IDEA Project No. 24549

KN229976-ARC FLASH STUDY FF02

Fort Frontenac

Department of National Defence

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RECORD OF REVISIONS			
REVISION	**DATE**	**BY**	**COMMENTS**
0	2025-01-10	Nicholas Frayn, P.Eng	Draft for client review
1	2025-03-14	Nicholas Frayn, P.Eng	Final Report



Disclaimer:

The arc flash values in this report have been determined through analysis conducted by IDEA Inc., following industry-recognized standards and utilizing tools that follow these standards. Improper maintenance of the electrical equipment listed within, age and condition of the equipment, modifications to the equipment, system modifications, and protective device settings could render the results of this study invalid. The results of this study assume that the equipment is operating properly as per the manufacturers' specifications. The data collected was provided by 3rd parties involved in the project, obtained onsite from the existing equipment, and when not available derived through recognized industry standards. This report is only to be used by the qualified personnel it was intended for in which IDEA Inc. has sent the original copy to, and IDEA Inc. assumes no liability or responsibility if the report is distributed or copied without consent from IDEA Inc.

Codes and Standards

- CSA C22.2:21 – Canadian Electrical Code, Part 1 (25th Edition)
- CSA Z462:24 – Workplace Electrical Safety
- IEEE 1584-208 – Guide for Performing Arc-Flash Hazard Calculations
- ANSI/IEEE C37.13 – Standard for Low Volage AC Power Breakers Used in Enclosures
- ANSI/IEEE C37.010 Standard Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current

UL 489-9 Standard for Safety for Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures

1. Executive Summary

DCC engaged IDEA Inc to perform an analysis of the existing electrical distribution system at building FF02 located at Fort Frontenac in Kingston Ontario.

The analysis intends to address the following items:

a) Perform a Short Circuit and Coordination study on both the medium voltage and low voltage systems for the building with short circuit results to be provided to confirm Short Circuit rating of the existing equipment.
b) Use the above short circuit results to provide a protective device coordination study utilizing individual time current coordination curves to provide recommended circuit breaker device settings and fuse types to limit incident energy and fault current.
c) Provide an Arc Flash Hazard Analysis as per CSA Z462-21 utilizing IEEE Std 1584 for the arc flash calculations to indicate incident energy from the medium voltage equipment down to the low voltage panels within the building. From these results and the coordination study recommended setting Arc Flash labels will be provided by the end of the project.
d) Provide the single line diagrams used to perform above studies.
e) Provide an Infrared Thermographic Scanning Report for all electrical distribution equipment from the service transformer down to all panel boards. The report will identify all equipment found to be anomalous, with current readings for this equipment provided and recommendations for correcting the equipment.
f) Provide Phase Balance Testing of the electrical distribution under normal load conditions. This will be measured at the incoming service to the building, and at each distribution panel, step down transformer, and low voltage panel board, where deemed safe to do so. Voltage drop measurements from the incoming main service down the furthest distribution equipment.

This report provides our findings associated with the existing equipment and lists the associated recommended work to be performed to bring the existing equipment up to code, reduce fault levels and incident energy to make the equipment safer to work on.

Multiple site visits were conducted by IDEA Inc., Eaton and Drycore Electric as part of the scope of work to investigate the existing electrical distribution system at building FF02 at Fort Frontenac. The equipment was opened and tested to document the equipment ratings, condition, wire sizes and types, perform voltage and current readings, take pictures and perform a thermographic scan while under load. This information was used to produce an updated single line diagram, and was entered into the Power System Software ETAP to perform the Short Circuit, Coordination, and Arc Flash Studies.

During the site visit, due to the condition and lack of maintenance reports on the 4160V equipment, it was deemed unsafe to open this equipment while energized to perform an inspection and analysis. With approval from DND and Kingston Utilities, the equipment was deenergized to perform the investigation.

The information for the electrical equipment used within the report by IDEA Inc. was provided by Drycore Electric and Kingston Utilities.

1.1. Study Introduction

The short circuit study is used to determine whether the SCCR (Short Circuit Current Rating) of the existing equipment is able to withstand the available fault current associated with the incoming service and down stream equipment.

The protective device coordination study analyzes the existing protective device settings and ratings under fault and normal operating conditions. This includes relay/breaker ratings and trip settings, and fuse ratings. The coordination study is used to ensure that during a fault or overload condition, the immediate upstream protective device associated with the equipment clears the anomaly opposed to a device further upstream. This limits the fault clearing time (FCT) and thus the associated incident energy.

The Arc Flash Incident Energy Report is produced based on CSA Z462:24 standard to study the incident energy available at the equipment and determine the Arc Flash Boundary. Per section 4.3.5.1 of CSA Z462:24, 'an arc flash risk assessment shall be performed to identify arc flash hazards, estimate the likelihood of occurrence of injury or damage to health and the potential of severity of injury or damage to health, and determine if additional protective measures are required, including the use of PPE'.

Once the arc flash assessment is performed, this information is used to determine the arc flash boundary and recommended PPE. The incident energy analysis method used in this report is the IEEE 1584 calculation method. With the incident energy and arc flash boundary determined, Table 2 of CSA Z462:24 provides the PPE requirements at that level of incident energy. The PPE, incident energy and boundary information is applied to an Arc Flash label specifically designed for each unique piece of equipment.

The Infrared Thermographic Scanning is performed to observe any temperature anomalies that occur within existing electrical equipment. These anomalies can occur due to many various reasons, including but not limited to:

- Loose connections or lugs
- Overloaded circuits
- Broken or malfunctioning equipment

An infrared thermal scan is a useful and less-invasive test to help keep electrical equipment in good working condition and should be performed at least once every 12 months for adequate maintenance of the equipment.

Phase balance and voltage drop readings are performed to make sure the electrical system is properly balanced, and the system isn't operating above or below nominal operating voltages regulated in Canada. Current readings are taken at the main service, and the down stream equipment while under load to observe the amperage readings on each phase. Voltage readings are taken at the incoming service transformer and then at each down stream piece of equipment such as panel or MCC to determine the voltage drop of the system.

Visual inspection to the interior and exterior of the existing equipment is performed to ensure that the equipment is free from any deterioration, damage, or corrosion. The installation is inspected to ensure the equipment meets or exceeds the current Canadian Electrical Code.

1.2. Recommendations

Recommendations obtained from the **Short Circuit Study**:

No recommendations from this section.

Further detail of the above recommendations can be found in section 2.6.

Recommendations obtained from the **Protective Device Coordination Study**:

Revise size of fuse F_TRN-2 from 250A to 50A.

Revise size of fuse F_DS-MAIN from 300A to 400A.

Revise style of fuse F_150kVA Tx from time delay to Very Fast Acting.

Revise instantaneous trip setting of breaker CB_FF02 in DP-PRN-2 from LO to HI.

Further detail of the above recommendations can be found in section 3.6.

Recommendations obtained from the **Arc Flash Incident Energy Report**:

Revise size of fuse F_TRN-2 from 250A to 50A to reduce the incident energy at DP-PRN-2 from Level B (15.894 cal/cm2) to Level A (0.8 cal/cm2).

Further detail of the above recommendations can be found in section 4.6.

Recommendations obtained from the **Infrared Thermographic Scan**:

No recommendations from this section.

Further detail of the above recommendations can be found in Appendix B.

Recommendations obtained from the **Phase Balance and Voltage Drop Readings**:

Perform phase balancing on panel P-A1.

Further detail of the above recommendations can be found in section 6.

Recommendations obtained from the **Visual and Mechanical Inspection**:

Panel DP:

1. Cover open panel sections with new filler
2. Remove equipment in front of panel to provide 1m clearance
3. Provide strapping to properly secure EMT conduit above panel

Panel P-A:

1. Remove equipment in front of panel to provide 1m clearance.
2. Replace locking mechanism on panel cover

Panel P-B:

1. Remove equipment in front of panel to provide 1m clearance.
2. Replace conduit with a larger size to suit conduit fill of the cables being routed to the ceiling space. Investigate if this continues within the ceiling space.
3. Perform panel clean

Panel P-C:

1. Provide strapping to properly secure conduits.
2. Perform panel clean

Panel P-D:

1. Install insulated bushing at panel entrance.
2. Replace conduit with a larger size to suit conduit fill of the cables being routed to the ceiling space. Investigate if this continues within the ceiling space.
3. Perform panel clean
4. Provide knockout cover

Panel P-F:

1. Provide strapping to properly secure conduits.

Panel P-A1:

1. Provide knockout covers
2. Provide two new 2P 30A breakers and one new 2P 15A breaker to suit the panel type.
3. Provide new panel cover screws

Panel P-A12:

1. Provide strapping to properly secure the ½" conduit.
2. Perform Panel clean.

Panel P-AA:

1. Replace panel in kind with gasketed panel due to installation location in exterior shed.

Panel P-QO:

1. Tag panel to be monitored with IR scan every one to two years as increased corrosion can cause failed connections
2. Replace Panel

General Building:

1. Print and Frame Single Line Diagram as required by CEC.

Further detail of the above recommendations can be found in section 7.

2. Short Circuit Study

The importance of the short circuit study is to determine whether the existing equipment can withstand the available fault current of the distribution system. If the equipment is underrated, significant damage to the equipment and personnel working near the equipment can occur due to mechanical and electrical forces created during the fault. The Short Circuit Study was performed using the ETAP Power System Software.

2.1. Methodology

Utilizing ETAP, the short circuit coordination study is performed using the ANSI C37 calculation method. From the data obtained within the field from the existing equipment, and fault levels provided by the Local Utilities Company, the single line diagram for the building is created within the software, and the software simulates three phase bolted faults and line to ground bolted faults at every bus included within the system. Critical information needed for the study includes cable impedance and lengths, and transformer X/R ratios to determine how the fault propagates through the system. The equipment analyzes both symmetrical and asymmetrical fault current contributions at each bus. The results are compared to the rating of the equipment to determine if any marginal or critical failures can occur from a fault.

2.2. Information Provided

The field information for the existing equipment was obtained by the electrical contracting company Drycore Electric.

The Hydro Fault information was provided by Kingston Utilities.

2.3. Assumptions

Where device information was not obtainable due to damaged name plates or lack there of, design values and standard values are used and listed within.

2.4. Input Information

The following reports are exported from ETAP to list the input information used within the study:

Cables:

ID	kV	Cond./ Phase	Cond./ Cable	Size AWG/mm²	Z						
					Z Ohms / Unit Length	R Ohms / Unit Length	X Ohms / Unit Length	L H / Unit Length	Y S / Unit Length	Length m	Conductor
CBL_DP	1	1	3/C	3/0	0.08976	0.0805	0.0397	0.0001053	0	10	CU
CBL_DS-DP	0.6	1	1/C	3/0	0.09458	0.079	0.052	0.0001379	0	5	CU
CBL_DS-MAIN	0.6	1	1/C	300	0.06801	0.045	0.051	0.0001353	0	10	CU
CBL_DS-SPARE	0.6	1	1/C	3	0.25687	0.25	0.059	0.0001565	0	15	CU
CBL_FF02	0.6	1	1/C	300	0.06014	0.044	0.041	0.0001088	0	100	CU
CBL_P-A	0.6	1	1/C	3	0.25687	0.25	0.059	0.0001565	0	100	CU
CBL_P-A1	0.6	1	1/C	3/0	0.09458	0.079	0.052	0.0001379	0	100	CU
CBL_P-A12	0.6	1	3/C	2	0.68235	0.6743	0.1045	0.0002772	0	20	CU
CBL_P-AA	0.6	1	1/C	2	0.20796	0.2	0.057	0.0001512	0	65	CU
CBL_P-B	0.6	1	1/C	3	0.25687	0.25	0.059	0.0001565	0	200	CU
CBL_P-C	0.6	1	1/C	3	0.25687	0.25	0.059	0.0001565	0	250	CU
CBL_P-D	0.6	1	1/C	3	0.25687	0.25	0.059	0.0001565	0	200	CU
CBL_P-E	0.6	1	1/C	3	0.25687	0.25	0.059	0.0001565	0	260	CU
CBL_P-F	0.6	1	1/C	3	0.25687	0.25	0.059	0.0001565	0	200	CU
CBL_P1-TRN1	5	1	1/C	1/0	0.13777	0.1281	0.0507	0.0001345	0	40	CU
CBL_TRN1-TRN2	5	1	1/C	1/0	0.13777	0.1281	0.0507	0.0001345	0	375	CU
CBL_TX PRI	0.6	1	1/C	2/0	0.11365	0.1	0.054	0.0001432	0	5	CU
CBL_TX SEC	0.6	2	1/C	250	0.07497	0.054	0.052	0.0001379	0	40	CU

Buses/ Panels/ Switch Gear:

ID	Nominal kV	Type	Vf (%)	Bracing Symm. kA	Bracing Asymm. kA	Bracing Peak kA
BUS_HV-SG	4.16	Switchgear	100		22	37.13
BUS_TRN-1	4.16	Cable Bus	100		22	37.13
BUS_TRN-2	4.16	Cable Bus	100		22	37.13
DP	0.208	Panelboard	100	10	10	
DP-PRN-2	0.6	Panelboard	100	22	22	
P-A	0.208	Panelboard	100	10	10	
P-A1	0.208	Panelboard	100	10	10	
P-A12	0.208	Panelboard	100	10	10	
P-AA	0.208	Panelboard	100	10	10	
P-B	0.208	Panelboard	100	10	10	
P-C	0.208	Panelboard	100	10	10	
P-D	0.208	Panelboard	100	10	10	
P-E	0.208	Panelboard	100	0	0	
P-F	0.208	Panelboard	100	10	10	
SPLITTER-1	0.6	Cable Bus	100	22	22	
SPLITTER-2	0.208	Cable Bus	100	22	27.4	
P-A12	0.208	Panelboard	100	10	10	
QO	0.208	Panelboard	100	10	10	

Circuit Breakers:

ID	kV	Type	Bus	Rated Int. Adj. kA	Rated Int. kA
CB_100A SPARE	0.208	Molded Case	DP	10	10
CB_FF01	0.6	Molded Case	DP-PRN-2	25	25
CB_FF02	0.6	Molded Case	DP-PRN-2	25	25
CB_FF07	0.6	Molded Case	DP-PRN-2	22	22
CB_P-A	0.208	Molded Case	DP	10	10
CB_P-AA	0.208	Molded Case	P-A12	10	10
CB_P-B	0.208	Molded Case	DP	10	10
CB_P-C	0.208	Molded Case	DP	10	10
CB_P-D	0.208	Molded Case	DP	10	10
CB_P-E	0.208	Molded Case	DP	10	10
CB_P-F	0.208	Molded Case	DP	10	10
CB_QO	0.208	Molded Case	P-A12	10	10

Fuses:

ID	kV	Type	Bus	Rated Int. Adj. kA	Rated Int. kA
F_150kVA TX	0.6	Fuse	SPLITTER-1	20	20
F_HV-SG	4.16	Fuse	BUS_HV-SG	26	26
F_P1	4.16	Fuse	BUS_HV-SG	26	26
F_TRN-2	600	Fuse	DP-PRN-2	200	200

Switches:

ID	V	Type	Bus	Rated Mom. Asymm. kA
DS-150kVA TX	600	SPST Switch	SPLITTER-1	20
DS-P-A1	208	SPST Switch	SPLITTER-2	10
SW1_TRN-1	4160	SPST Switch	BUS_TRN-1	22
SW1_TRN-2	4160	SPST Switch	BUS_TRN-2	22
SW2_TRN-1	4160	SPST Switch	BUS_TRN-1	22
SW_HV-SG	4160	SPST Switch	BUS_HV-SG	26
SW_P1	4160	SPST Switch	BUS_HV-SG	26
SW_TRN-2	4160	SPST Switch	BUS_TRN-2	63

2.5. Results

The following summary tables are exported from ETAP to evaluate the Fault Current Calculations against the Equipment ratings inputted into the software.

Project:	Arc Flash Study Fort Frontenac	ETAP		Page:	1
Location:	Fort Frontenac, Kingston	24.0.0C		Date:	01-10-2025
Contract:	KN229976			SN:	IDEAINC-01
Engineer:	Nicholas Frayn	Study Case:	SC	Revision:	Rev1
Filename:	24549 - DCC Arc Flash - FF02			Config.:	Normal

Momentary Duty Summary Report

3-Phase Fault Currents: (Prefault Voltage = 100 % of the Bus Nominal Voltage)

Bus		Device		Momentary Duty					Device Capability		
ID	kV	ID	Type	Symm. kA rms	X/R Ratio	M.F.	Asymm. kA rms	Asymm. kA Peak	Symm. kA rms	Asymm. kA rms	Asymm. kA Peak
BUS_HV-SG	4.160	BUS_HV-SG	Switchgear	13.242	5.6	1.284	17.003	29.392		22.000	37.130
	4.160	SW_HV-SG	SPST Switch	13.242	5.6	1.284	17.003	29.392		26.000	
	4.160	SW_P1	SPST Switch	13.242	5.6	1.284	17.003	29.392		26.000	
BUS_TRN-1	4.160	BUS_TRN-1	Cable Bus	13.029	4.9	1.245	16.219	28.086		22.000	37.130
	4.160	SW1_TRN-1	SPST Switch	13.029	4.9	1.245	16.219	28.086		22.000	
	4.160	SW2_TRN-1	SPST Switch	13.029	4.9	1.245	16.219	28.086		22.000	
BUS_TRN-2	4.160	BUS_TRN-2	Cable Bus	11.069	2.3	1.066	11.803	19.751		22.000	37.130
	4.160	SW1_TRN-2	SPST Switch	11.069	2.3	1.066	11.803	19.751		22.000	
	4.160	SW_TRN-2	SPST Switch	11.069	2.3	1.066	11.803	19.751		63.000	
DP	0.208	DP	Panelboard	5.105	2.7	1.090	5.563	9.429	10.000	10.000	
DP-PRN-2	0.600	DP-PRN-2	Panelboard	6.901	4.3	1.212	8.363	14.484	22.000	22.000	
P-A	0.208	P-A	Panelboard	2.764	0.8	1.001	2.766	4.001	10.000	10.000	
P-A1	0.208	P-A1	Panelboard	3.938	1.8	1.028	4.050	6.514	10.000	10.000	
P-A12	0.208	P-A12	Panelboard	3.625	1.4	1.013	3.671	5.704	10.000	10.000	
P-AA	0.208	P-AA	Panelboard	2.703	1.0	1.002	2.707	3.972	10.000	10.000	
P-B	0.208	P-B	Panelboard	1.782	0.6	1.000	1.782	2.531	10.000	10.000	
P-C	0.208	P-C	Panelboard	1.505	0.5	1.000	1.505	2.134	10.000	10.000	
P-D	0.208	P-D	Panelboard	1.782	0.6	1.000	1.782	2.531	10.000	10.000	
P-E	0.208	P-E	Panelboard	1.460	0.5	1.000	1.460	2.069			
P-F	0.208	P-F	Panelboard	1.782	0.6	1.000	1.782	2.531	10.000	10.000	
SPLITTER-1	0.600	SPLITTER-1	Cable Bus	6.197	3.3	1.140	7.067	12.161	22.000	22.000	
	0.600	DS-150kVA TX	SPST Switch	6.197	3.3	1.140	7.067	12.161		20.000	
SPLITTER-2	0.208	SPLITTER-2	Cable Bus	5.336	3.0	1.117	5.962	10.204	22.000	27.400	
	0.208	DS-P-A1	SPST Switch	5.336	3.0	1.117	5.962	10.204		10.000	

- Method: IEEE - X/R is calculated from separate R & X networks.
- Generator protective device duty is calculated based on maximum through fault current. Other protective device duty is calculated based on total fault current.

- The multiplication factors for high voltage circuit-breaker and high voltage bus momentary duty (asymmetrical and crest values) are calculated based on system X/R.

* Indicates a device with momentary duty exceeding the device capability.

