior to expiry of the warranty period have been completed, and documentation for those inspections and tests are included in this application.

Consultant Review	
Status:	☐ Reviewed ☐ Incomplete or deficient - resubmit
Signed:	
Date:	

End of Section

FIRE ALARM INITIATING AND INPUT DEVICES

28 46 11

1 GENERAL

1.1 Scope

- .1 Provide fire alarm system addressable initiating devices as shown.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 28 46 21.11 Addressable Fire Alarm System

1.3 Definitions

- .1 Terminology used in this specification is based upon CAN/ULC S524 definitions. Refer to S524 for a complete glossary of terms.

1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 Refer to Specification section 28 46 21.11
- .2 Product Standards:
 - .1 CAN/ULC-S528 Standard for Manual Stations for Fire Alarm Systems, Including Accessories
 - .2 CAN/ULC-S529 Smoke Detectors for Fire Alarm Systems
 - .3 CAN/ULC-S530 Standard for Heat Actuated Fire Detectors for Fire Alarm Systems

1.5 Submittals

- .1 Submit product data sheets for materials specified herein.

2 PRODUCTS

2.1 General

- .1 All Fire Alarm System components shall be listed to applicable ULC and/or CSA standards for use with the proposed fire alarm system.
- .2 Fire initiating devices shall be of the fire alarm system manufacturer product line or their approved products except where specified herein.

2.2 Addressable Heat Detectors

- .1 Listed to CAN/ULC-S530.
- .2 Automatic detectors to be of the following types:
 - .1 addressable type,
 - .2 57.2°C (135°F), fixed temperature and 8.3°C (15°F) per minute, rate of rise,
 - .3 93°C (200°F), fixed temperature only (if not available as addressable device, provide conventional device with monitoring module),
 - .4 as otherwise indicated on drawings.

- .3 Detectors to have suitable mounting plates with finish ring.
- .4 Provide conventional non-addressable heat detectors in unheated areas with an individual addressable module mounted in a heated part of the building.

2.3 Addressable Smoke Detectors

- .1 Listed to CAN/ULC-S529.
- .2 Multi-criteria detector:
 - .1 addressable type,
 - .2 smoke detection: multi-criteria photoelectric smoke sensing,
 - .3 heat detection: 8.3°C (15°F) per minute rate-of-rise with 57°C (135°F) fixed detection.
- .3 Remote adjustable sensitivity, with environmental condition monitoring function ("dirty", "excessive dirty" messages),
- .4 Incorporate an LED or lamp latched circuit to indicate the signal operation of the unit.
- .5 Power requirement: operate on 24 volts DC and be protected against electrical transients and electromagnetic interference.
- .6 Detectors to be equipped with NO/NC contacts to operate ancillary devices, where applicable.
- .7 Detectors to be equipped with a fine mesh insect screen to prevent contamination of the detection chamber by insects.
- .8 Recessed smoke detector to be complete with necessary shroud and flush mounting hardware.

2.4 Addressable Monitor Modules

- .1 Supervision of Class B normally-open dry contact initiating device circuits with end-of-line resistor.
- .2 Mount to standard 1-gang box.
- .3 Include wall plate with LED viewing ports.

3 EXECUTION

3.1 General

- .1 Installation of the Fire Alarm system components to be in accordance with the current applicable edition and all amendments of CAN/ULC-S524 and as specified herein.

END OF SECTION

ADDRESSABLE FIRE ALARM SYSTEM

28 46 21.11

1 GENERAL

1.1 Scope

- .1 Update existing fire alarm system to meet the requirements of this renovation and building expansion as shown, and as otherwise required.
- .2 Include for all costs associated with up-dating all the existing fire alarm system computer floor-plan graphics, and all existing facility or campus fire alarm annunciator graphic displays as required by the changes created by the Work.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 [01 91 00 General Commissioning Requirements]
 - .2 Division 8 Door Hardware
 - .3 Division 14 Vertical Transportation
 - .4 21 05 33 Heat Tracing for Fire-Suppression Piping
 - .5 21 30 13 Electric-Drive Fire Pump
 - .6 [23 83 43 Snow Melting Electric Heat Tracing]
 - .7 [25 07 05.13 Building Automation Smoke Management System]
 - .8 [25 07 05.26 Building Automation Interface to FAS Smoke Management]
 - .9 26 07 03 Wiring for Mechanical Services
 - .10 26 08 11 Testing of Integrated Fire Protection and Life Safety Systems
 - .11 [26 08 15 Electrical Commissioning]
 - .12 28 46 11 Fire Alarm Initiating and Input Devices
 - .13 28 46 23 Fire Alarm Notification and Output Devices
 - .14 28 46 90 Fire Alarm System Sequence of Operation.