Project:	Arc Flash Study Fort Frontenac	ETAP		Page:	2
Location:	Fort Frontenac, Kingston	24.0.0C		Date:	01-10-2025
Contract:	KN229976			SN:	IDEAINC-01
Engineer:	Nicholas Frayn	Study Case:	SC	Revision:	Rev1
Filename:	24549 - DCC Arc Flash - FF02			Config.:	Normal

Interrupting Duty Summary Report

3-Phase Fault Currents: (Prefault Voltage = 100 % of the Bus Nominal Voltage)

Bus		Device			Interrupting Duty				Device Capability			
ID	kV	ID	Type	CPT (Cy)	Symm. kA rms	X/R Ratio	M.F.	Adj. Sym. kA rms	kV	Test PF	Rated Int.	Adjusted Int.
BUS_HV-SG	4.160	F_HV-SG	Fuse		13.242	5.6	1.000	13.242	4.760	6.65	26.000	26.000
		F_P1	Fuse		13.242	5.6	1.000	13.242	4.760	6.65	26.000	26.000
DP	0.208	CB_P-A	Molded Case		5.105	2.7	1.062	5.421	0.240	50.00	10.000	10.000
		CB_P-B	Molded Case		5.105	2.7	1.062	5.421	0.240	50.00	10.000	10.000
		CB_P-C	Molded Case		5.105	2.7	1.062	5.421	0.240	50.00	10.000	10.000
		CB_P-D	Molded Case		5.105	2.7	1.062	5.421	0.240	50.00	10.000	10.000
		CB_P-E	Molded Case		5.105	2.7	1.062	5.421	0.240	50.00	10.000	10.000
		CB_100A SPARE	Molded Case		5.105	2.7	1.062	5.421	0.240	50.00	10.000	10.000
		CB_P-F	Molded Case		5.105	2.7	1.062	5.421	0.240	50.00	10.000	10.000
DP-PRN-2	0.600	CB_FF01	Molded Case		6.901	4.3	1.000	6.901	0.600	20.00	25.000	25.000
		CB_FF02	Molded Case		6.901	4.3	1.000	6.901	0.600	20.00	25.000	25.000
		CB_FF07	Molded Case		6.901	4.3	1.000	6.901	0.600	20.00	22.000	22.000
		F_TRN-2	Fuse		6.901	4.3	1.000	6.901	0.600	15.00	200.000	200.000
P-A	0.208				2.764	0.8						
P-A1	0.208	CB_PA12	Molded Case		3.938	1.8	1.002	3.946	0.240	50.00	10.000	10.000
P-A12	0.208	CB_P-AA	Molded Case		3.625	1.4	1.000	3.625	0.240	50.00	10.000	10.000
P-AA	0.208				2.703	1.0						
P-B	0.208				1.782	0.6						
P-C	0.208				1.505	0.5						
P-D	0.208				1.782	0.6						
P-E	0.208				1.460	0.5						
P-F	0.208				1.782	0.6						
SPLITTER-1	0.600	F_150kVA TX	Fuse		6.197	3.3	1.000	6.197	0.600	20.00	200.000	200.000

- Method: IEEE - X/R is calculated from separate R & X networks.
- HV CB interrupting capability is adjusted based on bus nominal voltage.
- Short-circuit multiplying factor for LV Molded Case and Insulated Case Circuit Breakers is calculated based on asymmetrical current.
- Generator protective device duty is calculated based on maximum through fault current. Other protective device duty is calculated based on total fault current.

* Indicates a device with interrupting duty exceeding the device capability

** Indicates that the circuit breaker has been flagged as a generator circuit breaker. However, ETAP could not detect a single path, without a transformer, to the specified generator. Therefore, this circuit breaker is treated as a regular circuit breaker in short-circuit calculations.

\+ The prefault voltage exceeds the rated maximum kV limit of the circuit breaker - The rated interrupting kA must be derated.

Project:	Arc Flash Study Fort Frontenac	**ETAP**		Page:	1
Location:	Fort Frontenac, Kingston	24.0.0C		Date:	01-10-2025
Contract:	KN229976			SN:	IDEAINC-01
Engineer:	Nicholas Frayn	Study Case:	SC	Revision:	Rev1
Filename:	24549 - DCC Arc Flash - FF02			Config.:	Normal

Momentary Duty Summary Report

3-Phase & 1-Phase Fault Currents: (Prefault Voltage = 100 % of the Bus Nominal Voltage)

Bus		Device			Momentary Duty					Device Capability		
ID	kV	ID	Ckt #	Type	Symm. kA rms	X/R Ratio	M.F.	Asymm. kA rms	Asymm. kA Peak	Symm. kA rms	Asymm. kA rms	Asymm. kA Peak
P-A12	0.208	P-A12		Panelboard	3.625	1.4	1.013	3.671	5.704	10.000	10.000	
QO	0.208	QO		Panelboard	1.811	0.6	1.000	1.811	2.581	10.000	10.000	

Method: IEEE - X/R is calculated from separate R & X networks.

Protective device duty is calculated based on total fault current

For 1-Phase 3-Wire systems (fed from center-tap transformers), the calculated momentary duty for panel's main and feeder protective devices are based on max. of 1-pole and 2-pole faults.

* Indicates a device with momentary duty exceeding the device capability

Project:	Arc Flash Study Fort Frontenac	**ETAP**		Page:	2
Location:	Fort Frontenac, Kingston	24.0.0C		Date:	01-10-2025
Contract:	KN229976			SN:	IDEAINC-01
Engineer:	Nicholas Frayn	Study Case:	SC	Revision:	Rev1
Filename:	24549 - DCC Arc Flash - FF02			Config.:	Normal

Interrupting Duty Summary Report

3-Phase & 1-Phase Fault Currents: (Prefault Voltage = 100 % of the Bus Nominal Voltage)

Bus		Device				Interrupting Duty				Device Capability			
ID	kV	ID	Ckt #	Type	CPT (Cy)	Symm. kA rms	X/R Ratio	M.F.	Adj. Sym. kA rms	kV	Test PF	Rated Int.	Adjusted Int.
P-A12	0.208	CB_QO		Molded Case		3.140	1.4	1.000	3.140	0.240	50.00	10.000	10.000

Method: IEEE - X/R is calculated from separate R & X networks.

HV CB interrupting capability is adjusted based on bus nominal voltage

Short-Circuit multiplying factor for LV Molded Case and Insulated Case Circuit Breakers is calculated based on asymmetrical current.

Generator protective device duty is calculated based on maximum through fault current. Other protective device duty is calculated based on total fault current.

For 1-Phase 3-Wire systems (fed from center-tap transformers), the calculated interrupting duty for panel's main and feeder protective devices are based on max. of 1-pole and 2-pole faults.

* Indicates a device with interrupting duty exceeding the device capability

+ The prefault voltage exceeds the rated maximum kV limit of the circuit breaker - The rated interrupting kA must be derated.

Project:	Arc Flash Study Fort Frontenac	ETAP		Page:	3
Location:	Fort Frontenac, Kingston	24.0.0C		Date:	01-10-2025
Contract:	KN229976			SN:	IDEAINC-01
Engineer:	Nicholas Frayn		Study Case: SC	Revision:	Rev1
Filename:	24549 - DCC Arc Flash - FF02			Config.:	Normal

Three-Phase System Equivalent Model

Bus		Positive Sequence Imp. (ohm)			Negative Sequence Imp. (ohm)			Zero Sequence Imp. (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
P-A12	0.208	0.01892	0.02719	0.03312	0.01892	0.02719	0.03312	0.03854	0.03082	0.04934

2.6. Observations and Recommendations

Based on the short circuit results listed above, the existing equipment is adequately sized to suit the available fault current at this location and no modifications are required with regards to the short circuit study.

Fuses for transformer TRN-2 were not accessible other than the AJT 250A fuses that we're placed in series with the current limiting fuses. The style of fuses that weren't accessible are Bay-O-Net fuses and current limiting fuses installed within the transformer, and due to the lack of maintenance records on these transformers, Drycore Electric and Kingston Utilities recommended to not remove these fuses due to the high chance of failure upon reinstallation. The recommendation is to replace these fuses. Standard values from manufacturers loaded within the ETAP software were used. The recommendation is to replace these fuses with the size indicated in the report, at the short circuit and continuous amperage ratins. Short circuit to be 12kA or greater for current limiting fuses. Continuous rating to be 50A for TRN-2.

3. Protective Device Coordination Study

The protective device coordination study is performed to ensure appropriate protective device ratings and settings are selected to protect the electrical system. The Canadian Electrical Code gives design standards for overcurrent protection ratings such that the equipment won't trip during operation at rated load and will trip at values greater than the continuous amperage rating. Protective device coordination studies are required when considering protecting the system under fault conditions. Coordination studies help with two main concepts:

1. To stop the entire distribution system from shutting down during a down stream fault depending on the location, and
2. To reduce incident energy at the location of the fault by lowering the fault clearing time (FCT)

The above situations are designed by using time-current characteristics plots to ensure that the nearest upstream overcurrent device clears the fault at the specific location it occurs, rather being cleared from a further upstream device that may serve more loads. This can be illustrated by considering a system with a distribution panel (Panel X) that also feeds three downstream panels (Panel A, Panel B and Panel C) . If fault occurred at Panel B, you would want the breaker for Panel B to clear the fault and only energized Panel B. Poor coordination of the system would have the main breaker for Panel X clearing the fault, which would deenergize all three panels. This further away breaker would also give more time for incident energy build, creating a larger arc flash boundary and a dangerous distribution system.

3.1. Methodology

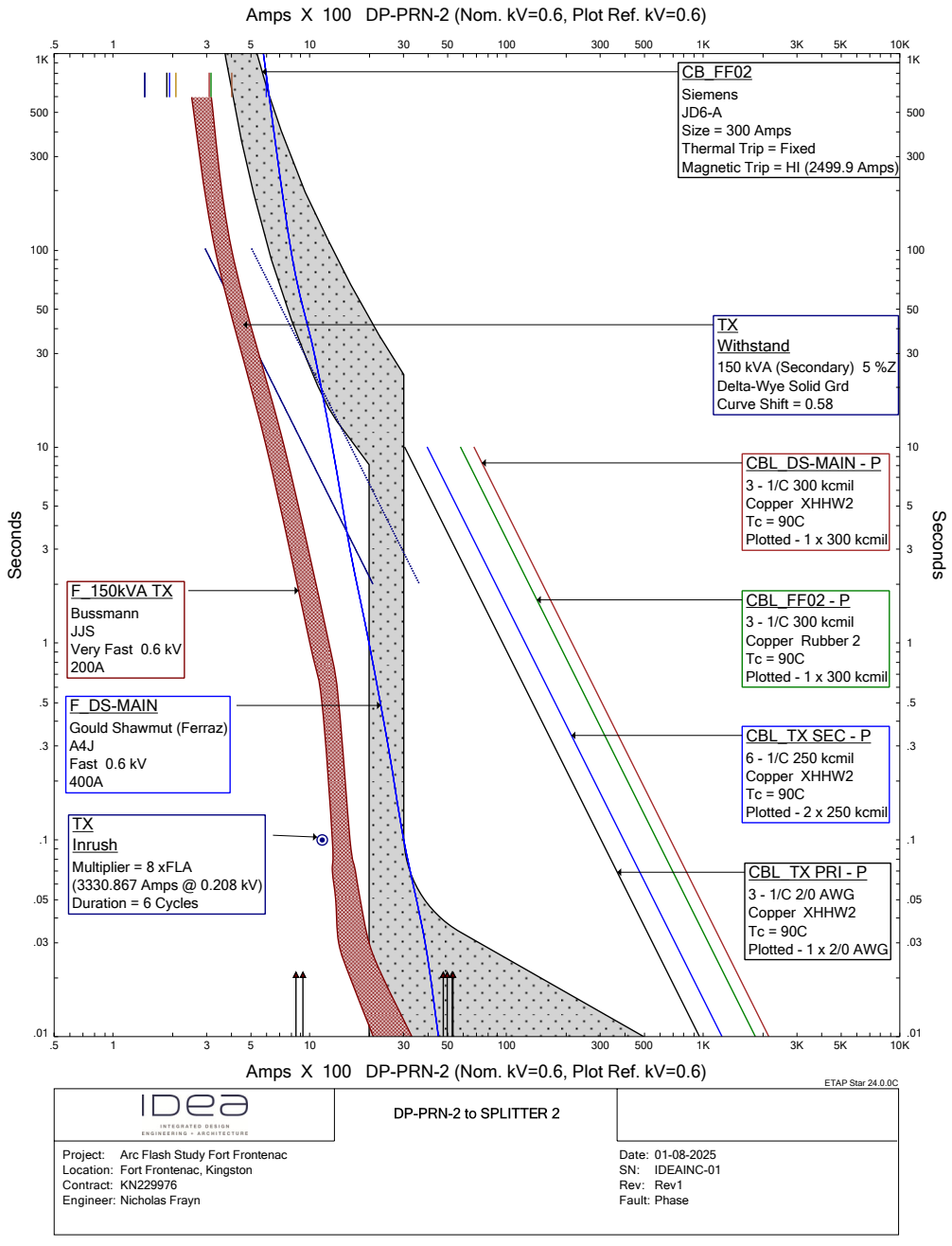
The Protective Device Coordination Study is performed utilizing the ETAP Power System Software. From the modeled distribution system, time-current characteristics curves for protective devices, cables, motors and transformers are plotted on logarithmic time plots (log-log axis). This view is used to visualize the order in which the protective devices will trip in an increasing order of magnitude of time versus current.

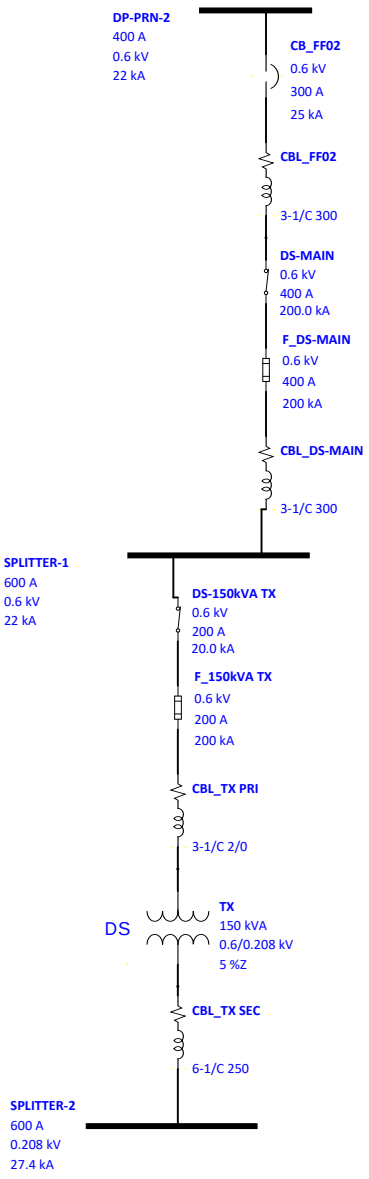
ETAP models the exact device make/models and breaker trip settings to show exactly how the device will operate in the field. In addition to protective device time-current plots, transformer damage curves and inrush current are plotted to ensure the transformer is adequately protected but will also not cause

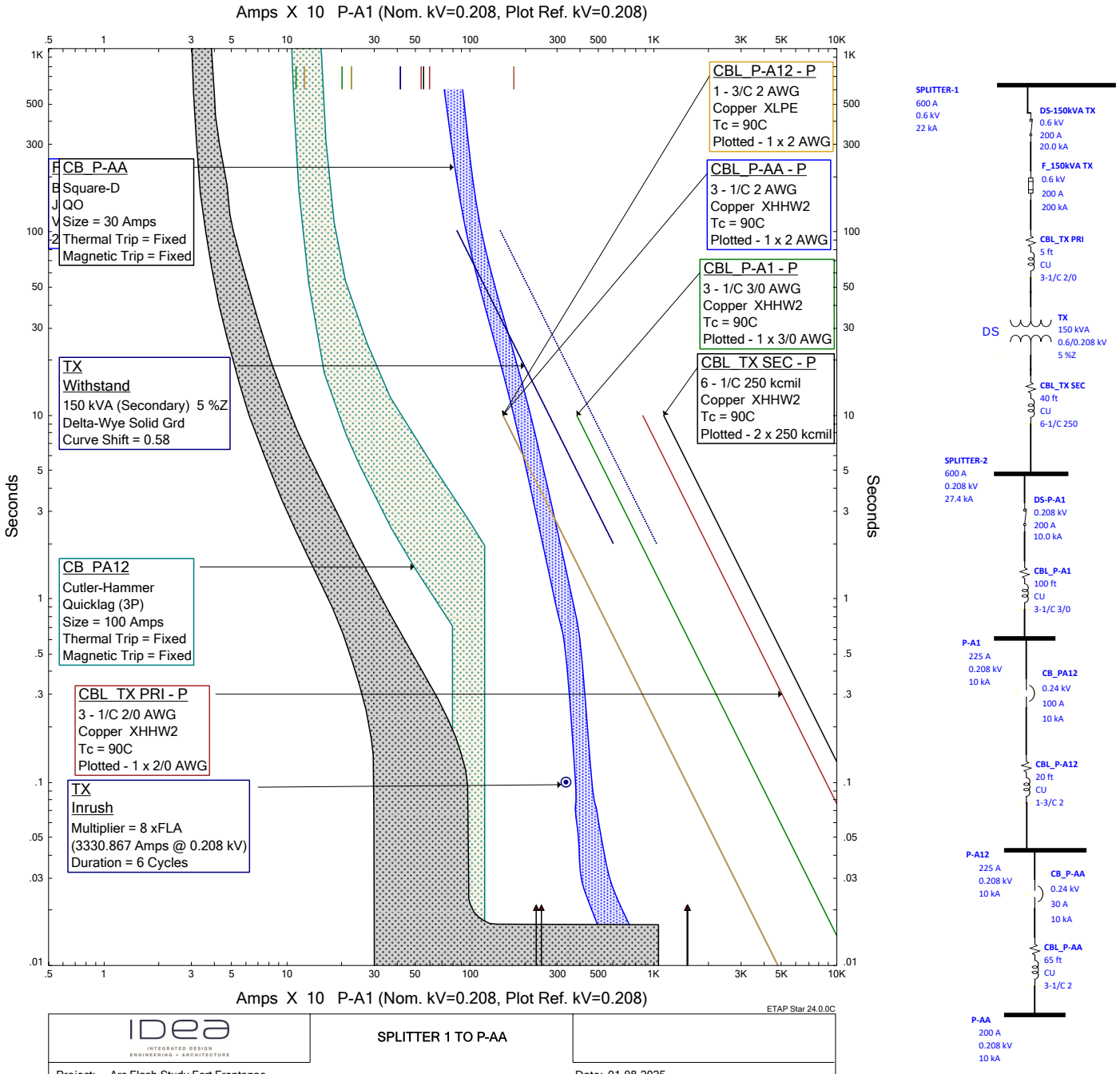
nuisance trips due to their magnetizing current. Cable curves are also displayed to show that the feeder and equipment cables are adequately protected.

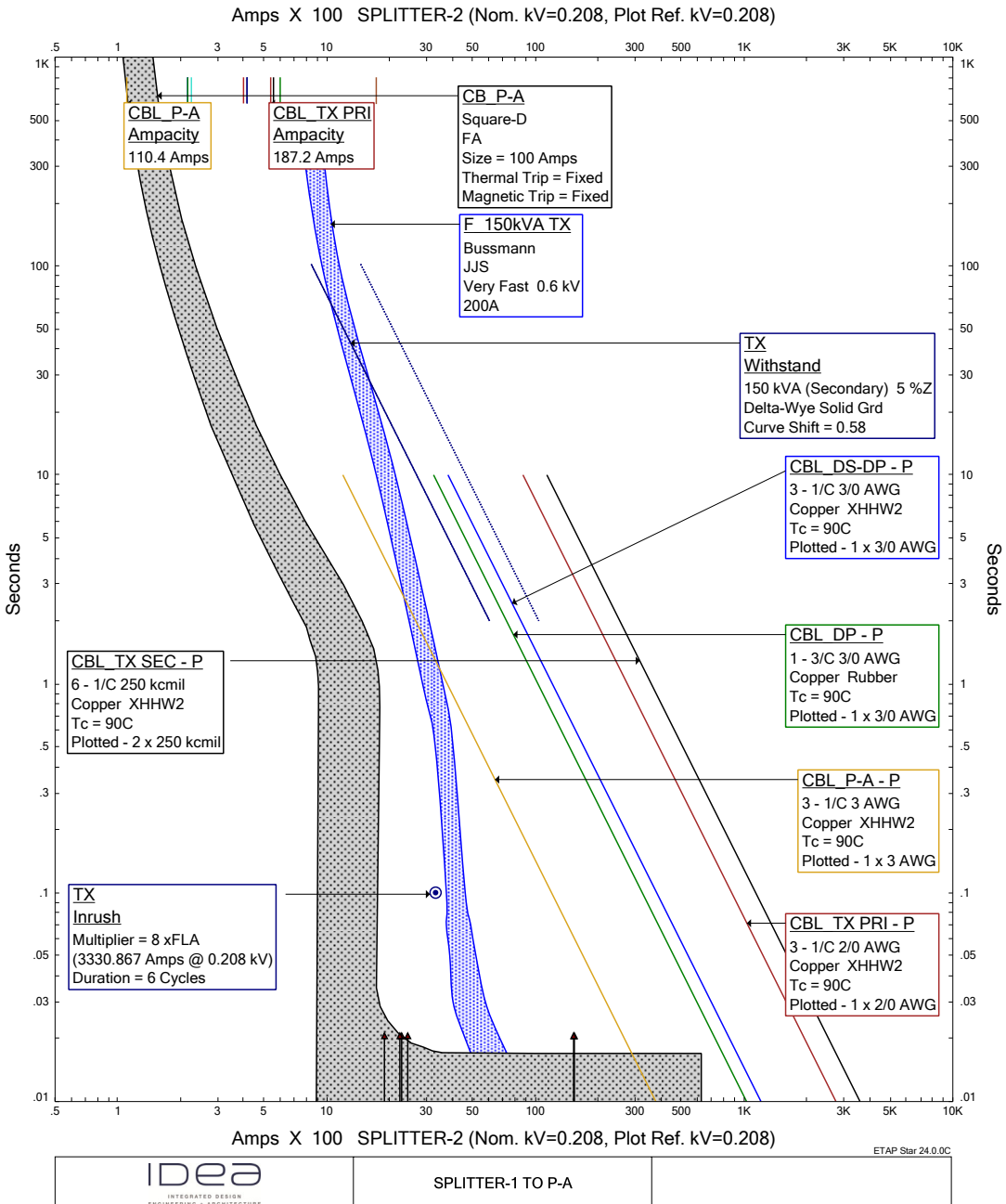
With the time curves plotted, adequate separation between the downstream protective devices and upstream protective devices must be maintained with minimal overlap to ensure only one device, the nearest device, will trip during a fault.

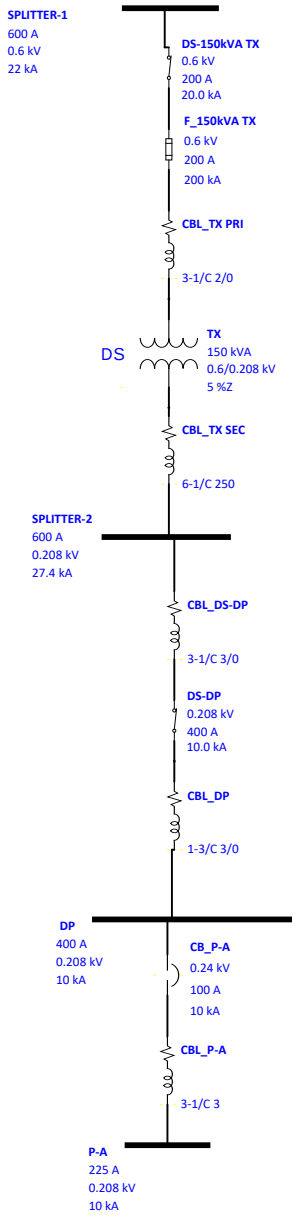
3.2. Time Current Plots


Amps X 100 DP-PRN-2 (Nom. kV=0.6, Plot Ref. kV=0.6)
Seconds
CB_FF02
Siemens
JD6-A
Size = 300 Amps
Thermal Trip = Fixed
Magnetic Trip = HI (2499.9 Amps)
TX
Withstand
150 kVA (Secondary) 5 %Z
Delta-Wye Solid Grd
Curve Shift = 0.58
CBL_DS-MAIN - P
3 - 1/C 300 kcmil
Copper XHHW2
Tc = 90C
Plotted - 1 x 300 kcmil
CBL_FF02 - P
3 - 1/C 300 kcmil
Copper Rubber 2
Tc = 90C
Plotted - 1 x 300 kcmil
CBL_TX SEC - P
6 - 1/C 250 kcmil
Copper XHHW2
Tc = 90C
Plotted - 2 x 250 kcmil
CBL_TX PRI - P
3 - 1/C 2/0 AWG
Copper XHHW2
Tc = 90C
Plotted - 1 x 2/0 AWG
F_150kVA TX
Bussmann
JJS
Very Fast 0.6 kV
200A
F_DS-MAIN
Gould Shawmut (Ferraz)
A4J
Fast 0.6 kV
400A
TX
Inrush
Multiplier = 8 xFLA
(3330.867 Amps @ 0.208 kV)
Duration = 6 Cycles
Amps X 100 DP-PRN-2 (Nom. kV=0.6, Plot Ref. kV=0.6)
ETAP Star 24.0.0C
IDEA
INTEGRATED DESIGN ENGINEERING + ARCHITECTURE
DP-PRN-2 to SPLITTER 2
Project: Arc Flash Study Fort Frontenac
Location: Fort Frontenac, Kingston
Contract: KN229976
Engineer: Nicholas Frayn
Date: 01-08-2025
SN: IDEAINC-01
Rev: Rev1
Fault: Phase


DP-PRN-2
400 A
0.6 kV
22 kA
CB_FF02
0.6 kV
300 A
25 kA
CBL_FF02
3-1/C 300
DS-MAIN
0.6 kV
400 A
200.0 kA
F_DS-MAIN
0.6 kV
400 A
200 kA
CBL_DS-MAIN
3-1/C 300
SPLITTER-1
600 A
0.6 kV
22 kA
DS-150kVA TX
0.6 kV
200 A
20.0 kA
F_150kVA TX
0.6 kV
200 A
200 kA
CBL_TX PRI
3-1/C 2/0
DS
TX
150 kVA
0.6/0.208 kV
5 %Z
CBL_TX SEC
6-1/C 250
SPLITTER-2
600 A
0.208 kV
27.4 kA


Amps X 10 P-A1 (Nom. kV=0.208, Plot Ref. kV=0.208)
Seconds
CB_P-AA
Square-D
QO
Size = 30 Amps
Thermal Trip = Fixed
Magnetic Trip = Fixed
TX
Withstand
150 kVA (Secondary) 5 %Z
Delta-Wye Solid Grd
Curve Shift = 0.58
CB_PA12
Cutler-Hammer
Quicklag (3P)
Size = 100 Amps
Thermal Trip = Fixed
Magnetic Trip = Fixed
CBL_TX PRI - P
3 - 1/C 2/0 AWG
Copper XHHW2
Tc = 90C
Plotted - 1 x 2/0 AWG
TX
Inrush
Multiplier = 8 xFLA
(3330.867 Amps @ 0.208 kV)
Duration = 6 Cycles
CBL_P-A12 - P
1 - 3/C 2 AWG
Copper XLPE
Tc = 90C
Plotted - 1 x 2 AWG
CBL_P-AA - P
3 - 1/C 2 AWG
Copper XHHW2
Tc = 90C
Plotted - 1 x 2 AWG
CBL_P-A1 - P
3 - 1/C 3/0 AWG
Copper XHHW2
Tc = 90C
Plotted - 1 x 3/0 AWG
CBL_TX SEC - P
6 - 1/C 250 kcmil
Copper XHHW2
Tc = 90C
Plotted - 2 x 250 kcmil
SPLITTER-1
600 A
0.6 kV
22 kA
DS-150kVA TX
0.6 kV
200 A
20.0 kA
F_150kVA TX
0.6 kV
200 A
200 kA
CBL_TX PRI
5 ft
CU
3-1/C 2/0
DS
TX
150 kVA
0.6/0.208 kV
5 %Z
CBL_TX SEC
40 ft
CU
6-1/C 250
SPLITTER-2
600 A
0.208 kV
27.4 kA
DS-P-A1
0.208 kV
200 A
10.0 kA
CBL_P-A1
100 ft
CU
3-1/C 3/0
P-A1
225 A
0.208 kV
10 kA
CB_PA12
0.24 kV
100 A
10 kA
CBL_P-A12
20 ft
CU
1-3/C 2
P-A12
225 A
0.208 kV
10 kA
CB_P-AA
0.24 kV
30 A
10 kA
CBL_P-AA
65 ft
CU
3-1/C 2
P-AA
200 A
0.208 kV
10 kA
Amps X 10 P-A1 (Nom. kV=0.208, Plot Ref. kV=0.208)
ETAP Star 24.0.0C
IDEA
INTEGRATED DESIGN ENGINEERING + ARCHITECTURE
SPLITTER 1 TO P-AA
Project: Arc Flash Study Fort Frontenac
Location: Fort Frontenac, Kingston
Contract: KN229976
Engineer: Nicholas Frayn
Date: 01-08-2025
SN: IDEAINC-01
Rev: Rev1
Fault: Phase





ETAP Star 24.0.0C

IDEA INTEGRATED DESIGN ENGINEERING + ARCHITECTURE

SPLITTER-1 TO P-A

Project: Arc Flash Study Fort Frontenac
Location: Fort Frontenac, Kingston
Contract: KN229976
Engineer: Nicholas Frayn

Date: 01-08-2025
SN: IDEAINC-01
Rev: Rev1
Fault: Phase

3.3. Recommended Device Ratings and Settings

Protective Device Settings Report

Project:	Arc Flash Study Fort Frontenac	**Date:**	01-10-2025
Location:	Fort Frontenac, Kingston	**Revision:**	Rev1 vs Base
Contract:	KN229976	When Revision vs Base/Revision is Reported:	
Filename:	H:\2024 Projects\24549 DCC Arc Flash\03 ELEC\ETAP Files\24549 - DCC Arc Flash -		= Revision color

Protective Device Settings - Fuse									
Notes	**Designated Bus**	**Fuse ID**	**Base / Revision ID**	**Manufacturer**	**Model**	**Max kV**	**Speed**	**Size**	**Cont. Amp**
	Bus2	F_HV-SG	Base	S&C	SM-5	4.76	Standard	200E	225
	BUS_HV-SG	F_P1	Base	S&C	SM-5	4.76	Standard	150E	187
	DP-PRN-2	F_TRN-2	Base	Gould Shawmut (Ferraz)	AJT	0.6	Time Delay	250A	250
1	DP-PRN-2	F_TRN-2	Rev1	Gould Shawmut (Ferraz)	AJT	0.6	Time Delay	50A	50
	Bus4	F_DS-MAIN	Base	Gould Shawmut (Ferraz)	CJ	0.6	Other	300A	300
1	Bus4	F_DS-MAIN	Rev1	Gould Shawmut (Ferraz)	A4J	0.6	Fast	400A	400
*	SPLITTER-1	F_150kVA TX	Base	Gould Shawmut (Ferraz)	CRS	0.6	Time Delay	200A	200
1	SPLITTER-1	F_150kVA TX	Rev1	Bussmann	JJS	0.6	Very Fast	200A	200

Notes:

1 Rev1 settings is different from Base

* Device Rating is different from Library

Protective Device Settings - Low Voltage Circuit Breaker with Thermal-Magnetic Trip Device										
Notes	Designated Bus	LVCB ID	Base / Revision ID	Manufacturer	Breaker		Thermal		Magnetic (Inst.)	
					Model	Size	Setting	Trip (Amps)	Setting	Trip (Amps)
	DP-PRN-2	CB_FF02	Base	Siemens	JD6-A	300	Fixed	300.000	LO	1250.100
1	DP-PRN-2	CB_FF02	Rev1	Siemens	JD6-A	300	Fixed	300.000	HI	2499.900
	P-A12	CB_P-AA	Base	Square-D	QO	30	Fixed	30.000	Fixed	
	P-A12	CB_QO	Base	Square-D	QO	30	Fixed	30.000	Fixed	
	DP	CB_P-A	Base	Square-D	FA 240V	100	Fixed	100.000	Fixed	
	DP	CB_P-B	Base	Square-D	FA 240V	100	Fixed	100.000	Fixed	
	DP	CB_P-C	Base	Square-D	FA 240V	100	Fixed	100.000	Fixed	
	DP	CB_P-D	Base	Square-D	FA 240V	100	Fixed	100.000	Fixed	
	DP	CB_SPARE 20A	Base	Square-D	FA 240V	20	Fixed	20.000	Fixed	
	DP	CB_P-E	Base	Square-D	FA 240V	100	Fixed	100.000	Fixed	
	DP	CB_100A SPARE	Base	Square-D	FA 240V	100	Fixed	100.000	Fixed	
	DP	CB_P-F	Base	Square-D	FA 240V	100	Fixed	100.000	Fixed	
	DP	CB_SPARE 30A	Base	Square-D	FA 240V	30	Fixed	30.000	Fixed	
	DP	CB_SPARE 60A	Base	Square-D	FA 240V	60	Fixed	60.000	Fixed	
	P-A1	CB_PA12	Base	Westinghouse	BAB	100	Fixed	100.000	Fixed	

Notes:

1 Rev1 settings is different from Base

* Device Rating is different from Library

4. Arc Flash Incident Energy Report

Arc Flash Risk Assessment has become far more recognized in the electrical industry over the past couple years and more specifically in Ontario as the Occupational Health and Safety Act (OHSA) has become more stringent on workplaces putting together protective measure and safety procedures for working with Electrical Equipment. The OHSA references CSA Z462:24 for good practice in electrical safety requirements and procedures.

Arc Flash Risk Assessment is covered via section 4.3.5 of CSA Z462:24. With respect to the frequency of when this analysis should be performed, the standard indicates that 'the incident energy analysis shall be updated when changes occur in the electrical distribution system that could affect the results of the analysis. The incident energy analysis shall also be review for accuracy at intervals not to exceed 5 years.

Performing the incident energy analysis determines the magnitude of energy available at the equipment and the distance of the arc flash boundary. The incident energy is defined as the amount of energy impressed on a surface, a certain distance from the source, generated during an electrical arcing event. As the incident energy magnitude increases, so does that danger to the personnel working around the equipment. The most common injury to personnel is burns through arcs when the incident energy is released. There are four types of energies released during an arcing event. They are thermal energy, blast pressure energy, acoustic energy, and light energy.

Thermal energy causes the most damage to humans, by causing burns to both the skin and respiratory system. Blast pressure energy can cause damage to humans via physical trauma, such as door ejections or shattered equipment striking the person, causing falls and concussions. Acoustic and light energy cause the least harm to people, however the sound and bright intensity can be of the intensity to cause temporary discomfort.

The arc flash boundary is the distance at which the incident energy equals 1.2 cal/cm^2. People are exposed to multiple hazards within the arc flash boundary as listed above, and therefor need to take the appropriate precautions when entering within the boundary. Only qualified personnel should be allowed to work within the boundary, and they are to protect themselves with the appropriate PPE.

4.1. Personal Protective Equipment

Table 2 of CSA Z462:24 lists the selection of arc flash clothing and other PPE for when within the arc flash boundary. The rating of the clothing must also match or exceed the available arc flash energy at the equipment.

Table 2
Selection of arc-rated clothing and other PPE when the incident energy analysis method or an arc flash PPE selection table method is used
(See Clauses 4.3.5.6.2, H.1, H.2, Q.4, and V.4, and Tables H.1, V.1, V.2, and V.3.)

Incident energy exposures equal to 1.2 cal/cm² (5 J/cm²) up to and including 12 cal/cm² (50 J/cm²)
Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy* • Arc-rated long-sleeve shirt and pants or arc-rated coverall or arc flash suit (SR) • Arc-rated faceshield and arc-rated balaclava or arc flash suit hood (SR)† • Arc-rated outerwear (e.g., jacket, parka, rainwear, hard hat liner, high-visibility apparel) (AN)‡ Heavy-duty leather gloves, arc-rated gloves or rubber insulating gloves with protectors (SR)§ Hard hat Safety glasses or safety goggles (SR) Hearing protection Leather footwear**
Incident energy exposures greater than 12 cal/cm² (50 J/cm²)
Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy* • Arc-rated long-sleeve shirt and pants or arc-rated coverall or arc flash suit (SR) • Arc-rated arc flash suit hood • Arc-rated outerwear (e.g., jacket, parka, rainwear, hard hat liner, high-visibility apparel) (AN)‡ Arc-rated gloves or rubber insulating gloves with protectors (SR)§ Hard hat Safety glasses or safety goggles (SR) Hearing protection Leather footwear**

Legend:
SR = selection of one in group is required
AN = as needed

** Arc ratings can be for a single layer, such as an arc-rated shirt and pants or a coverall, or for an arc flash suit or a multi-layer system if tested as a combination consisting of an arc-rated shirt and pants, coverall, and arc flash suit.*
† Faceshields with a wrap-around guarding to protect the face, chin, forehead, ears, and neck area are required by Clause 4.3.7.3.10 c). Where the back of the head is inside the arc flash boundary, a balaclava or an arc flash hood shall be required for full head and neck protection.
‡ The arc rating of outerwear worn over arc-rated clothing that are not used as part of a layered system shall not be required to be equal to or greater than the estimated incident energy exposure.
§ Rubber insulating gloves with protectors provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with protectors, due to their increased material thickness, provide increased arc flash protection.
*** Footwear other than leather or dielectric may be used, provided it has been tested for and demonstrates no ignition, melting, or dripping at or greater than the estimated incident energy exposure.*

The equipment selected for use within an Arc Flash Boundary from Table 2 also have to meet the standards of Table 4 from CSA Z462:24.

4.2. Job Safety Planning

The Arc Flash risk assessment is only one portion of the standardized best practice for electrical job safety in accordance with CSA Z462:24. Employers are required to put in place an Electrical Safety Program to ensure for each and every electrical job all hazards are identified. With this program a Job

Safety Plan is to be in place in order to identify the risk for each and every job. Section 4.1.7.9.2 identifies that the Job Safety Plan for each job shall have the following requirements:

1. Be completed by a qualified person,
2. Be documented,
3. Include the following information:
    a. A description of the job and task;
    b. Identification of the electrical hazards associated with each task;
    c. A shock risk assessment in accordance with Clause 4.3.4 for task involving shock hazards
    d. An arc flash risk assessment in accordance with Clause 4.3.5 for tasks involving an arc flash hazard;
    e. Work procedures involved, special precautions, and energy source controls; and
    f. An emergency response plan.

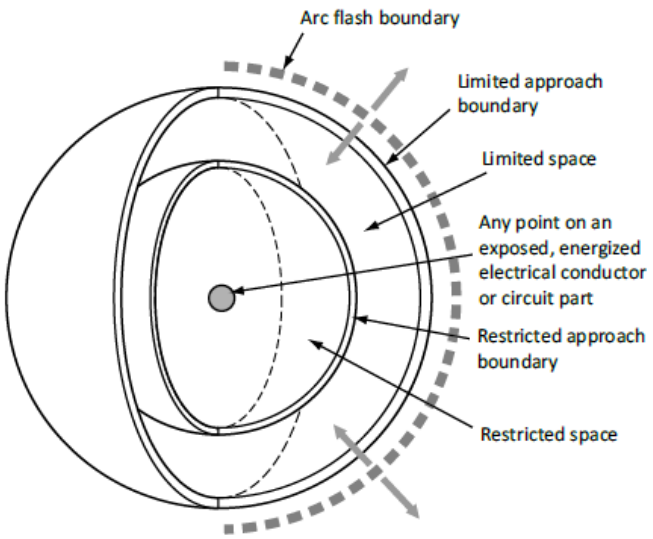
CSA Z462:24 should be reviewed in depth by each employer to create the Job Safety Plan to properly identify the information noted above.

4.3. Shock Risk Assessment

In most cases projects that have an arc flash risk will also have a shock risk component to them in dealing with electrical sources. The shock risk assessment is performed to identify shock hazards, estimate the likelihood of occurrence of injury or damage to health and the potential severity of injury or damage to health, and determine if additional protective measures are required.

By performing a shock risk hazard assessment, the shock protection boundaries will be identified. These are known as the limited and restricted approach boundaries, with each having their own degree of requirements to ensure worker safety. The arc flash boundary, limited approach boundary, and restricted approach boundary are depicted in the image below pulled from CSA Z462.

Limits of approach
(See Clause C.1.3.)



The Arc Flash boundary indicates the proximity to the electrical equipment in which workers are to be wearing arc flash rated clothing.

The limited approach boundary is the area in which no unqualified personnel shall be permitted to approach near energized conductors and circuit parts. Where there is a need for an unqualified person to enter the limited approach boundary, a qualified person shall warn workers of the possible hazards and continuously escort the unqualified person(s) while inside the limited approach boundary.

The restricted approach boundary has the most strict rules for approaching the equipment. Under absolutely no circumstance shall unqualified person(s) be permitted to cross the restricted approach boundary. Qualified persons shall not approach or bring conductive objects closer to the exposed energized electrical conductors or circuit parts operating greater than 30Vac or 60Vdc than the restricted approach boundary specified in Tables 1A and 1B unless at least one of the following applies:

a) The qualified person is insulated or guarded from the energized electrical conductors or circuit parts operating at voltages greater than 30 V ac or 60 V dc. Rubber insulating gloves and sleeves shall be considered insulation only with regard to the energized parts on which work is being performed.

b) The energized electrical conductors or circuit parts are insulated or guarded by a barrier in accordance with Clause 4.3.7.4.8 from the qualified person and from any other conductive object at a different potential.

4.4. Rated Personnel Protective Equipment

In addition to the Arc Flash rating, there are additional standards to the personal protective equipment the qualified personnel are to use within arc flash and shock boundaries. The standards that are to be followed are listed in Table 4 from CSA Z462 below:

Table 4
Standards for personal protective equipment
(See Clause 4.3.7.3.14 and Table A.1.)

Subject	Standard(s)
Apparel — Arc-rated	ASTM F1506
	ASTM F1449
	ASTM F2757
Aprons — Insulating	ASTM F2677
Eye and face protection — General	CSA Z94.3
Face protective products — Arc-rated	ASTM F2178/F2178M
Fall protection	CSA Z259 series of Standards on fall protection
	ASTM F887

Table 4 (Continued)

Subject	Standard(s)
Footwear — Dielectric specification	ASTM F1117
Footwear — Dielectric test method	ASTM F1116
Footwear — Standard performance specification and test method	CSA Z195
Gloves — Arc-rated	ASTM F2675/F2675M
Gloves — Leather protectors	ASTM F696
Gloves and sleeves — Rubber insulating — In-service care	ASTM F496
Gloves – Non-Leather Protectors	ASTM F3258
Gloves — Rubber insulating	ASTM D120
Head protection — Hard hats	CSA Z94.1
Raingear — Arc-rated	ASTM F1891
Rubber protective products — Visual inspection	ASTM F1236
Sleeves — Rubber insulating	ASTM D1051

The shock risk assessment also lists the glove class the qualified worker is to wear when approaching the live equipment. The gloves classifications with respect to equipment voltage are as follows:

Table 3A
Maximum use voltage for rubber insulating gloves
(See Clause 4.3.7.3.7.)

Class designation of glove or sleeve	Maximum AC use Voltage rms, V	Maximum DC use Voltage avg., V	Distances between protector glove cuff and rubber insulating glove cuff, min
00	500	750	13 mm (0.5 in)
0	1000	1500	13 mm (0.5 in)
1	7500	11 250	25 mm (1 in)
2	17 000	25 500	51 mm (2 in)
3	26 500	39 750	76 mm (3 in)
4	36 000	54 000	102 mm (4 in)

Both the protective equipment and gloves listed above are to be maintained on a regular basis, in which CSAZ462 gives guidelines for the appropriate intervals for maintenance of your equipment.

Table 3B
Rubber insulating equipment test intervals
(See Clauses 4.3.7.2.4 and 4.3.7.3.7.)