1.3 Definitions and Abbreviations

- .1 Terminology used in this specification is based upon CAN/ULC S524 definitions. Refer to CAN/ULC-S524 for a complete glossary of terms.
 - .1 **Building Automation System** – the control system which controls and monitors building systems other than a fire alarm system.
 - .2 **Local Authority (Authorities)** – means a regulatory authority for building safety and/or fire safety.
- .2 The following abbreviations apply to this section:
 - .1 **AHJ** - Authority Having Jurisdiction
 - .2 **CACF** - Central Alarm and Control Facility
 - .3 **DCL** - Data Communication Link
 - .4 **DCC** - Display and Control Centre
 - .5 **FAC** - Fire Alarm Computer
 - .6 **FAS** - Fire Alarm System

1.4 Applicable Codes and Standards

.1 Installation codes and standards:

- | | | |
|-----|---------------|--|
| .1 | CSA C22.1 | Electrical Safety Code, as amended in the jurisdiction of the Work, |
| .2 | CSA C282 | Emergency Electrical Power Supply for Buildings |
| .3 | CSA Z32 | Electrical Safety and Essential Electrical Systems in Health Care Facilities |
| .4 | CAN/ULC-S524 | Installation of Fire Alarm Systems |
| .5 | CAN/ULC-S536 | Inspection and Testing of Fire Alarm Systems |
| .6 | CAN/ULC-S537 | Verification of Fire Alarm Systems |
| .7 | CAN/ULC-S573 | Installation of Ancillary Devices Connected to Fire Alarm Systems |
| .8 | CAN/ULC-S1001 | Integrated Systems Testing of Fire Protection and Life Safety Systems |
| .9 | NFPA 13 | Installation of Sprinkler Systems |
| .10 | NFPA 20 | Installation of Stationary Pumps for Fire Protection |

.2 Product standards:

- | | | |
|----|--------------|---|
| .1 | CAN/ULC-S527 | Standard for Control Units for Fire Alarm Systems |
| .2 | CAN/ULC-S533 | Egress Door Securing and Releasing Devices |
| .3 | CAN/ULC-S548 | Devices and Accessories for Water Type Extinguishing Systems |
| .4 | ULC-S139 | Standard Method of Fire Test for Evaluation of Integrity of Electrical Cables |

1.5 Qualified Tradesperson

- .1 Installing electricians to be qualified, licensed, and from a recognized firm with an established reputation in this field.
- .2 Fire alarm technicians to be CFAA Registered.

1.6 System Requirements

- .1 All system components to be listed by a Standards Counsel of Canada accredited testing laboratory to applicable standards adopted for Canada for use with the Fire Alarm System.
- .2 All system components to comply with applicable provisions of the building code applicable to the location of the Work, CAN/ULC-S524, and meet the requirements of the local AHJ for building safety.
- .3 General design and performance requirements:
 - .1 FAS to comply with ULC and as specified herein.
 - .2 FAS to be an integrated Fire Alarm and Voice Communication system.

1.7 Submittals

.1 Submit shop drawings to include:

- .1 product data sheets for system components highlighted to indicate the specific products, features, and functions,
- .2 fire alarm system sequence of operation,
- .3 fire alarm graphic drawing,
- .4 system power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate in accordance with the prescribed backup time periods and under all voltage conditions per ULC Standards and applicable Building Code.