Type of rubber insulating equipment	When to test	Governing Standard for test voltage
Blankets	Before first issue and every 12 months thereafter	ASTM F479
Covers	Upon indication that insulating value is suspect	ASTM F478
Gloves	Before first issue and every 6 months thereafter	ASTM F496
Line hose	Upon indication that insulating value is suspect	ASTM F478
Sleeves	Before first issue and every 12 months thereafter	ASTM F496

4.5. Methodology

The incident energy analysis method is used in this report to determine the appropriate protective equipment and procedures on is to use during an arc flash, and also produce the arc flash labels stating the ratings of the equipment. The incident energy exposure level is based on the working distance of the worker's face and chest area from a perspective of arc source for the task to be performed. In addition to this the incident energy analysis takes into consideration the characteristics of the overcurrent protective device and its fault clearing time, including its condition of maintenance.

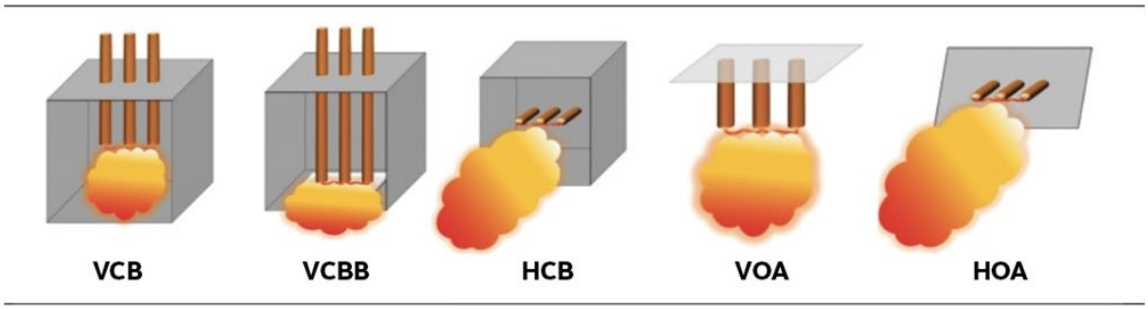
ETAP Power System Software is used to calculate the available arc flash incident energy. The software uses the IEEE 1584 calculation method to determine the available energy and Arc Flash boundary.

The IEEE 1584 method uses updated mathematical models for the calculations. The models take into consideration the system nominal voltage, gap spacing between conductors, electrode configuration, box size, open/enclosed equipment, working distance and coordination information (Time Characteristics Curves). This is why it's important to perform the coordination study and obtain this information for the arc flash analysis.

The electrode configuration is important to take into consideration as it drastically effects how much energy can be released from the equipment. The different types of configurations are:

1. VCB – Vertical conductors/electrodes in a metal box/enclosure
2. VCBB – Vertical conductors/electrodes terminated in a metal box/enclosure's insulating barrier
3. HCB –Horizontal conductors/electrodes in a metal box/enclosure
4. VOA – Vertical conductors/electrodes in open air
5. HOA – Horizontal conductors/electrodes in open air

The five types are illustrated below:



arc flash direction in the various electrode/bus configurations

VCBB, HCB, and HOA were the most recently added configurations to the standard as they were found to greatly increase the incident energy released from the enclosure.

4.6. Arc Incident Energy Summary

Bus Arc Flash Hazard Analysis Summary

Faulted Bus				Fault Current			Trip Device							
ID	Nom. kV	Equipment Type	Gap (mm)	Bolted Fault (kA) Bus	Bolted Fault (kA) PD	PD Arc Fault (kA)	Source Trip Device ID	Trip (cycle)	Open (cycle)	FCT (cycle)	Arc Flash Boundary (ft)	Incident Energy (cal/cm²)	Working Distance (in)	Energy Level
QO	0.208	Panelboard	25	1.811	1.811	0.614	CB_QO	19.76	0.00	19.76	0.8	0.4	18	Level A

Bus Arc Flash Hazard Analysis Summary

Faulted Bus				Fault Current			Trip Device							
ID	Nom. kV	Equipment Type	Gap (mm)	Bolted Fault (kA) Bus	Bolted Fault (kA) PD	PD Arc Fault (kA)	Source Trip Device ID	Trip (cycle)	Open (cycle)	FCT (cycle)	Arc Flash Boundary (ft)	Incident Energy (cal/cm²)	Working Distance (in)	Energy Level
BUS_HV-SG	4.160	Switchgear	104	13.242	13.242	11.487	F_HV-SG	1.53	0.00	1.53	1.4	0.3	36	Level A
BUS_TRN-1	4.160	Cable Bus	104	13.029	13.029	11.306	F_P1	1.42	0.00	1.42	1.5	0.4	36	Level A
BUS_TRN-2	4.160	Cable Bus	104	11.069	11.069	9.636	F_P1	1.60	0.00	1.60	1.4	0.4	36	Level A
DP	0.208	Panelboard	25	5.105	1.770	0.657	F_TRN-2	3.47	0.00	3.47	0.6	0.2	18	Level A
DP-PRN-2	0.600	Panelboard	25	6.901	6.901	5.651	F_TRN-2	0.60	0.00	0.60	0.4	0.1	18	Level A
P-A	0.208	Panelboard	25	2.764	0.958	0.391	F_TRN-2	120.00	0.00	120.00	3.6	4.8	18	Level A
P-A1	0.208	Panelboard	25	3.938	1.365	0.495	F_TRN-2	19.63	0.00	19.63	1.4	1.0	18	Level A
P-A12	0.208	Panelboard	25	3.625	3.625	1.514	CB_PA12	0.50	0.00	0.50	0.1	0.0	18	Level A
P-AA	0.208	Panelboard	25	2.703	2.703	0.948	CB_P-AA	6.76	0.00	6.76	0.5	0.2	18	Level A
P-B	0.208	Panelboard	25	1.782	1.782	0.700	CB_P-B	120.00	0.00	120.00	2.6	2.9	18	Level A
P-C	0.208	Panelboard	25	1.505	1.505	0.583	CB_P-C	120.00	0.00	120.00	2.3	2.4	18	Level A
P-D	0.208	Panelboard	25	1.782	1.782	0.700	CB_P-D	120.00	0.00	120.00	2.6	2.9	18	Level A
P-E	0.208	Panelboard	25	1.460	1.460	0.564	CB_P-E	120.00	0.00	120.00	2.3	2.3	18	Level A
P-F	0.208	Panelboard	25	1.782	1.782	0.700	CB_P-F	120.00	0.00	120.00	2.6	2.9	18	Level A
SPLITTER-1	0.600	Cable Bus	13	6.197	6.197	5.336	F_DS-MAIN	0.60	0.00	0.60	0.3	0.1	18	Level A
SPLITTER-2	0.208	Cable Bus	13	5.336	1.850	0.794	F_TRN-2	1.66	0.00	1.66	0.3	0.1	18	Level A

Arc Flash Analysis Results:

The results of the Arc Flash Incident Energy summary indicate all electrical equipment within the study have an Arc Flash Energy Level Classification of Level A. This states that all energy levels are below 12 cal/cm2 and are within the first class of Arc Flash Personal Protective Equipment. No further reduction of Arc Flash Hazard is deemed necessary at this level.

Please note that the size of fuse TRN-2 has been revised to 40A in an Arc Flash Study for Building FF01, and this reduced the Arc Flash Incident Energy at DP-PRN-2 from Level B (15.894 cal/cm2) to Level A (0.8 cal/cm2).

4.7. Arc Flash Labels

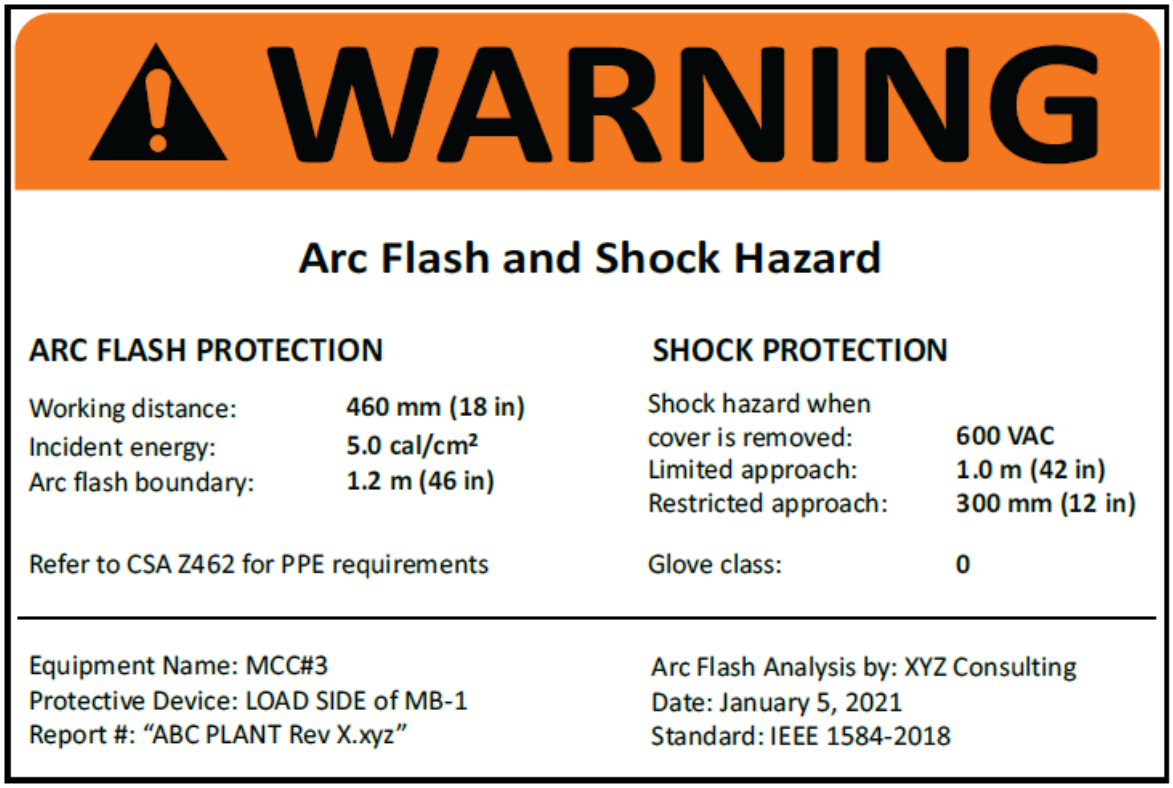
With the incident energy, arc flash boundary, and PPE requirements determined, the information is to be affixed to the equipment in the form of an Arc Flash Label. The Arc Flash labels contain the following information:

1. Nominal System Voltage
2. Arc Flash Boundary
3. At least one of the following:
    a. Available incident energy and the corresponding working distance;
    b. The arc flash PPE minimum arc rating in Table V.1 or V.2 for ac equipment, or V.3 for dc equipment;
    c. Minimum arc-rating of PPE; or
    d. site-specific level of PPE; and
4. date the information required by this Clause was determined.

The label must also:

1. be sufficiently durable to withstand the environment involved.
2. The method of calculation and data to support the information must be documented
3. And the data shall be reviewed for accuracy at intervals not to exceed 5 years

An example of an arc flash label is below:



5. Infrared Thermographic Scanning Report

An infrared thermographic scan should be performed as part of an electrical distribution systems yearly maintenance. Temperature variations can show defects in electrical distribution systems due to the direct correlation of heat loss from current flowing through equipment. Temperature variations can occur because of improper installation (loose connections or lugs), unbalanced loading, undersized equipment due to design error, faulty equipment, and overloaded circuits.

The scan is performed with the equipment covers removed, while under normal operating load to be able to observe any anomalies in temperature variations throughout the internal components and terminations. DCC was notified that the main switchgear was not able to be inspected live, so the two 4160V main switch gear equipment on base were not thermally scanned. The scanning was performed by Eaton personnel with both Arc Flash and Infrared certified training using state of the art equipment exceeding NFPA standards.

The thermographic scan performed by Eaton indicated that no anomalies were present at this building. The thermal images for the equipment can be found in the following:

1. Remaining Equipment with no Anomalies (Remaining Thermal Images - in Appendix B)

6. Phase Balancing Analysis and Equipment Testing

Current and voltage readings were taken at every piece of equipment to determine loading of the distribution system and the voltage drop witnessed from the incoming service to the furthest panel

installed. The results complete with notable observations and solutions are listed below. The complete list of equipment within FF02 including all current and voltage readings can be found in Appendix E.

Observations:

1. Panel E had lock outs from another electrician on site performing work and the electrician was not able to have readings recorded due to the inability to work within the panel.
2. Panel P-A1 has current readings at Ia=34.5A, Ib=3.4A and Ic=25.1A. **Our recommendation is to perform phase balancing on this panel.**
3. The voltage drop readings from the incoming electrical service to the furthest downstream electrical equipment are within the appropriate tolerances to meet the requirements of the Canadian Electrical Code.

7. Visual and Mechanical Inspections

A visual and mechanical inspection was performed while the equipment was scanned and analysed during the site visit. Observations were made to note any corrosion, rust, leaks, safety hazards, violations of the Canadian Electrical Code, grounding issues, physical damage, evidence of moisture, electrical arcing, and the overall general condition of the equipment to ensure it is operating as intended. The internal components were checked for discolouration and proper anchorage. Labelling and panel schedules were also observed on-site and noted for compliance. Lastly the age of the equipment was obtained or estimated from the equipment and included within the report. The results complete with notable observations and solutions are listed below. The complete list of equipment within FF02 including all physical observations can be found in Appendices D&E.

Observations:

Panel E had lock outs from another electrician on site performing work and the electrician was not able to fully open the panel to perform an interior mechanical inspection.

Panel DP:

1. One meter of clearance not met per Canadian Electrical Code.
2. Panel filler missing from one section.
3. EMT above panel is not properly secured.

Recommendation:

1. **Cover open panel sections with new filler**
2. **Remove equipment in front of panel to provide 1m clearance.**
3. **Provide strapping to properly secure EMT conduit above panel**

Panel P-A:

1. One meter of clearance not met per Canadian Electrical Code.
2. Panel cover lock is malfunctioning and not operating properly

Recommendation:

1. **Remove equipment in front of panel to provide 1m clearance.**
2. **Replace locking mechanism on panel cover**

Panel P-B:

1. One meter of clearance not met per Canadian Electrical Code.
2. Conduit fill from a 2” conduit branch conduit is exceeded up to ceiling space
3. Panel has excessive dust and debris within enclosure

Recommendation:

1. **Remove equipment in front of panel to provide 1m clearance.**
2. **Replace conduit with a larger size to suit conduit fill of the cables being routed to the ceiling space. Investigate if this continues within the ceiling space.**
3. **Perform panel clean**

Panel P-C:

1. EMT conduits leaving the panel are not strapped properly
2. Panel has excessive dust and debris within enclosure

Recommendation:

1. **Provide strapping to properly secure conduits.**
2. **Perform panel clean**

Panel P-D:

1. No insulated bushing at feeder conduit.
2. Conduit fill to most conduits installed above the panel are exceeded
3. Panel has excessive dust and debris within enclosure
4. An open knockout is present within the panel.

Recommendation:

1. **Install insulated bushing at panel entrance.**
2. **Replace conduit with a larger size to suit conduit fill of the cables being routed to the ceiling space. Investigate if this continues within the ceiling space.**
3. **Perform panel clean**
4. **Provide knockout cover**

Panel P-F:

1. EMT conduits leaving the panel are not strapped properly

Recommendation:

1. **Provide strapping to properly secure conduits.**

Panel P-A1:

1. Open knockouts are present within the panel.
2. 3 breakers are the incorrect type for the panel.
3. Panel cover is missing screws

Recommendation:

1. **Provide knockout covers**
2. **Provide two new 2P 30A breakers and one new 2P 15A breaker to suit the panel type.**
3. **Provide new panel cover screws**

Panel P-A12:

1. ½"EMT is not secured properly leaving the panel.
2. Panel has excessive dust and debris within cover

Recommendation:

1. **Provide strapping to properly secure the ½" conduit.**
2. **Perform Panel clean.**

Panel P-AA:

1. Moisture, rust, corrosion and oxidization are present within the panel

Recommendation:

1. **Replace panel in kind with gasketed panel due to installation location in exterior shed.**

Panel P-QO:

1. Light rust and corrosion is present within the panel

Recommendation:

1. **Tag panel to be monitored with IR scan every one to two years as increased corrosion can cause failed connections**
2. **Replace panel.**

General Building:

1. Single Line Diagram missing from Electrical Room

Recommendation:

1. **Print and Frame Single Line Diagram as required by CEC.**

Appendix A – Single Line Diagram



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LEVEL OF SECURITY | NIVEAU DE SÉCURITÉ
UNCLASS | NON CLASSIFIÉ

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IDEA
INTEGRATED DESIGN
ENGINEERING + ARCHITECTURE

595 Byron Ave., Ottawa Ont. Ca.
Tele: (613) 728-0008 - Email: info@integrateddesign.ca

NO.	DATE	REVISION	APPR.
1	2025-03-14	ISSUED FOR FINAL REPORT	

SCALE | ÉCHELLE
1:150

LOCATION | EMPLACEMENT
388 ONTARIO STREET
KINGSTON
ONTARIO

PROJECT | PROJET
ARC FLASH STUDY
FORT FRONTENAC
KN299976

TRADE | MÉTIER	DATE
ELECTRICAL	2025-03-14

SUBJECT | SUJET
ELECTRICAL
SITE PLAN

PRODUCTION	REVIEWED | REVU	
DESIGNED | ÉTUDIÉ N.F.	ENG O | O ING	DES O | AGENT CONC
DRAWN | DESSINÉ B.R.	CUSTOMER | CLIENT	PROJ MGR | GEST PROJ
CHECKED | VÉRIFIÉ N.F.	SECT OC | CMDT CSG	DES MGR | GEST CONC
COORDINATION		FIRE | INCENDIE

WBS NO. | NO. OTP	PF NO. | NO. DP
N.700114.23.15	PF500659505

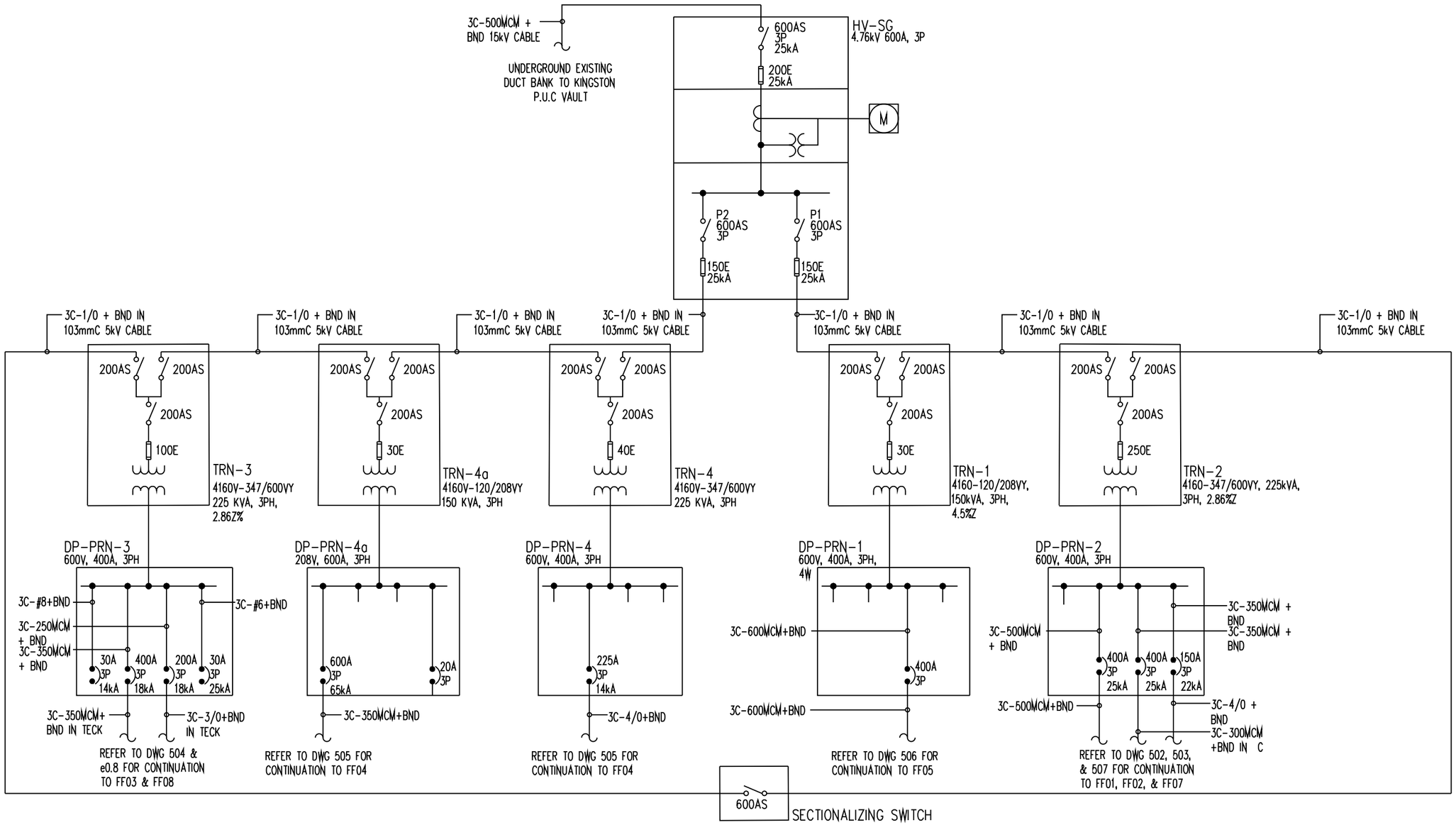
DWG. NO. | NO. DESSIN
K-B35-9306/91-500

Canada

BORDER LAST UPDATED 2012-04-01

2025/Mar/12, 4:50pm nfrayn H:\2024 Projects\24549 DCC Arc Flash\01 A DWGs\5 CADs\04 Electrical\01 Drawing Sheets Electrical\24549 Single Line Diagrams.dwg

Government of Canada / Gouvernement du Canada



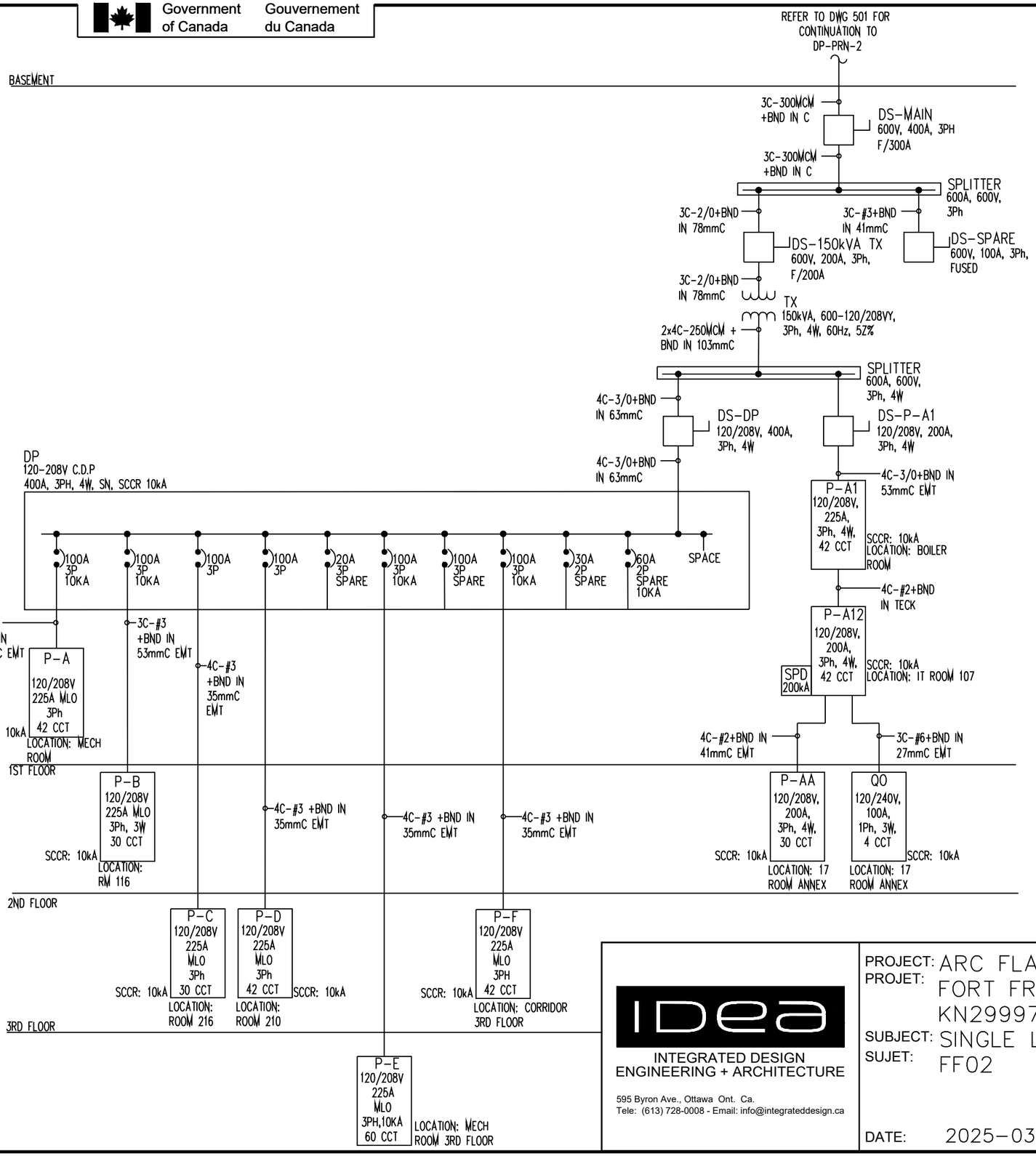
BORDER LAST UPDATED 2011-11-11

IDEA
INTEGRATED DESIGN ENGINEERING + ARCHITECTURE
595 Byron Ave., Ottawa Ont. Ca.
Tele: (613) 728-0008 - Email: info@integrateddesign.ca

PROJECT: ARC FLASH STUDY
PROJET: FORT FRONTENAC KN299976
SUBJECT: SINGLE LINE DIAGRAM
SUJET: TRANSFORMER LOOP
DATE: 2025-03-14

APPROVED: / APPROUVÉ PAR:	N.F.	
	N.F.	
SCALE: / ÉCHELLE:	N/A	
WBS NO.: / NO. OTP:	N.700114.23.15	
PF NO.: / NO. DP:	PF500659505	2/10
DWG NO.: / NO. DESSIN:	K-B35-9306/91-501	

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IDEA
INTEGRATED DESIGN ENGINEERING + ARCHITECTURE
595 Byron Ave., Ottawa Ont. Ca.
Tele: (613) 728-0008 - Email: info@integrateddesign.ca

PROJECT: ARC FLASH STUDY
PROJET: FORT FRONTENAC KN299976
SUBJECT: SINGLE LINE DIAGRAM
SUJET: FF02

DATE: 2025-03-14

APPROVED: / APPROUVÉ PAR:	N.F.	
	N.F.	
SCALE: / ÉCHELLE:	N/A	
WBS NO.: / NO. OTP:	N.700114.23.15	
PF NO.: / NO. DP:	PF500659505	4/10
DWG NO.: / NO. DESSIN:	K-B35-9306/91-503	

BORDER LAST UPDATED 2011-11-11

Appendix B – Thermal Scan Images

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[redacted]

INFRARED SCAN AND EQUIPMENT PICTURES

[redacted]

FORT FRONTENAC

388 ONTARIO ST.

KINGSTON, ONTARIO

K7K 2X9

5480 Canotek Rd., Unit 1, Ottawa, Ontario K1J 9H5 • Tel: 613-745-7600 • Fax: 613-745-5600

DRYCORE
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Job Summary

Project Name: Fort Frontenac IR Scan October 2024

Drycore Job Number: 24-348

Service Location: Fort Frontenac 388 Ontario St. Kingston Ontario

Performed for:
Idea Integrated Design
595 Byron Ave.
Ottawa Ontario
K2A 4C4

Customer Contact: Nick Frayn

Performed By:
Drycore Electric,
1-5480 Canotek Rd.
Ottawa Ontario
K1B 5N2

Field Representative: Andrew Beuman

Date of Scan: October 28th to November 1st, 2024

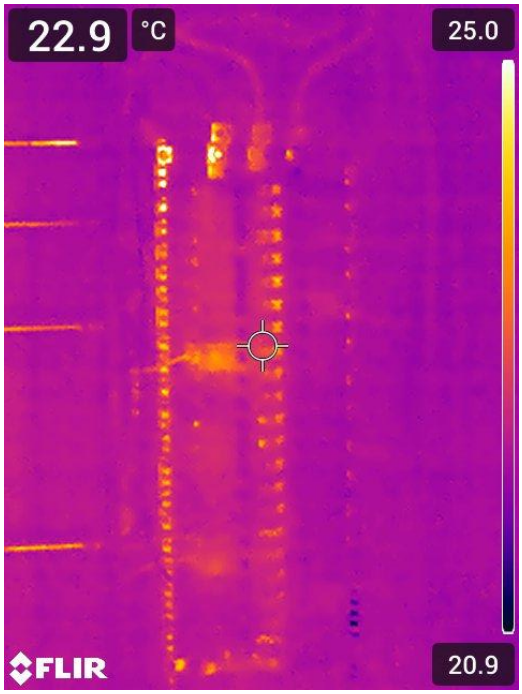
DRYCORE
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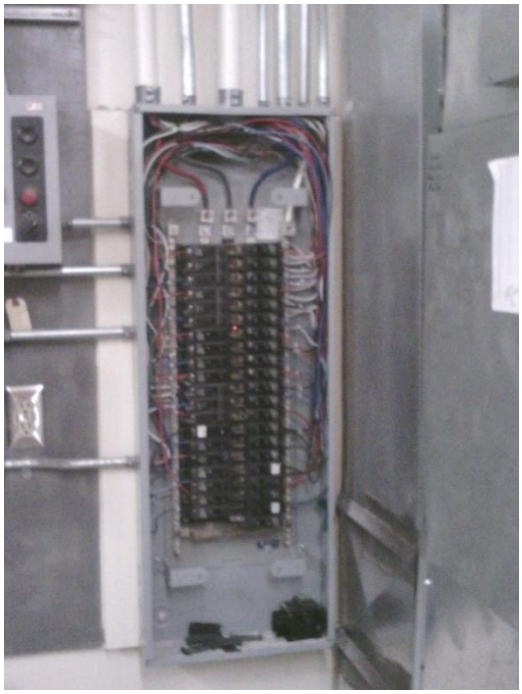
Floor/ Room Number	Equipment Type	Equipment Identification	IR File Number	Picture File Number
Building FF02				
Room 106	PANEL	A Panel	2102	2103
	PANEL	A1 Panel	2104	2105
Room 108	DISC	Main – DP	2106	2107
	PANEL	PNL-DP	2110	2111
Room 107	PANEL	A12 Panel	2112	2113
Room 116	PANEL	B Panel	2114	2115
Room 216	PANEL	C Panel	2116	2117
Room 210	PANEL	D Panel	2118	2119
Hall By Room 309	PANEL	F PANEL	2120	2121
Room 305	PANEL	E Panel	2122	2123
Annex/ Bell Rm	DISC	Main Disc	2126	2127
	DISC	Feed 150KVA	2128	2129
	DISC	Existing PANEL	2130	2131
	DISC	Spare 100A Disc	2132	2133
	SPLITTER	SPLT 120/208V	2134	2135
	SPLITTER	SPLT 347/600V	2124	2125
	DISC	Feed New Panel	2136	2137
	PANEL	AA Panel	2138	2139
	PANEL	QO Panel	2140	2141
Outside Annex	Transformer	150KVA	2142	2143

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Location	Building FF02 ROOM 106
Component	PANEL A
IR File Name	FLIR2102
Picture File Name	FLIR2103
Date	Tuesday October 29th
Image time	8:55 AM



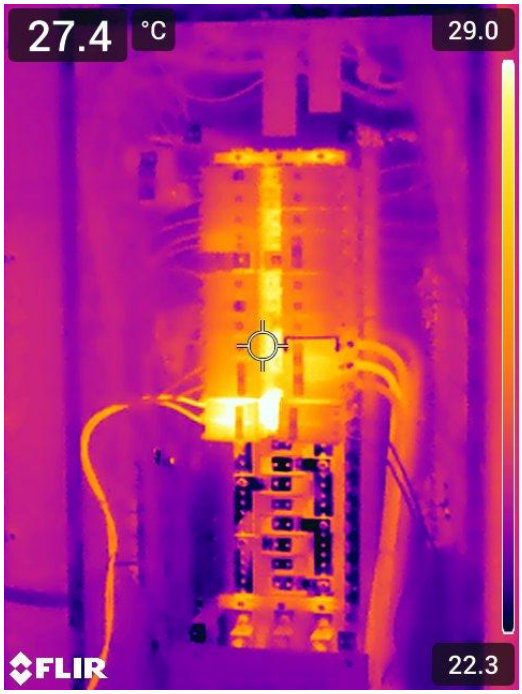


PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	7.8	**A-N**	122
B PHASE	13.8	**B-N**	122
C PHASE	9.8	**C-N**	123
NEUTRAL	4.6	**A-B**	212
		A-C	213
		B-C	212

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Location	Building FF02 ROOM 106
Component	PANEL A1
IR File Name	FLIR2104
Picture File Name	FLIR2105
Date	Tuesday October 29th
Image time	9:06 AM

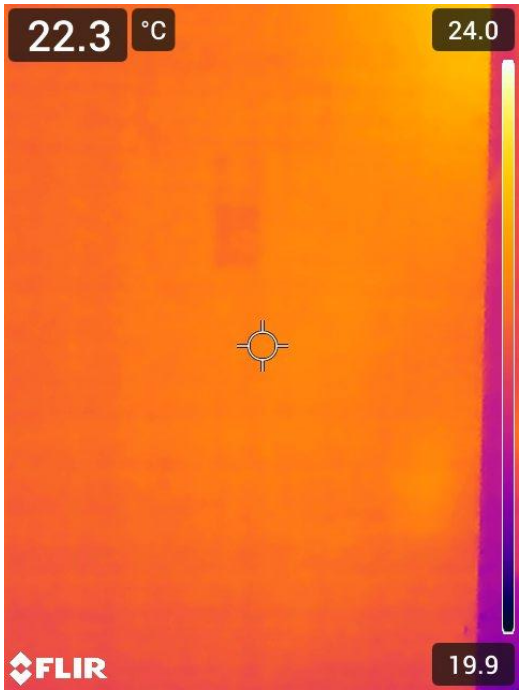




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A PHASE	34.5	**A-N**	124
B PHASE	3.4	**B-N**	125
C PHASE	25.1	**C-N**	124
NEUTRAL	15.9	**A-B**	216
		A-C	215
		B-C	217

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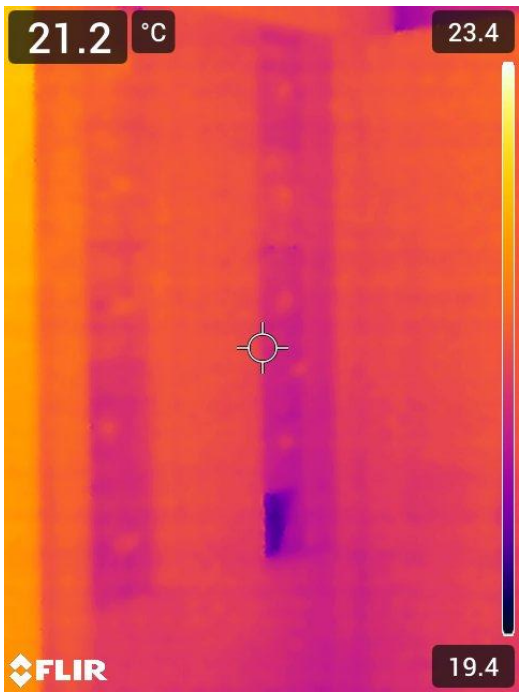
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Component	MAIN DISCONNECT
IR File Name	FLIR2106
Picture File Name	FLIR2107
Date	Tuesday October 29th
Image time	9:59 AM





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Component	PANEL PNL-DP
IR File Name	FLIR2110
Picture File Name	FLIR2111
Date	Tuesday October 29th
Image time	10:00 AM



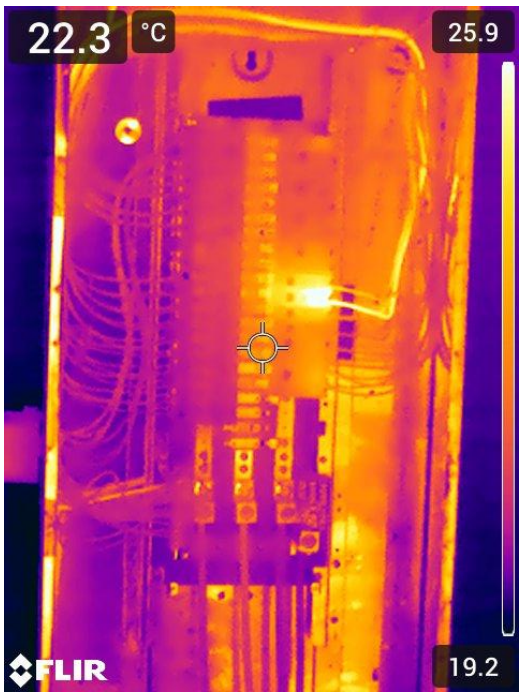


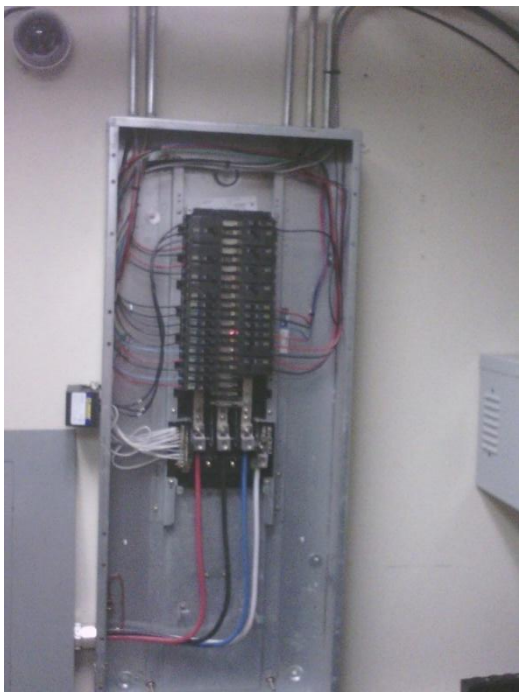
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B PHASE	47	**B-N**	125
C PHASE	36	**C-N**	124
NEUTRAL	13.7	**A-B**	217
		A-C	216
		B-C	217

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Location	Building FF02 ROOM 107
Component	PANEL A12
IR File Name	FLIR2112
Picture File Name	FLIR2113
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Image time	10:14 AM



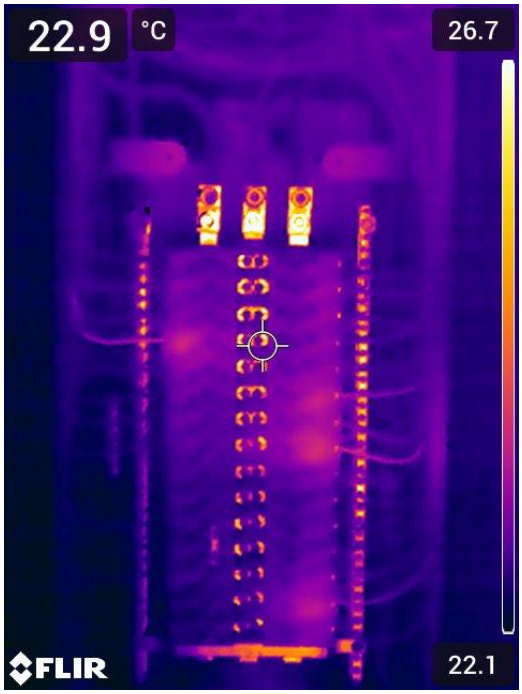


PHASE	LOAD IN AMPS	PHASE	VOLTS
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B PHASE	2.2	**B-N**	123
C PHASE	4.7	**C-N**	125
NEUTRAL	13.2	**A-B**	215
		A-C	216
		B-C	215

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Location	Building FF02 ROOM 116
Component	PANEL B
IR File Name	FLIR2114
Picture File Name	FLIR2115
Date	Thursday October 31st
Image time	12:53 PM



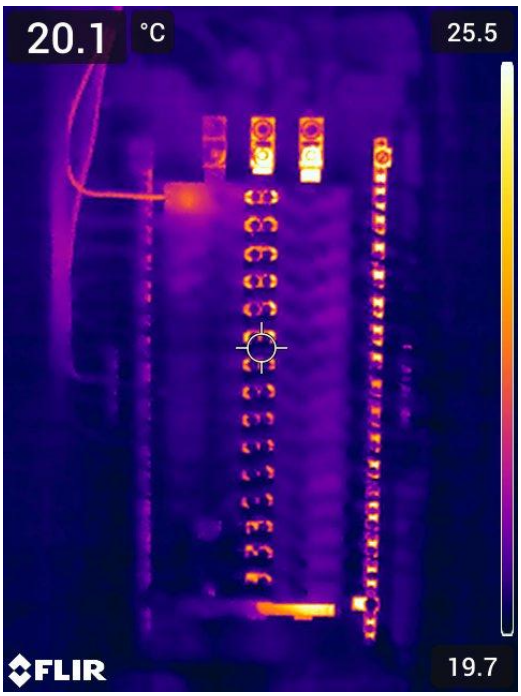


PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	7	**A-N**	125
B PHASE	6.8	**B-N**	124
C PHASE	5.2	**C-N**	123
NEUTRAL	5.8	**A-B**	216
		A-C	216
		B-C	215

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Location	Building FF02 ROOM 216
Component	PANEL C
IR File Name	FLIR2116
Picture File Name	FLIR2117
Date	Thursday October 31st
Image time	1:11 PM