1.8 Operation and Maintenance Data

- .1 Provide operation and maintenance data in accordance with the requirements of Division 01 and as follows.
- .2 Operation and maintenance data to include:
 - .1 a copy of reviewed shop drawings with corrections completed and marks removed except review stamps,
 - .2 instructions for complete fire alarm system to permit effective operation and maintenance,
 - .3 a list of spare parts for system,
 - .4 detailed maintenance instructions for control equipment and each device type, maintenance schedule in accordance with CAN/ULC-S536,
 - .5 troubleshooting guide for control panels and devices,
 - .6 a copy of the fire alarm verification certificate and verification report
 - .7 warranty certificates for fire alarm system, batteries, ancillary devices, and other similar items, including battery suppliers date coding for batteries.
 - .8 the name, address, and telephone number of service representative of manufacturer to be contacted during warranty period,
 - .9 any additional fire alarm equipment information required for the facility Fire Safety Plan.
- .3 Update shop drawing riser diagram to "As-Built" condition at the completion of the project. Submit both a printed drawing, a PDF file, and an AutoCAD file.
- .4 Documentation required by CAN/ULC S573 to be maintained on site for ancillary device installations:
 - .1 A completed and detailed description for all ancillary device installations including, but not limited to the following:
 - (a) description and function of the ancillary device(s);
 - (b) sequence of operation;
 - (c) installation instructions;
 - (d) operating instructions; and
 - (e) maintenance and testing instructions.
 - .2 The plans of the building showing the location and identification of each ancillary device.
 - .3 Documentation showing the interconnection of each ancillary device or system connections to field devices, control units, transponders, and external power supplies.
 - .4 Documentation for ancillary devices and circuits serving smoke control and venting systems including building plans that indicate the type and location of all smoke control and venting equipment (fans, dampers, etc.)

2 PRODUCTS

2.1 General

- .1 All Fire Alarm System components shall be listed to applicable ULC and/or CSA for use with the proposed fire alarm system.

2.2 EXISTING SYSTEM

- .1 It is the intent to maintain the operation of the existing FAS
- .2 The existing FAS is Siemens Cerberus
- .3

2.3 Input (Alarm Initiating) Circuits

- .1 Alarm receiving circuits and addressable line cards for alarm initiating devices, such as manual pull stations, smoke detectors, combination smoke detectors/ heat detectors (Intelligent type), heat detectors, and water flow switches as shown on schedules and drawings.

2.4 Output Alarm Circuits

- .1 Alarm output circuits for audible signals such as speakers, horns and visual indicators as shown.
- .2 Alarm output circuit:
 - .1 includes necessary amplifiers and tone generator modules for electronic audible alarm devices as required.
 - .2 capable of being manually tested on a circuit-by-circuit basis by the CPU using a keypad or a keyboard.
 - .3 capable of being manually disconnected on a circuit-by-circuit basis at the transponder for testing purposes.
 - .4 a trouble signal is to sound when any output circuit is manually disconnected.

2.5 Fire Alarm Wires and Cables

- .1 General requirements:
 - .1 wiring sizing and type to be as recommended by fire alarm system manufacturer,
 - .2 type: copper, not less than #18 AWG,
 - .3 wiring for speaker circuits to be twisted pair. Shielded or as recommended by manufacturer.
- .2 Non-fire rated:
 - .1 fire alarm wiring:
 - (a) type FAS, 300V, 105°C,
 - (b) to be installed in conduit.

Standard of Acceptance

- Nexans
- General Cable
- Belden
- Southwire

- .2 Armoured fire alarm cable:
 - (a) type FAS, 300V, 105°C,
 - (b) aluminum interlocked armour

Standard of Acceptance

- Securex II FAS 105

- .3 Fire rated:
 - .1 fire rated armored cables:
 - (a) 2-hour fire rating with hose stream, listed to CAN/ULC S139,
 - (b) type FAS, 300V, 90°C.

Standard of Acceptance

- VITALink (Marmon, Comtram)
- .2 fire rated mineral Insulated cables:
 - (a) 600V mineral insulated cable, as recommended by fire alarm manufacturer.

Standard of Acceptance

- Pyrotenax (nVent)

3 EXECUTION

3.1 General

- .1 Install all control panels, graphics, and equipment required for a fully operational system as shown on drawings or as otherwise required.
- .2 FAS to be installed under the supervision of manufacturer.
- .3 At the completion of the Work, the building is to be left with a complete fire alarm and voice communication system accepted by the Local Authorities and meeting all applicable codes. System will be left ready for continuous and satisfactory operation.