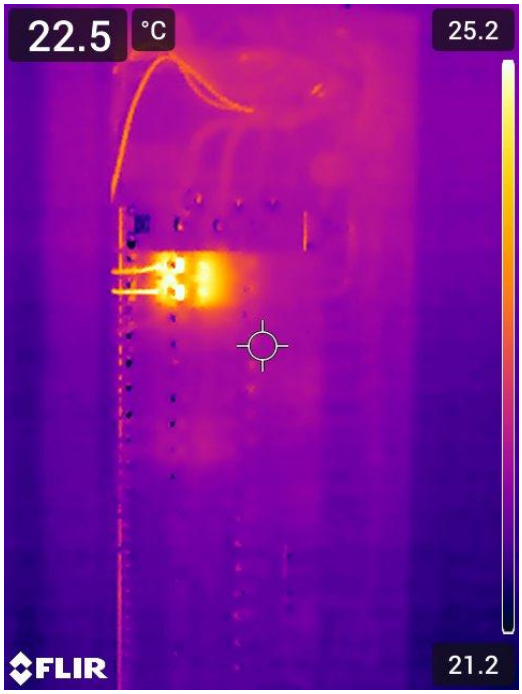


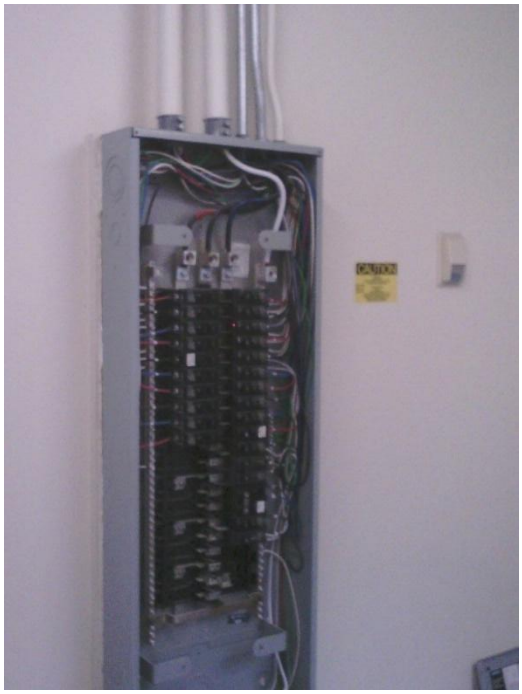
PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	6.4	**A-N**	123
B PHASE	5.5	**B-N**	124
C PHASE	4.3	**C-N**	124
NEUTRAL	4.8	**A-B**	214
		A-C	215
		B-C	216

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Location	Building FF02 ROOM 210
Component	PANEL D
IR File Name	FLIR2118
Picture File Name	FLIR2119
Date	Thursday October 31st
Image time	1:28 PM



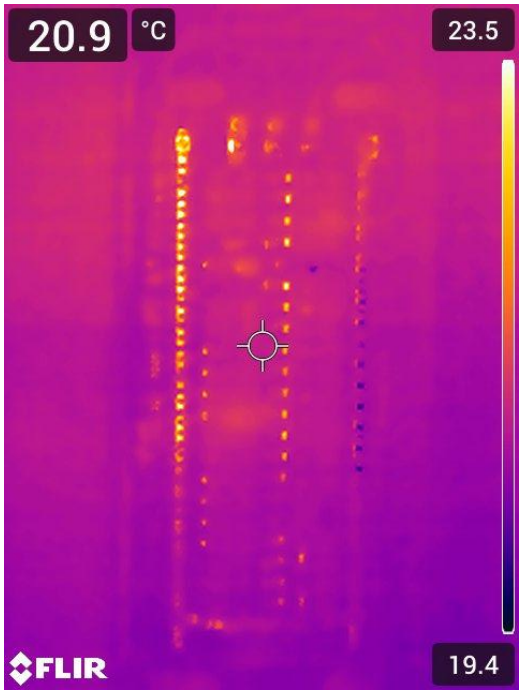


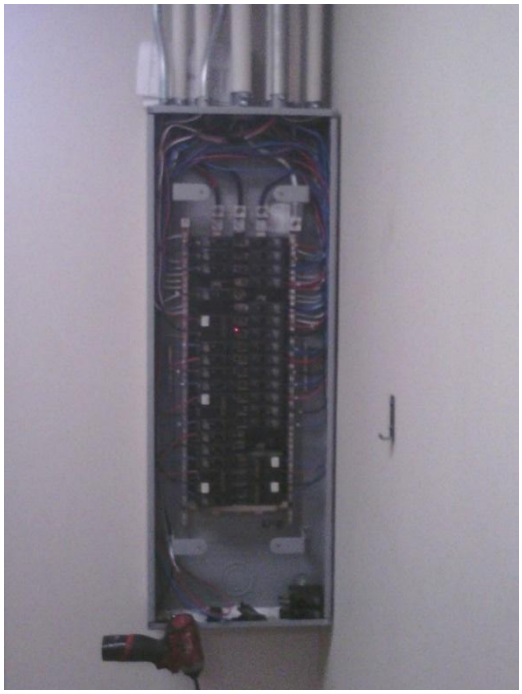
PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	8.5	**A-N**	124
B PHASE	6.8	**B-N**	125
C PHASE	5.8	**C-N**	123
NEUTRAL	5.6	**A-B**	216
		A-C	215
		B-C	214

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Location	Building FF02 HALL BY ROOM 309
Component	PANEL F
IR File Name	FLIR2120
Picture File Name	FLIR2121
Date	Tuesday October 29th
Image time	11:17 AM

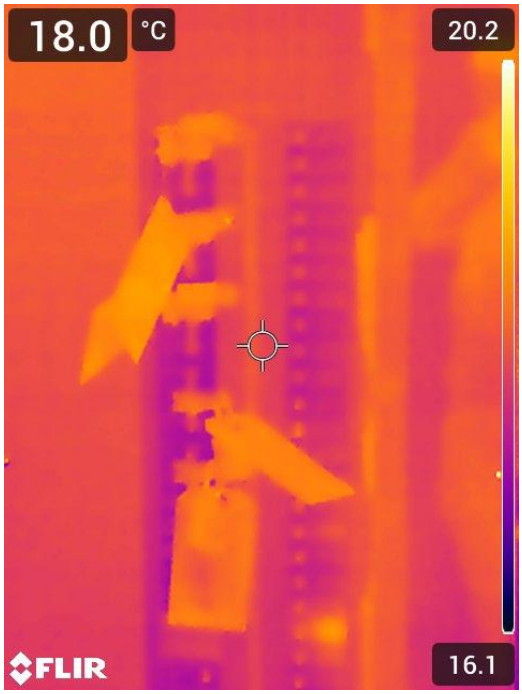




PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	1.5	**A-N**	123
B PHASE	.6	**B-N**	124
C PHASE	4.6	**C-N**	124
NEUTRAL	3.5	**A-B**	214
		A-C	215
		B-C	216

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Location	Building FF02 ROOM 305
Component	PANEL E
IR File Name	FLIR2122
Picture File Name	FLIR2123
Date	Tuesday October 29th
Image time	11:30 AM



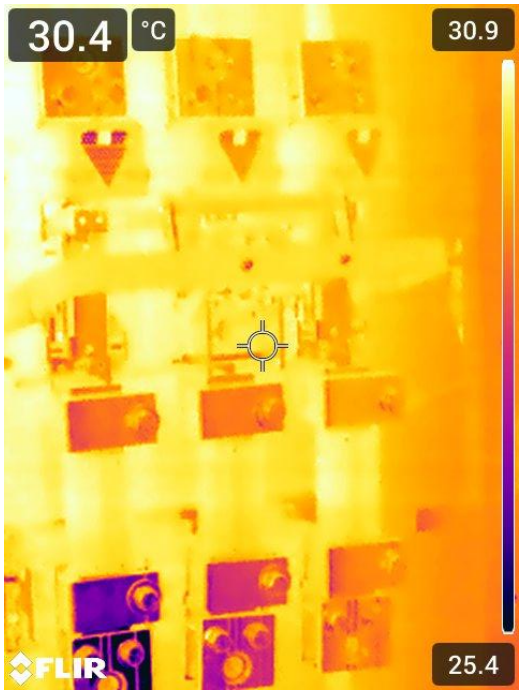


PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	N/A LOTO	**A-N**	
B PHASE	N/A LOTO	**B-N**	
C PHASE	N/A LOTO	**C-N**	
NEUTRAL	N/A LOTO	**A-B**	
		A-C	
		B-C	

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Location	Building FF02 ANNEX/BELL ROOM
Component	MAIN DISCONNECT
IR File Name	FLIR2126
Picture File Name	FLIR2127
Date	Tuesday October 29th
Image time	1:00 PM

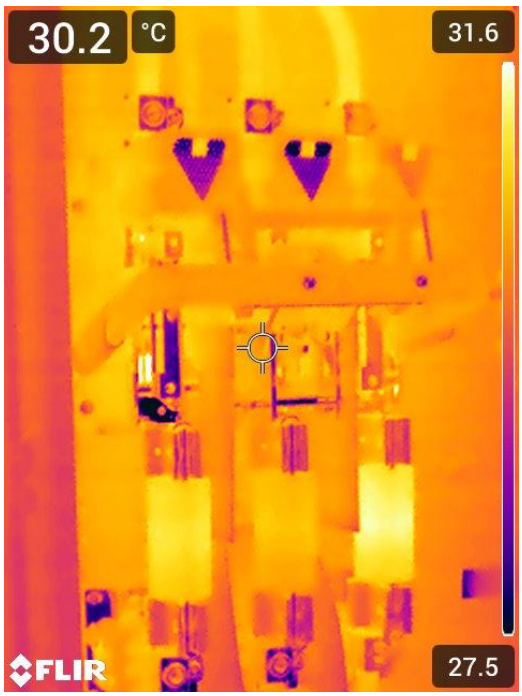




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Location	Building FF02 ANNEX/BELL ROOM
Component	DS-150KVA DISCONNECT
IR File Name	FLIR2128
Picture File Name	FLIR2129
Date	Tuesday October 29th
Image time	1:01 PM

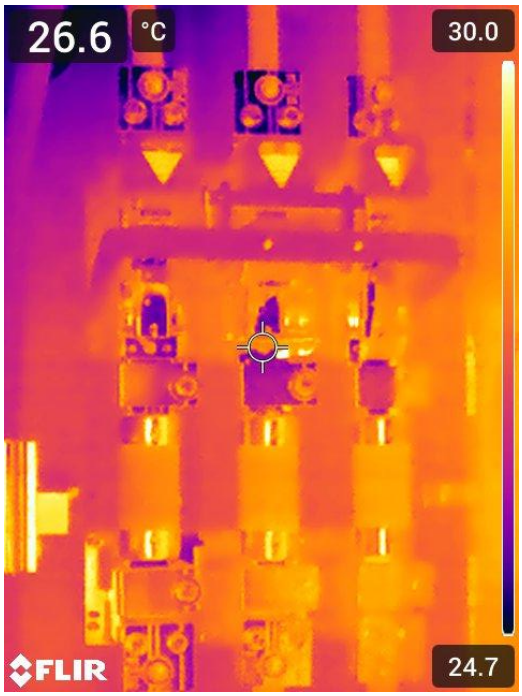




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Location	Building FF02 ANNEX/BELL ROOM
Component	EXISITING PANEL DISCONNECT
IR File Name	FLIR2130
Picture File Name	FLIR2131
Date	Tuesday October 29th
Image time	1:02 PM

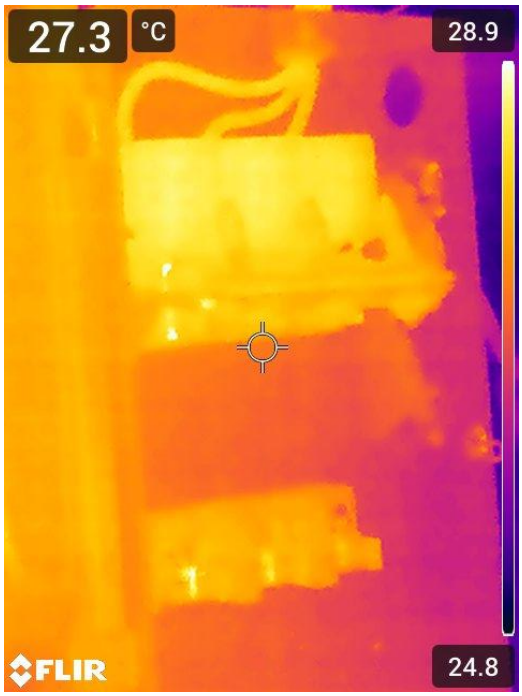


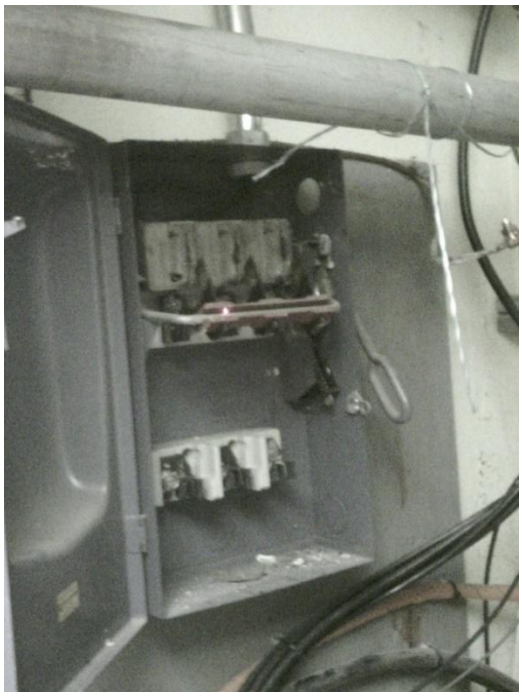


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Location	Building FF02 ANNEX/BELL ROOM
Component	SPARE 100A DISCONNECT
IR File Name	FLIR2132
Picture File Name	FLIR2133
Date	Tuesday October 29th
Image time	1:03 PM





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Location	Building FF02 ANNEX/BELL ROOM
Component	SPLITTER 120/208V
IR File Name	FLIR2134
Picture File Name	FLIR2135
Date	Tuesday October 29th
Image time	1:04 PM

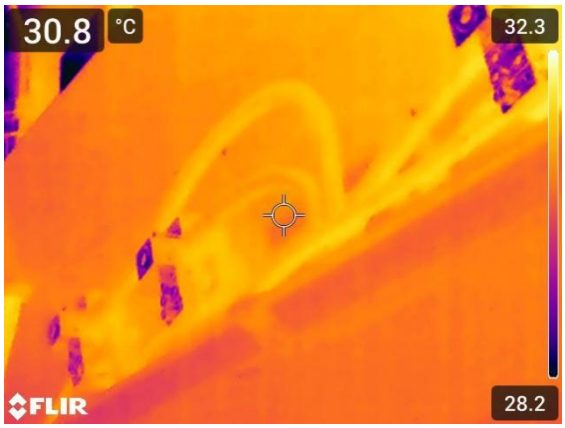




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Location	Building FF02 ANNEX/BELL ROOM
Component	SPLITTER 347/600V
IR File Name	FLIR2124
Picture File Name	FLIR2125
Date	Tuesday October 29th
Image time	12:56 PM

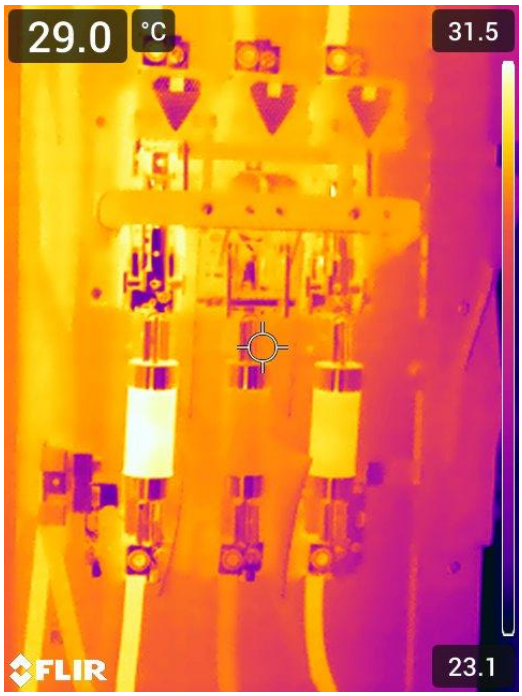




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Location	Building FF02 ANNEX/BELL ROOM
Component	NEW PANEL DISCONNECT
IR File Name	FLIR2136
Picture File Name	FLIR2137
Date	Tuesday October 29th
Image time	1:06 PM

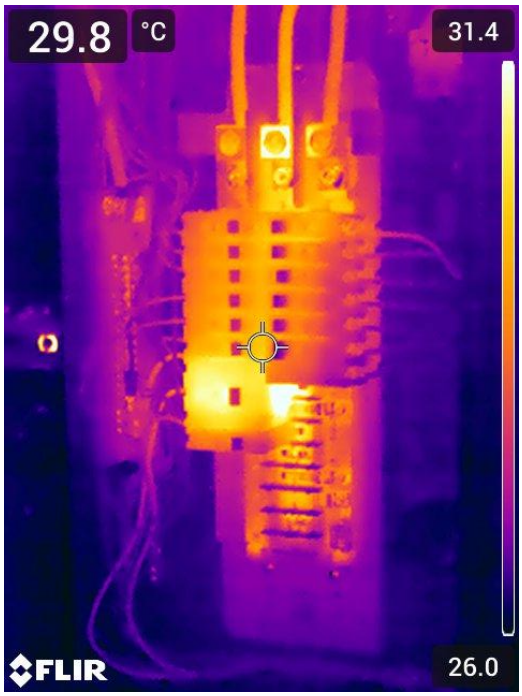


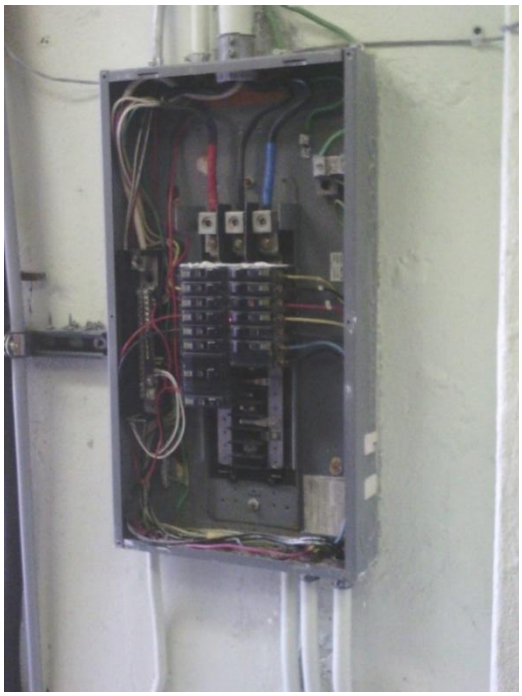


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Location	Building FF02 ANNEX/BELL ROOM
Component	PANEL AA
IR File Name	FLIR2138
Picture File Name	FLIR2139
Date	Tuesday October 29th
Image time	1:08 PM



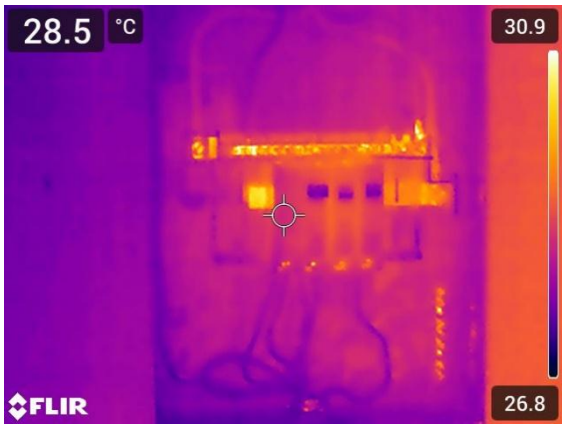


PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	10.7	**A-N**	124
B PHASE	5.3	**B-N**	124
C PHASE	0.0	**C-N**	124
NEUTRAL	7.6	**A-B**	216
		A-C	216
		B-C	215

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Location	Building FF02 ANNEX/BELL ROOM
Component	PANEL QO
IR File Name	FLIR2140
Picture File Name	FLIR2141
Date	Tuesday October 29th
Image time	1:18 PM





PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	1.2	**A-N**	124
B PHASE	1.2	**B-N**	124
C PHASE	N/A	**C-N**	N/A
NEUTRAL	0.0	**A-B**	215
		A-C	N/A
		B-C	N/A

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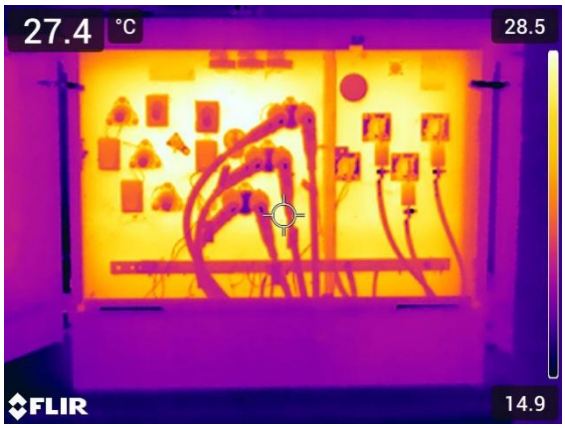
Location	Building FF02 OUTSIDE ANNEX/BELL ROOM
Component	TRANSFORMER 150KVA
IR File Name	FLIR2142
Picture File Name	FLIR2143
Date	Tuesday October 29th
Image time	2:28 PM





DRYCORE
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Location	EXTERIOR BEHIND FF07
Component	TRANSFORMER TRN-2
IR File Name	FLIR2204
Picture File Name	FLIR2205
Date	THURDSAY October 31th
Image time	10:30 AM

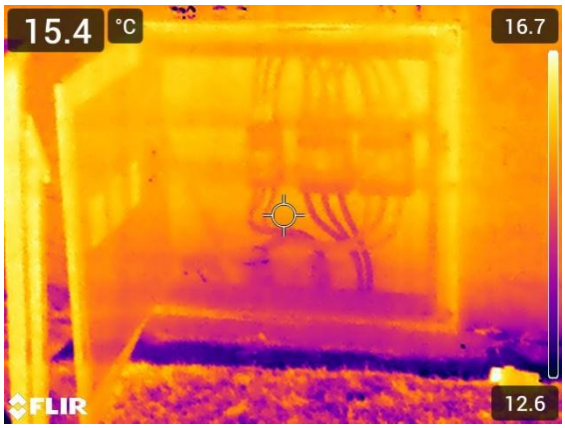




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Location	EXTERIOR BEHIND FF07
Component	TAP BOX DP-PRN2
IR File Name	FLIR2202
Picture File Name	FLIR2203
Date	THURDSAY October 31th
Image time	10:06 AM





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Appendix C – Site Checklist

FF02

Line #	Tasks	Confirmation of Completion	Results/Notes
1	DS-MAIN ANNEX/ BELL ROOM OUTSIDE		
2	Confirm amperage rating	☐	400A
3	Confirm voltage rating	☐	600V
4	Remove cover panel	☐	
5	Perform thermal scanning, record photo's for report	☐	
6	Confirm if fused or unfused	☐	FUSED
7	Confirm fuse ratings (if applicable)	☐	CJ 300A HRC1
8	Confirm fuse type, series, & manufacturer	☐	GOULD SHAWMUT
9	Confirm SCCR rating	☐	
10	Confirm wire size, number of cables per phase, & cable type (Cu/Al) from DS-MAIN to SPLITTER	☐	300 MCM CU 3PH 3 WIRE
11	Confirm wire length, conduit type, & conduit size from DS-MAIN to SPLITTER	☐	4" NIPPLE 10' OF WIRE
12			
13	SPLITTER ANNEX/ BELL ROOM		
14	Confirm amperage rating	☐	600 A
15	Confirm voltage rating	☐	600 V
16	Remove cover panel	☐	
17	Perform thermal scanning, record photo's for report	☐	
18			
19	*Confirm the following wire sizes, number of cables per phase, & cable type (Cu/Al):*		
20	SPLITTER to DS-150kVA TX	☐	2/0 CU 1 WIRE PER PHASE
21	SPLITTER TO DS-SPARE	☐	#3 CU 1 WIRE PER PHASE
22			
23	*Confirm the following lengths of wire, conduit type, & conduit size:*		
24	SPLITTER to DS-150kVA TX	☐	5' OF 3" RIGID
25	SPLITTER TO DS	☐	15' OF 1 1/2 EMT
26			
27	DS-SPARE		
28	Confirm amperage rating	☐	100 A
29	Confirm voltage rating	☐	575 V 30HP
30	Remove cover panel	☐	
31	Perform thermal scanning, record photo's for report	☐	
32	Confirm if fused or unfused	☐	FUSED
33	Confirm fuse ratings (if applicable)	☐	NO FUSES IN DISCONNECT
34	Confirm fuse type, series, & manufacturer	☐	
35	Confirm SCCR rating	☐	
36			
37	DS-150kVA TX		
38	Confirm amperage rating	☐	200 A
39	Confirm voltage rating	☐	600 V
40	Remove cover panel	☐	
41	Perform thermal scanning, record photo's for report	☐	
42	Confirm if fused or unfused	☐	FUSED
43	Confirm fuse ratings (if applicable)	☐	200A
44	Confirm fuse type, series, & manufacturer	☐	GOULD 20KA LR14742
45	Confirm SCCR rating	☐	AMPTRAP
46			
47	TX		
48	Perform thermal scanning, record photo's for report	☐	
49	Confirm wire size, number of cables per phase, & cable type (Cu/Al) from TX to DS-150kVA TX	☐	3" RIGID 3 WIRE 2/0 CU 1 WIRE PER PHASE
50	Confirm wire size, number of cables per phase, & cable type (Cu/Al) from TX to SPLITTER	☐	4" RIGID 4 WIRE 250MCM CU 2 WIRE PER PHASE
51	Confirm wire length, conduit type, & conduit size from TX to DS-150kVA TX	☐	
52	Confirm wire length, conduit type, & conduit size from TX to SPLITTER	☐	40' OF 4" RIGID
53	Confirm kVA rating	☐	15KVA
54	Confirm winding configurations	☐	DELTA/WYE
55	Confirm impedance rating & X/R ratio	☐	600/208V 5%

56			
57	SPLITTER		
58	Confirm amperage rating	☐	600 A
59	Confirm voltage rating	☐	600 V
60	Remove cover panel	☐	
61	Perform thermal scanning, record photo's for report	☐	
62			
63	*Confirm the following wire sizes, number of cables per phase, & cable type (Cu/Al):*		
64	SPLITTER to DS-DP	☐	2 1/2" EMT 5'
65	SPLITTER to DS-P-A1	☐	
66			
67	*Confirm the following lengths of wire, conduit type, & conduit size:*		
68	SPLITTER to DS-DP	☐	3/0 PHASE 4 WIRE Cu 1 WIRE PER PHASE
69	SPLITTER to DS-P-A1	☐	
70			
71	DS-P-A1		
72	Confirm amperage rating	☐	
73	Confirm voltage rating	☐	
74	Remove cover panel	☐	
75	Perform thermal scanning, record photo's for report	☐	
76	Confirm if fused or unfused	☐	
77	Confirm fuse ratings (if applicable)	☐	
78	Confirm fuse type, series, & manufacturer	☐	
79	Confirm SCCR rating	☐	
80			
81	P-A1 ROOM 106		
82	Refer to panel information sheet & perform visual testing for P-A1	☐	
83	Remove panel coverplate	☐	
84	Perform thermal scanning, record photo's for report	☐	
85	Refer to panel information sheet and perform panel testing	☐	
86	Confirm all breaker ratings	☐	
87	Confirm all breaker SCCR ratings	☐	10KA
88	Confirm incoming wire size, number of cables per phase, & cable type (Cu/Al):	☐	3P 4 WIRE CU 3/0
89	Confirm wire length, conduit type, & conduit size from DS-P-A1 to P-A1	☐	2"EMT 100'
90			
91	P-A12 107 IT ROOM		
92	Refer to panel information sheet & perform visual testing for P-A12	☐	
93	Remove panel coverplate	☐	
94	Perform thermal scanning, record photo's for report	☐	
95	Refer to panel information sheet and perform panel testing	☐	
96	Confirm all breaker ratings	☐	10KA
97	Confirm all breaker SCCR ratings	☐	10KA
98	Confirm incoming wire size, number of cables per phase, & cable type (Cu/Al):	☐	3P 4WIRE #2 CU
99	Confirm wire length, conduit type, & conduit size from P-A1 to P-A12	☐	TECK
100			
101	P-AA ANNEX/ BELL ROOM		
102	Refer to panel information sheet & perform visual testing for P-AA	☐	
103	Remove panel coverplate	☐	
104	Perform thermal scanning, record photo's for report	☐	
105	Refer to panel information sheet and perform panel testing	☐	
106	Confirm all breaker ratings	☐	10KA
107	Confirm all breaker SCCR ratings	☐	10KA
108	Confirm incoming wire size, number of cables per phase, & cable type (Cu/Al):	☐	#2 CU 3P 4 WIRE
109	Confirm wire length, conduit type, & conduit size from P-A12 to P-AA	☐	65' OF 1 1/2 EMT
110	Trace P-AA and confirm its fed from P-A12	☐	
111			
112	P-QO ANNEX/ BELL ROOM		
113	Refer to panel information sheet & perform visual testing for P-QO	☐	
114	Remove panel coverplate	☐	
115	Perform thermal scanning, record photo's for report	☐	
116	Refer to panel information sheet and perform panel testing	☐	
117	Confirm all breaker ratings	☐	

118	Confirm all breaker SCCR ratings	☐	10KA
119	Confirm incoming wire size, number of cables per phase, & cable type (Cu/Al):	☐	#6 CU 1P 3 WIRE
120	Confirm wire length, conduit type, & conduit size from P-A12 to P-QO	☐	1" EMT 60'
121	Trace P-QO and confirm its fed from P-A12	☐	CONFIRMED
122			
123	DS-DP RM 108		
124	Confirm amperage rating	☐	400A
125	Confirm voltage rating	☐	120/208V
126	Remove cover panel	☐	
127	Perform thermal scanning, record photo's for report	☐	DISCONNECT COULD NOT BE DEFEATED
128	Confirm if fused or unfused	☐	LIVE
129	Confirm fuse ratings (if applicable)	☐	
130	Confirm fuse type, series, & manufacturer	☐	
131	Confirm SCCR rating	☐	
132			
133	DP ROOM NOT LARGE ENOUGH TO OPEN LIVE		
134	Refer to panel information sheet & perform visual testing for DP	☐	
135	Remove panel coverplate	☐	
136	Perform thermal scanning, record photo's for report	☐	
137	Refer to panel information sheet and perform panel testing	☐	
138	Trace and verify all down stream equipment	☐	
139			
140	*Confirm breaker ratings, SCCR ratings, Trip plug settings for the following:*		
141	Breaker 1	☐	100A 10KA 1,3,5
142	Breaker 2	☐	100A 10KA 2,4,6
143	Breaker 3	☐	100A SET CURVE 7,9,11
144	Breaker 4	☐	100A SET CURVE 8,10,12
145	Breaker 5	☐	100A SET CURVE 13,15,17
146	Breaker 6	☐	100A 10KA 14,16,18
147	Breaker 7	☐	20A 18KA 19,21,23
148	Breaker 8	☐	30A 2POLE 20,22
149	Breaker 9	☐	100A 10KA 25,27,29
150	Breaker 10	☐	60A 2 POLE 10KA 24,26
151			
152	*Confirm the following wire sizes, number of cables per phase, & cable type (Cu/Al):*		
153	DP to DS-DP	☐	3P 4 WIRE
154	DP to P-A	☐	3P 4WIRE #3 CU
155	DP to P-B	☐	3P 4WIRE #3 CU
156	DP to P-C	☐	3P 4WIRE #3 CU
157	DP to P-D	☐	3P 4WIRE #3 CU
158	DP to P-E	☐	3P 4WIRE
159	DP to P-F	☐	3P 4WIRE #3 CU
160			
161	*Confirm the following lengths of wire, conduit type, & conduit size:*		
162	DP to DS-DP	☐	10'
163	DP to P-A	☐	100' in 2" EMT
164	DP to P-B	☐	200' in 2" EMT
165	DP to P-C	☐	250' in 1 1/4 EMT
166	DP to P-D	☐	200' in 1 1/4 EMT
167	DP to P-E	☐	260' in 1 1/4 EMT
168	DP to P-F	☐	200' in 1 1/4 EMT
169			
170	P-A RM106		
171	Refer to panel information sheet & perform visual testing for P-A	☐	
172	Remove panel coverplate	☐	
173	Perform thermal scanning, record photo's for report	☐	
174	Refer to panel information sheet and perform panel testing	☐	
175	Confirm all breaker ratings	☐	
176	Confirm all breaker SCCR ratings	☐	10KA
177			
178	P-B RM116		
179	Refer to panel information sheet & perform visual testing for P-B	☐	
180	Remove panel coverplate	☐	

181	Perform thermal scanning, record photo's for report	☐	
182	Refer to panel information sheet and perform panel testing	☐	
183	Confirm all breaker ratings	☐	
184	Confirm all breaker SCCR ratings	☐	10KA
185			
186	P-C RM216		
187	Refer to panel information sheet & perform visual testing for P-C	☐	
188	Remove panel coverplate	☐	
189	Perform thermal scanning, record photo's for report	☐	
190	Refer to panel information sheet and perform panel testing	☐	
191	Confirm all breaker ratings	☐	
192	Confirm all breaker SCCR ratings	☐	10KA
193			
194	P-D RM210		
195	Refer to panel information sheet & perform visual testing for P-D	☐	
196	Remove panel coverplate	☐	
197	Perform thermal scanning, record photo's for report	☐	
198	Refer to panel information sheet and perform panel testing	☐	
199	Confirm all breaker ratings	☐	
200	Confirm all breaker SCCR ratings	☐	10KA
201			
202	P-E		
203	Refer to panel information sheet & perform visual testing for P-E	☐	
204	Remove panel coverplate	☐	
205	Perform thermal scanning, record photo's for report	☐	
206	Refer to panel information sheet and perform panel testing	☐	
207	Confirm all breaker ratings	☐	
208	Confirm all breaker SCCR ratings	☐	
209			
210	P-F		
211	Refer to panel information sheet & perform visual testing for P-F	☐	TOO MANY BREAKER LOCKS TO TOTALLY OPEN
212	Remove panel coverplate	☐	THE PANEL
213	Perform thermal scanning, record photo's for report	☐	
214	Refer to panel information sheet and perform panel testing	☐	
215	Confirm all breaker ratings	☐	
216	Confirm all breaker SCCR ratings	☐	10KA
217			
218	P-SP NEVER FOUND		
219	Confirm if panel P-SP exists	☐	
220	Confirm where panel P-SP is fed from (if applicable)	☐	
221	Refer to panel information sheet & perform visual testing for P-D	☐	
222	Remove panel coverplate	☐	
223	Perform thermal scanning, record photo's for report	☐	
224	Refer to panel information sheet and perform panel testing	☐	
225	Confirm all breaker ratings	☐	
226	Confirm all breaker SCCR ratings	☐	
227	Confirm incoming wire size, number of cables per phase, & cable type (Cu/Al):	☐	
228	Confirm incoming wire length, conduit type, & conduit size	☐	
229			
230	General		
231	Ensure all relays are located and captured	☐	
232	Measure current on all phases of any piece of equipment found to be anomalous during thermal scans	☐	

TRANSFORMERS USE BAYONET FUSES THAT ARE UNREADABLE WITHOUT DE-ENERGIZATION AND REMOVAL
WE WERE ADVISED BY EATON AND UTILITIES KINGSTON NOT TO TOUCH

Exterior Inspection

Line #	Tasks	Confirmation of Completion	Results/Notes
1	HV Switchgear		
2	*Confirm the following wire sizes, number of cables per phase, & cable type (Cu/Al):*		
3	Incoming service 1 CABLE IN 3 DIFFERENT CONDUITS	☐	500 MCM 15KV CABLE 1 WIRE PER PHASE
4	Feeder P1 to TRN 1	☐	1/0, 5 KV CABLE 1 WIRE PER PHASE
5	Feeder TRN 1 to TRN 2	☐	1/0, 5KV CABLE 1 WIRE PER PHASE
6	Feeder P2 to TRN 3	☐	1/0, 5 KV CABLE 1 WIRE PER PHASE
7	Feeder TRN 3 to TRN 4	☐	1/0, 5 KV CABLE 1 WIRE PER PHASE
8	Feeder TRN 4 to TRN 4a	☐	1/0 5 KV CABLE 1 WIRE PER PHASE
9	Feeder TRN 4a to Sectionaliazing Switch	☐	1/0, 5KV CABLE 1 WIRE PER PHASE
10	Feeder TRN 2 to Sectionaliazing Switch	☐	1/0, 5KV CABLE 1 WIRE PER PHASE
11			
12	*Confirm the following lengths of wire, conduit type, & conduit size:*		
13	HV Switchgear to upstream equipment/location	☐	UNKNOWN
14	Feeder P1 to TRN 1	☐	40' THROUGH 4" DB2
15	Feeder TRN 1 to TRN 2	☐	375' THROUGH 4" DB2
16	Feeder P2 to ~~TRN 3~~ TRN4	☐	250' THROUGH 4" DB2
17	Feeder TRN 3 to TRN 4	☐	225' THROUGH 4" DB2
18	Feeder TRN 4 to TRN 4a	☐	20' THROUGH 4" DB2
19	Feeder TRN 4a to Sectionaliazing Switch	☐	300' THROUGH 4" DB2
20	Feeder TRN 2 to Sectionaliazing Switch	☐	500' THROUGH 4" DB2
21			
22	Refer to panel information sheet & perform visual testing for HV Switchgear	☐	
23	Refer to panel information sheet & perform primary conductor testing	☐	
24	Confirm all upstream equipment from switchgear	☐	KINGSTON UTILITIES EQUIPMENT UNKNOWN
25	Confirm voltage rating	☐	4.76 KV
26	Confirm amperage rating	☐	600A
27	Confirm fuse ratings	☐	200A
28	Confirm fuse type, series, & manufacturers	☐	S&C ELECTRIC CANADA LTD.
29	Confirm fuse SCCR rating	☐	25000 A
30	Confirm main switch amperage rating	☐	200A
31	Confirm main switch SCCR rating	☐	25000A
32	Confirm feeder P1 amperage rating	☐	150A
33	Confirm feeder P1 SCCR rating	☐	25000A
34	Confirm feeder P2 amperage rating	☐	150A
35	Confirm feeder P2 SCCR rating	☐	25000A
36	Open incoming main feeder enclosure and perfrom thermal scanning, record photo's for report	☐	
37	Open main switch enclosure and perfrom thermal scanning, record photo's for report	☐	
38	Open metering enclosure and perform thermal scanning, record photo's for report	☐	
39	Open feeder P1 enclosure and perform thermal scanning, record photo's for report	☐	
40	Open feeder P2 enclosure and perform thermal scanning, record photo's for report	☐	
41			
42	TRN 01		
43	Refer to panel information sheet & perform visual testing for TRN 01	☐	
44	Refer to panel information sheet and perform transformer primary and secondary testing	☐	

45	Confirm primary voltage rating	☐	4161/2400V
46	Confirm secondary voltage rating	☐	120/208V
47	Confirm kVA rating	☐	150KVA
48	Confirm winding configurations	☐	DELTA/WYE
49	Confirm impedance rating & X/R ratio	☐	4.5%
50	Open TRN 01 enclosure and perform thermal scanning, record photo's for report	☐	
51	Confirm over current protection device	☐	Fuses are bayonet fuses: UK advise not to touch
52	Confirm if FF05 is supplied by main tap at TRN 01 or if its fed from distribution panel PRN-1	☐	Fed through DP-PRN-1
53	Remove cover panel from PRN-1 and perform thermal scanning, record photo's for report	☐	
54	Confirm breaker ratings within PRN-1	☐	
55	Confirm breaker SCCR ratings within PRN-1	☐	
56			
57	DP-PRN-1		
58	Refer to panel information sheet & perform visual testing for DP-PRN-1	☐	
59	Remove panel coverplate	☐	
60	Perform thermal scanning, record photo's for report	☐	
61	Refer to panel information sheet and perform panel testing	☐	
62	Confirm all breaker ratings	☐	
63	Confirm all breaker SCCR ratings	☐	60KA @ 220VAC
64			
65	TRN 02		
66	Refer to panel information sheet & perform visual testing for TRN 01	☐	
67	Refer to panel information sheet and perform transformer primary and secondary testing	☐	
68	Confirm primary voltage rating	☐	4160/2400V
69	Confirm secondary voltage rating	☐	347/600V
70	Confirm kVA rating	☐	225KVA
71	Confirm winding configurations	☐	DELTA/ WYE
72	Confirm impedance rating & X/R ratio	☐	2.86%
73	Open TRN 02 enclosure and perfrom thermal scanning, record photo's for report	☐	
74	Confirm over current protection device	☐	250A Fuses AMPTRAMP Dual Element Time Delay
75	Confirm if FF01, 02, & 07 are supplied by main tap at TRN 02 or if they're fed from distribution panel	☐	FED THROUGH DP-PRN-2
76	If TRN 02 feeds a pad mount distribution panel (PRN-#) perfrom the following:	☐	
77	Remove cover panel from PRN and perform thermal scanning, record photo's for report	☐	
78	Confirm breaker ratings within PRN	☐	
79	Confirm breaker SCCR ratings within PRN	☐	
80			
81	DP-PRN-2		
82	Refer to panel information sheet & perform visual testing for DP-PRN-2	☐	
83	Remove panel coverplate	☐	
84	Perform thermal scanning, record photo's for report	☐	
85	Refer to panel information sheet and perform panel testing	☐	
86	Confirm all breaker ratings	☐	
87	Confirm all breaker SCCR ratings	☐	
88			
89	TRN 03		
90	Refer to panel information sheet & perform visual testing for TRN 01	☐	
91	Refer to panel information sheet and perform transformer primary and secondary testing	☐	

Appendix D – Site Panel Information

Arc Flash Study Fort Frontenac – KN299976
Visual Inspection Sheet
388 Ontario St, Kingston, Ontario, K7K 2X9
IDEA #24549

NOTE: These sequences of operation and the test parameters are written to convey the general sequence of events and the expected minimum test parameters measured and testes. This testing document does not convey or attempt to convey the requirements for the contractor's safety program, lockout/tagout or compliance with the CSA Standard Z462 for Arc Flash and Low Voltage Safety. Safety procedures and protocols are the responsibility of the constructor to develop and implement.

PANEL INSPECTION NOTES:

1. Electrician to ensure interior pictures have been recorded for all panels within this inspection document. All recorded pictures are to be sent to IDEA Inc. alongside this completed document.
2. CEC violations inspection is to include the presence of any stored equipment obstructing all electrical equipment listed below.