3.2 Wiring

- .1 Wiring material selection:
 - .1 main DCL wiring interconnecting transponders: in 2-hour rated fire compartment or interconnected with 2-hour fire rated cables.
 - .2 wiring between transponder to the first initiating device or output device: 2-hour fire rated, or utilize isolators as outlined in CAN/ULC-S524 if the transponder is in a different fire alarm zone than the device it is serving.
 - .3 wiring for annunciators: solid copper 2-hour fire rated, serial link communication conductor as recommended by the manufacturer.
 - .4 wiring to firemen's handsets: solid copper 2-hour fire rated and laid out in a horizontal radial or star topology from the transponder location to each handset on each floor.
 - .5 power wiring to each fire alarm transponder: 2-hour fire rated,
 - .6 all other wiring: non-fire rated or fire rated.
- .2 Connect wiring for input alarm initiating circuits and output alarm circuits corresponding to the same fire alarm zone to the same transponder to ensure stand-alone operation is maintained.
- .3 Align alarm devices and signals, where grouped together, one above the other.
- .4 Provide fire alarm monitoring from each emergency generator control panel for "generator trouble", "generator running" and "Generator not in auto" signals.
- .5 Equip raceways with a separate ground conductor and connect to nearest ground bus.
- .6 Wire and annunciate signals from fire pumps or sprinkler pumps as required by the building code and its references to NFPA 13 and NFPA 20.
- .7 Connect each control panel, and transponder to the nearest life safety branch panel on the respective floor. Provide a "red" coloured circuit breaker, sized as required, and distinctly labelled. Provide a "Lock On" device on the breaker.
- .8 Wire signal circuits alternatively such that no two adjacent signal devices are on the same circuit.
- .9 Provide a minimum of two speaker circuits per voice paging [and public address] zone.
- .10 Provide line isolators (on both sides) when crossing fire alarm zone boundaries.

3.3 Installation of Input Circuits and Initiating Devices

- .1 Initiating devices to conform to Specification section 28 46 11.
- .2 Protect smoke detectors during construction with a dust cover which is to be removed at the time of verification.
- .3 Wire alarm receiving circuits in a Class A, 2 wire configuration with the loop returning to the control panel via a separate conduit. Provide a conduit run from the respective control panel to the first and last device on the loop.
- .4 Supervise all alarm receiving circuits for open, short, or ground fault conditions.
- .5 Do not load circuits above 80% of capacity to allow for future additions.
- .6 Install manual pull-stations as shown and in accordance with the following:
 - .1 [1200 mm] [between 1000 to 1200 mm] above the finished floor level, measured from the centre of the manual pull station,
 - .2 be adjacent to and centered on either the length or the width of a clear floor area of 1350 x 800 mm,
 - .3 install the manual pull station on the latch side of a single door at a maximum lateral distance of 1500 mm from the door opening, except where installed adjacent to an electromagnetically locked door or a door utilized for crossover access, install within 500mm.
- .7 Provide a Lamacoid label for all monitoring modules indicating address and device monitored.

3.4 Installation of Output Circuits and Devices

- .1 Notification and output devices to conform to Specification section 28 46 23.
- .2 Wire alarm output circuits in a class B, 2 wire configuration.
- .3 Supervise all alarm output circuits for open, short, or ground fault conditions by the use of an end of line resistor.
- .4 Do not load circuits above 80% of capacity to allow for future additions.
- .5 In finished areas, install speakers flush with the ceiling. Secure the back box to the runners above the ceiling. Install adequate supports for the speaker back boxes covered by the covers.
- .6 In stairways and equipment spaces, surface-mount speakers and/or horns.
- .7 Install wall-mounted audible signal devices at least 150 mm (6 in) below the ceiling, measured to the top of the device.
- .8 Provide Lamacoid label for all control modules indicating address.

3.5 Installation of End of Line Resistors

- .1 Where Class B wiring is specified or permitted, install the end-of-line resistors in an outlet box with stainless steel cover plate.

3.6 Wet Pipe System Heat Tracing

- .1 Provide electrical supervision monitoring module to indicate a loss of power to a heat tracing cable that is installed to heat:
 - .1 standpipe piping,
 - .2 sprinkler line as part of a fire suppression system,
 - .3 an exit or means of egress to keep it free of ice and snow.
- .2 Heat tracing of these systems provided under specification section 21 05 33 or 23 83 43 as applicable.

3.7 Control of ancillary devices

- .1 Where power to an ancillary device is provided from the fire alarm system, the power supply equipment and wiring shall be installed in accordance with CAN/ULC S573 and CAN/ULC-S524.
- .2 Where power to an ancillary device or system is provided independent of the fire alarm system, the power supply equipment and wiring shall be installed in accordance with CAN/ULC S573 and CSA C22.1.
- .3 Where control of an ancillary device is from multiple sources (ex. BMS and fire alarm), a warning label is to be installed at the ancillary device with the following wording:
 - .1 "THIS DEVICE IS CONTROLLED BY MORE THAN ONE SOURCE"
- .4 Relays used for elevator recall are to be labelled "ELEVATOR RECALL RELAY" and note the specific recall function provided.
- .5 Where ancillary devices or systems connect to an electrically supervised circuit and the devices or systems are not provided with dual input and output wire leads or terminals, the connection shall be made with a soldered joint or non removable crimped ring tongue connector. Except:
 - .1 This requirement does not apply to end-of-line devices, and
 - .2 it is permitted to have a non-supervised portion of the circuit, provided it is limited to the following lengths:
 - (a) 3 m when the non-supervised portion of the circuit is located outside of a service room; or
 - (b) 18 m when the non-supervised portion of the circuit is located entirely within the same service room.

3.8 System Verification

- .1 Verify the fire alarm system in accordance with CAN/ULC-S537. Verification is to be performed by the FAS manufacturer/vendor and the electrical installers.
- .2 Provide any necessary equipment, test apparatus, ladders and scaffolding as required.
- .3 Adjust system and components as required to ensure system fully operating as intended.

3.9 Testing of Integrated Fire Protection and Life Safety Systems

- .1 Comply with the requirements of specification section 26 08 11 for the testing of the integration of the FAS with other life safety and fire protection systems.
- .2 All verification and testing requirements specified in this section must be complete and free of deficiencies prior to commencing Testing of Integrated Fire Protection and Life Safety Systems.

3.10 Local Authorities Demonstration

- .1 Only after the testing and verification task is completed, and all deficiencies rectified, notify the Owner, Consultant and representatives of the Local Authority and demonstrate the proper functioning of the system. This will include, but not be limited to:
 - .1 detailed demonstration of each operable device,
 - .2 removal of individual speakers from their wiring connections to prove that adjacent speakers operate properly and subsequent reinstallation of speakers on selected floors,
 - .3 interfacing of voice communication and fire alarm systems,
 - .4 operation of individual handsets,
 - .5 operation of ceiling speakers.

End of Section

FIRE ALARM NOTIFICATION AND OUTPUT DEVICES 28 46 23

1 GENERAL

1.1 Scope

- .1 Provide fire alarm system notification and output control devices as shown.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 28 46 21.11 Addressable Fire Alarm System

1.3 Definitions

- .1 Terminology used in this specification is based upon CAN/ULC S524 definitions. Refer to S524 for a complete glossary of terms.

1.4 Applicable Codes and Standards

- .1 Product standards:
 - .1 CAN/ULC-S525 Audible Signal Devices for Fire Alarm System and Signaling Systems, Including Accessories
 - .2 CAN/ULC-S526 Visible Signal Devices for Fire Alarm Systems and Signaling Systems, Including Accessories
 - .3 CAN/ULC-S541 Speakers for Fire Alarm Systems, Including Accessories

1.5 Submittals

- .1 Submit product data sheets for materials specified herein.

2 PRODUCTS

2.1 General

- .1 All Fire Alarm System components shall be listed to applicable ULC and/or CSA for use with the proposed fire alarm system.
- .2 Annunciation and output control devices to be of the fire alarm system manufacturer product line or their approved products except where specified herein.

2.2 Speakers

- .1 Listed to CAN/ULC-S541.
- .2 Speakers for the fire alarm system to have the following features:
 - .1 acoustically treated enclosure,
 - .2 line matching transformer with ¼, ½, 1, and 2 Watt taps,
 - .3 permanent magnet type speaker,
 - .4 wide dispersion bandwidth in hemispherical pattern, in both horizontal and vertical planes,
 - .5 minimum frequency response of 400 to 4000 Hz,

- .6 high fidelity type speaker, 520 Hz type.
- .3 For flush-mounting as shown, and provided with speaker enclosures where shown as surface mounted.
- .4 Unit to be complete with hook-up terminals with screw-type connection.

2.3 Horn Speakers

- .1 Listed to CAN/ULC-S541.
- .2 Surface mounted with a weatherproof gland connection.
- .3 Dispersion angle of 120°H x 80°V.
- .4 Selectable weather protected taps of 1, 2, 4, & 7.5 watts.
- .5 Finish colour: fire alarm red.
- .6 Power supply: Powered by fire alarm output circuit.

2.4 Fire Alarm Bell

- .1 Listed to CAN/ULC-S525.
- .2 150 mm (6 in) in diameter.
- .3 Surface mounted.
- .4 Finish colour: fire alarm red.

Power supply: Powered by fire alarm output circuit.

2.5 Visible Signal Devices (Strobe Lights)

- .1 Listed to CAN/ULC-S526.
- .2 Performance:
 - .1 flash rate: one flash per second in alarm mode,
 - .2 the words "FIRE" to appear on the lens or attached nameplate.
 - .3 effective luminous intensity in a sleeping room or bed space: not less than 175 candela (cd).
 - .4 effective luminous intensity in all other areas: not less than 15 candela (cd) and selected to meet ULC S524 for the installed location.

2.6 Combination Signal Appliances

- .1 Combination audible and visual signaling devices to conform to individual articles specified herein.

2.7 Addressable Control Relay Modules

- .1 Form "C" dry relay contact to control external appliances.
- .2 Contact rating: 2A @ 24V, 0.5A @ 120V.
- .3 Designed to be installed in a standard 1-gang box.
- .4 Include wall plate with LED viewing ports.

2.8 Alarm Signal Appliances

- .1 For remote indication of alarm condition.
- .2 Alarm lamp fixtures: high intensity (200 mcd) LED lamps, with screw-type terminals.

- .3 Mounting plate: single gang-box plate.

2.9 Fire Do Not Enter Signs

- .1 Listed to CAN/ULC-S526
- .2 Extruded aluminum body and aluminum faceplate, with LED bulbs.
- .3 Warning message:
 - .1 "FIRE DO NOT ENTER"
 - .2 red in colour,
 - .3 to be visible only when the sign is illuminated.
- .4 Power supply: from fire alarm system.

3 EXECUTION

3.1 General

- .1 Provide notification and output devices as shown.
- .2 Installation of the fire alarm system components to be in accordance with the current applicable edition and all amendments of CAN/ULC-S524 and as specified herein.

3.2 Speaker Installation

- .1 Initially set speaker taps to be ½ W. Verify suitability of sound levels in each area and adjust tap to suit.
- .2 Speaker baffles to be held in place with approved fasteners.
- .3 Speakers to be flush mounted unless otherwise noted.
- .4 Speaker enclosures in stairwells to be suitable for surface mounting.

3.3 Visible Signal Devices Installation

- .1 Where there are more than two strobe lights in a corridors or room in the same field of view, adjust units to flash in synchronization regardless of whether the strobe light is served from one or more control units / transponders.
- .2 Suspend or mount ceiling-mounted strobe lights at not more than 9000mm above the finished floor.
- .3 Mount wall-mounted strobe lights such that the entire lens is not less than 2000mm and not more than 2400 mm above the finished floor.

3.4 Addressable Control Relay Module Installation

- .1 Mount control relay modules in a standard 1-gang box.

3.5 Remote Alarm Signal Appliances Installation

- .1 Provide alarm signal appliances directly connected to initiating devices that require remote annunciation
- .2 Mount remote indicating alarm lamps in a 1-gang box.

END OF SECTION