FF02

Distribution Panel – DP:

Visual Testing

1.	Make/Model/Age of Equipment	Square D/HCN-2345-4/
2.	Voltage Rating	600V
3.	Amperage Rating	400A
4.	Number of Circuits	30CCT
5.	Phase (1/3)	3
6.	MLO or MCB	MLO
7.	MCB Rating (If Applicable)	NA
8.	Short Circuit Current Rating (kA)	10KA
9.	Corrosion/Rust/Leaks Present?	NO
10.	Panel Location (Floor #, Room #)	ROOM
11.	Physical Damage Present?	NO
12.	Evidence of Moisture or Intrusions?	NO
13.	General Condition of Components	GOOD
14.	Bus Bar Condition	GOOD
15.	Verify Panel Labeling	PRESENT
16.	Verify Panel Directories	PRESENT
17.	Condition of Cable Connections	GOOD
18.	CEC Violations Present?	1 M CLEARENCE PANEL FILLER MISSING
19.	Insulation Bushing at Entrance	YES
20.	Appropriate Anchoring Present?	YES
21.	Evidence of Arcing?	NO
22.	Notes	EMT NOT STRAPPER ABOVE PANEL

Panel Testing

1.	Voltage Phase A to Neutral	124
2.	Voltage Phase B to Neutral	125
3.	Voltage Phase C to Neutral	124
4.	Voltage Phase A to B	217
5.	Voltage Phase A to C	216
6.	Voltage Phase B to C	217
7.	Current Phase A	37.4
8.	Current Phase B	47
9.	Current Phase C	36
10.	Current on Neutral	13.7
11.	Current on Ground	3.6
12.	Notes	

Branch Panel – P-A:

Visual Testing

1.	Make/Model/Age of Equipment	Siemens/NLAB442C/
2.	Voltage Rating	120/208V
3.	Amperage Rating	225A
4.	Number of Circuits	42cct
5.	Phase (1/3)	3
6.	MLO or MCB	MLO
7.	MCB Rating (If Applicable)	NA
8.	Short Circuit Current Rating (kA)	10KA
9.	Corrosion/Rust/Leaks Present?	NO
10.	Panel Location (Floor #, Room #)	Basement, Mech Room
11.	Physical Damage Present?	NO
12.	Evidence of Moisture or Intrusions?	NO
13.	General Condition of Components	GOOD
14.	Bus Bar Condition	GOOD
15.	Verify Panel Labeling	PRESENT
16.	Verify Panel Directories	PRESENT
17.	Condition of Cable Connections	GOOD
18.	CEC Violations Present?	1 M CLEARANCE
19.	Insulation Bushing at Entrance	YES
20.	Appropriate Anchoring Present?	YES
21.	Evidence of Arcing?	NO
22.	Notes	PANEL COVER LOCK MALFUCTION

Panel Testing

1.	Voltage Phase A to Neutral	122
2.	Voltage Phase B to Neutral	122
3.	Voltage Phase C to Neutral	123
4.	Voltage Phase A to B	212
5.	Voltage Phase A to C	213
6.	Voltage Phase B to C	212
7.	Current Phase A	7.8
8.	Current Phase B	13.8
9.	Current Phase C	9.8
10.	Current on Neutral	4.6
11.	Current on Ground	0
12.	Notes	

Branch Panel – P-B:

Visual Testing

1. Make/Model/Age of Equipment	NL1B43OCS SEIMENS NEWER
2. Voltage Rating	120/208
3. Amperage Rating	225
4. Number of Circuits	30CCT
5. Phase (1/3)	3 PHASE 3 WIRE
6. MLO or MCB	MLO
7. MCB Rating (If Applicable)	NA
8. Short Circuit Current Rating (kA)	10 KA
9. Corrosion/Rust/Leaks Present?	NONE
10. Panel Location (Floor #, Room #)	1ST FLOOR RM116
11. Physical Damage Present?	NONE
12. Evidence of Moisture or Intrusions?	NONE
13. General Condition of Components	GOOD
14. Bus Bar Condition	GOOD
15. Verify Panel Labeling	PRESNET
16. Verify Panel Directories	PRESENT
17. Condition of Cable Connections	GOOD
18. CEC Violations Present?	1 M CLEARANCE/ CONDUIT FILL
19. Insulation Bushing at Entrance	YES
20. Appropriate Anchoring Present?	YES
21. Evidence of Arcing?	NONE
22. Notes	NEEDS CLEANING

Panel Testing

1. Voltage Phase A to Neutral	125
2. Voltage Phase B to Neutral	124
3. Voltage Phase C to Neutral	123
4. Voltage Phase A to B	216
5. Voltage Phase A to C	216
6. Voltage Phase B to C	215
7. Current Phase A	7
8. Current Phase B	6.8
9. Current Phase C	5.2
10. Current on Neutral	5.8
11. Current on Ground	0
12. Notes	

Branch Panel – P-C:

Visual Testing

1. Make/Model/Age of Equipment	Siemens/NLAB430CS/
2. Voltage Rating	120/208V
3. Amperage Rating	225A
4. Number of Circuits	30
5. Phase (1/3)	3
6. MLO or MCB	MLO
7. MCB Rating (If Applicable)	NA
8. Short Circuit Current Rating (kA)	10KA
9. Corrosion/Rust/Leaks Present?	NONE
10. Panel Location (Floor #, Room #)	2nd Floor, Room 210
11. Physical Damage Present?	NO
12. Evidence of Moisture or Intrusions?	NO
13. General Condition of Components	GOOD
14. Bus Bar Condition	GOOD
15. Verify Panel Labeling	GOOD
16. Verify Panel Directories	PRESENT
17. Condition of Cable Connections	PRESENT
18. CEC Violations Present?	EMT CONDUITS NOT STRAPPED CORRECT
19. Insulation Bushing at Entrance	YES
20. Appropriate Anchoring Present?	GOOD
21. Evidence of Arcing?	NO
22. Notes	NEEDS CLEANING

Panel Testing

1. Voltage Phase A to Neutral	123
2. Voltage Phase B to Neutral	124
3. Voltage Phase C to Neutral	124
4. Voltage Phase A to B	214
5. Voltage Phase A to C	215
6. Voltage Phase B to C	216
7. Current Phase A	6.4
8. Current Phase B	5.5
9. Current Phase C	4.3
10. Current on Neutral	4.8
11. Current on Ground	.2
12. Notes	

Branch Panel – P-D:

Visual Testing

1. Make/Model/Age of Equipment	Siemens/NLAB442C/
2. Voltage Rating	120/208V
3. Amperage Rating	225A
4. Number of Circuits	42
5. Phase (1/3)	3
6. MLO or MCB	MLO
7. MCB Rating (If Applicable)	NA
8. Short Circuit Current Rating (kA)	10 KA
9. Corrosion/Rust/Leaks Present?	NO
10. Panel Location (Floor #, Room #)	2nd Floor, Room 210
11. Physical Damage Present?	NO
12. Evidence of Moisture or Intrusions?	NO
13. General Condition of Components	GOOD
14. Bus Bar Condition	GOOD
15. Verify Panel Labeling	PRESENT
16. Verify Panel Directories	PRESENT
17. Condition of Cable Connections	GOOD
18. CEC Violations Present?	OPEN KNOCKOUT, CONDUIT FILL
19. Insulation Bushing at Entrance	NO
20. Appropriate Anchoring Present?	YES
21. Evidence of Arcing?	NO
22. Notes	CLEANING

Panel Testing

1. Voltage Phase A to Neutral	124
2. Voltage Phase B to Neutral	125
3. Voltage Phase C to Neutral	123
4. Voltage Phase A to B	216
5. Voltage Phase A to C	215
6. Voltage Phase B to C	214
7. Current Phase A	8.5
8. Current Phase B	6.8
9. Current Phase C	5.8
10. Current on Neutral	5.6
11. Current on Ground	.5
12. Notes	

TOO many Lockouts present in panel to open fully

Branch Panel – P-E

Visual Testing

1. Make/Model/Age of Equipment — Siemens/CDP-7/
2. Voltage Rating — 120/208V
3. Amperage Rating — 225A
4. Number of Circuits — 60cct
5. Phase (1/3) — 3
6. MLO or MCB — MLO
7. MCB Rating (If Applicable) —
8. Short Circuit Current Rating (kA) — 10kA
9. Corrosion/Rust/Leaks Present? —
10. Panel Location (Floor #, Room #) — 3rd Floor, Mech Room
11. Physical Damage Present? —
12. Evidence of Moisture or Intrusions? —
13. General Condition of Components —
14. Bus Bar Condition —
15. Verify Panel Labeling —
16. Verify Panel Directories —
17. Condition of Cable Connections —
18. CEC Violations Present? —
19. Insulation Bushing at Entrance —
20. Appropriate Anchoring Present? —
21. Evidence of Arcing? —
22. Notes —

Panel Testing

1. Voltage Phase A to Neutral —
2. Voltage Phase B to Neutral —
3. Voltage Phase C to Neutral —
4. Voltage Phase A to B —
5. Voltage Phase A to C —
6. Voltage Phase B to C —
7. Current Phase A —
8. Current Phase B —
9. Current Phase C —
10. Current on Neutral —
11. Current on Ground —
12. Notes —

Branch Panel – P-F:

Visual Testing

1. Make/Model/Age of Equipment	Siemens/NLAB442C/
2. Voltage Rating	120/208V
3. Amperage Rating	225A
4. Number of Circuits	42cct
5. Phase (1/3)	3
6. MLO or MCB	MLO
7. MCB Rating (If Applicable)	NA
8. Short Circuit Current Rating (kA)	10KA
9. Corrosion/Rust/Leaks Present?	NO
10. Panel Location (Floor #, Room #)	3rd Floor, Corridor
11. Physical Damage Present?	NO
12. Evidence of Moisture or Intrusions?	NO
13. General Condition of Components	GOOD
14. Bus Bar Condition	GOOD
15. Verify Panel Labeling	PRESENT
16. Verify Panel Directories	PRESENT
17. Condition of Cable Connections	GOOD
18. CEC Violations Present?	NO
19. Insulation Bushing at Entrance	YES
20. Appropriate Anchoring Present?	GOOD
21. Evidence of Arcing?	NONE
22. Notes	EMT NOT STRAPPED CORRECTLY

Panel Testing

1. Voltage Phase A to Neutral	123
2. Voltage Phase B to Neutral	124
3. Voltage Phase C to Neutral	124
4. Voltage Phase A to B	214
5. Voltage Phase A to C	215
6. Voltage Phase B to C	216
7. Current Phase A	1.5
8. Current Phase B	.6
9. Current Phase C	4.6
10. Current on Neutral	3.5
11. Current on Ground	0
12. Notes	

Branch Panel – P-A1:

Visual Testing

1. Make/Model/Age of Equipment	WESTING HOUSE
2. Voltage Rating	120/208V
3. Amperage Rating	225A
4. Number of Circuits	42cct
5. Phase (1/3)	3
6. MLO or MCB	MLO
7. MCB Rating (If Applicable)	NA
8. Short Circuit Current Rating (kA)	10KA
9. Corrosion/Rust/Leaks Present?	NO
10. Panel Location (Floor #, Room #)	Boiler Room
11. Physical Damage Present?	NO
12. Evidence of Moisture or Intrusions?	NO
13. General Condition of Components	GOOD
14. Bus Bar Condition	GOOD
15. Verify Panel Labeling	PRESENT
16. Verify Panel Directories	PRESENT
17. Condition of Cable Connections	GOOD
18. CEC Violations Present?	MISSING KNOCKOUTS, WRONG BREAKERS FOR PANEL TYPE
19. Insulation Bushing at Entrance	YES
20. Appropriate Anchoring Present?	YES
21. Evidence of Arcing?	NO
22. Notes	MISSING SCREWS IN COVER breakers wrong type for panel, 2p 30A, 2p 30A, 2p 12A

Panel Testing

1. Voltage Phase A to Neutral	124
2. Voltage Phase B to Neutral	125
3. Voltage Phase C to Neutral	124
4. Voltage Phase A to B	216
5. Voltage Phase A to C	215
6. Voltage Phase B to C	217
7. Current Phase A	34.5
8. Current Phase B	3.4
9. Current Phase C	25.1
10. Current on Neutral	15.9
11. Current on Ground	0
12. Notes	

Branch Panel – P-A12:

Visual Testing

1. Make/Model/Age of Equipment	Square D/NQOD442L225CU/
2. Voltage Rating	120/208V
3. Amperage Rating	225A 200A
4. Number of Circuits	42cct
5. Phase (1/3)	3
6. MLO or MCB	MLO
7. MCB Rating (If Applicable)	NA
8. Short Circuit Current Rating (kA)	10KA
9. Corrosion/Rust/Leaks Present?	NONE
10. Panel Location (Floor #, Room #)	IT Room 107
11. Physical Damage Present?	NO
12. Evidence of Moisture or Intrusions?	NONE
13. General Condition of Components	GOOD
14. Bus Bar Condition	GOOD
15. Verify Panel Labeling	PRESENT
16. Verify Panel Directories	PRESENT
17. Condition of Cable Connections	GOOD
18. CEC Violations Present?	1/2" EMT NOT SUPPORTED
19. Insulation Bushing at Entrance	YES
20. Appropriate Anchoring Present?	YES
21. Evidence of Arcing?	NONE
22. Notes	NEEDS CLEANING

Panel Testing

1. Voltage Phase A to Neutral	124
2. Voltage Phase B to Neutral	123
3. Voltage Phase C to Neutral	125
4. Voltage Phase A to B	215
5. Voltage Phase A to C	216
6. Voltage Phase B to C	215
7. Current Phase A	14.2
8. Current Phase B	2.2
9. Current Phase C	4.7
10. Current on Neutral	13.2
11. Current on Ground	0
12. Notes	

Branch Panel – P-AA:

Visual Testing

1.	Make/Model/Age of Equipment	Square D/QO424ML-2/
2.	Voltage Rating	120/240V
3.	Amperage Rating	200A
4.	Number of Circuits	30cct
5.	Phase (1/3)	3
6.	MLO or MCB	MLO
7.	MCB Rating (If Applicable)	NA
8.	Short Circuit Current Rating (kA)	10KA
9.	Corrosion/Rust/Leaks Present?	YES RUST AND CORROSION
10.	Panel Location (Floor #, Room #)	Room 17 Annex
11.	Physical Damage Present?	NO
12.	Evidence of Moisture or Intrusions?	MOISTURE
13.	General Condition of Components	CORRODED AND OXIDIZED
14.	Bus Bar Condition	OXIDIZED
15.	Verify Panel Labeling	PRESENT
16.	Verify Panel Directories	PRESENT
17.	Condition of Cable Connections	GOOD BUT OXIDIZED
18.	CEC Violations Present?	NO
19.	Insulation Bushing at Entrance	YES
20.	Appropriate Anchoring Present?	YES
21.	Evidence of Arcing?	NO
22.	Notes	Wall of panel is decaying, panel shows signs of water & condensation inside

Panel Testing

1.	Voltage Phase A to Neutral	124
2.	Voltage Phase B to Neutral	124
3.	Voltage Phase C to Neutral	124
4.	Voltage Phase A to B	216
5.	Voltage Phase A to C	216
6.	Voltage Phase B to C	215
7.	Current Phase A	10.7
8.	Current Phase B	5.3
9.	Current Phase C	0.0
10.	Current on Neutral	7.6
11.	Current on Ground	0
12.	Notes	

Branch Panel – QO:

Visual Testing

1.	Make/Model/Age of Equipment	Square D/QO4L-100S/
2.	Voltage Rating	120/240V
3.	Amperage Rating	100A
4.	Number of Circuits	4cct
5.	Phase (1/3)	1
6.	MLO or MCB	MLO
7.	MCB Rating (If Applicable)	NA
8.	Short Circuit Current Rating (kA)	10KA
9.	Corrosion/Rust/Leaks Present?	RUST
10.	Panel Location (Floor #, Room #)	Room 17 Annex
11.	Physical Damage Present?	NO
12.	Evidence of Moisture or Intrusions?	NO
13.	General Condition of Components	LIGHT CORROSION
14.	Bus Bar Condition	LIGHT CORROSION
15.	Verify Panel Labeling	PRESENT
16.	Verify Panel Directories	PRESENT
17.	Condition of Cable Connections	GOOD
18.	CEC Violations Present?	NO
19.	Insulation Bushing at Entrance	YES
20.	Appropriate Anchoring Present?	YES
21.	Evidence of Arcing?	NONE
22.	Notes	RUSTY

Panel Testing

1.	Voltage Phase A to Neutral	124
2.	Voltage Phase B to Neutral	124
3.	Voltage Phase C to Neutral	
4.	Voltage Phase A to B	215
5.	Voltage Phase A to C	
6.	Voltage Phase B to C	
7.	Current Phase A	1.2
8.	Current Phase B	1.2
9.	Current Phase C	
10.	Current on Neutral	0
11.	Current on Ground	0
12.	Notes	

Transformer – TRN-2:

Visual Testing

1. Make/Model/Age of Equipment	CARTE INTERNATIONAL INC.
2. Voltage Rating	4160/2400V 600/347V
3. Amperage Rating	
4. Number of Circuits	
5. Phase (1/3)	3
6. MLO or MCB	
7. MCB Rating (If Applicable)	
8. Short Circuit Current Rating (kA)	
9. Corrosion/Rust/Leaks Present?	
10. Panel Location (Floor #, Room #)	BETWEEN FF01 AND FF02
11. Physical Damage Present?	NO
12. Evidence of Moisture or Intrusions?	NO
13. General Condition of Components	GOOD
14. Bus Bar Condition	GOOD
15. Verify Panel Labeling	NA
16. Verify Panel Directories	NA
17. Condition of Cable Connections	GOOD
18. CEC Violations Present?	NO
19. Insulation Bushing at Entrance	NA
20. Appropriate Anchoring Present?	YES
21. Evidence of Arcing?	NONE
22. Notes	NO penetrox at connections

Transformer Testing (Primary)

1. Voltage Phase A to B	NO VOLTAGE DUE TO HIGH VOLTAGE TERMINATIONS
2. Voltage Phase A to C	
3. Voltage Phase B to C	
4. Current Phase A	
5. Current Phase B	
6. Current Phase C	
7. Current on Ground	
8. Notes	

Transformer Testing (Secondary)

1. Voltage Phase A to Neutral — 353
2. Voltage Phase B to Neutral — 354
3. Voltage Phase C to Neutral — 351
4. Voltage Phase A to B — 614
5. Voltage Phase A to C — 611
6. Voltage Phase B to C — 611
7. Current Phase A — 24.6
8. Current Phase B — 33.4
9. Current Phase C — 28
10. Current on Neutral — NA
11. Current on Ground — .1
12. Notes

Sault Ste. Marie
705.949.5291
421 Bay St. Suite 507
Sault Ste. Marie, ON, P6A 1X3

info@integrateddesign.ca
www.integrateddesign.ca

Ottawa
613.728.0008
595 Byron Ave.
Ottawa, ON, K2A 4C4

Distribution Panel – DP-PRN-2:

Visual Testing

1.	Make/Model/Age of Equipment	UNKNOWN
2.	Voltage Rating	UNKNOWN
3.	Amperage Rating	UNKNOWN
4.	Number of Circuits	SPACE FOR 4 BREAKERS
5.	Phase (1/3)	3
6.	MLO or MCB	
7.	MCB Rating (If Applicable)	NA
8.	Short Circuit Current Rating (kA)	UNKNOWN
9.	Corrosion/Rust/Leaks Present?	MINOR SURFACE RUST
10.	Panel Location (Floor #, Room #)	OUTSIDE FF04
11.	Physical Damage Present?	NO
12.	Evidence of Moisture or Intrusions?	NO
13.	General Condition of Components	GROUND LUG OXIDIZED
14.	Bus Bar Condition	NA
15.	Verify Panel Labeling	NO
16.	Verify Panel Directories	YES
17.	Condition of Cable Connections	GOOD
18.	CEC Violations Present?	REQUIRES FEILD EVALUATION OF ESAFE
19.	Insulation Bushing at Entrance	NA
20.	Appropriate Anchoring Present?	YES
21.	Evidence of Arcing?	NONE
22.	Notes	Needs field evaluation Esafe

Panel Testing

1.	Voltage Phase A to Neutral	353
2.	Voltage Phase B to Neutral	354
3.	Voltage Phase C to Neutral	351
4.	Voltage Phase A to B	614
5.	Voltage Phase A to C	611
6.	Voltage Phase B to C	611
7.	Current Phase A	24.6
8.	Current Phase B	33.4
9.	Current Phase C	28
10.	Current on Neutral	
11.	Current on Ground	.1
12.	Notes	

CB1 EMPTY POSITION
CB2
SIEMENS
CENTRO SERIES 150A
FXD6A
FXD63B150
600V
22KA
SETTINGS LOW
LINE 350MCM CU
LOAD 3/0 CU
FEEDING FF07

CB3
SIEMENS
400A
SERIEN SERIES
JD63F400
JD6A
25KA
SETTING MIN
LINE 500 MCM CU
LOAD 350MCM CU
FEEDING FF01

CB4
SIEMENS
400A
SERIEN SERIES
JD63F400
J06-A
25KA
SETTINGS MIN
LINE 350 MCM CU
LOAD 300 MCM TECK 90
FEEDING FF02

Main High Voltage Switch Gear at TRN1 Location:

Visual Testing

1. Make/Model/Age of Equipment	S&C ELECTRIC CANADA LTD.
2. Voltage Rating	4.76 KV
3. Amperage Rating	600
4. Number of Circuits	
5. Phase (1/3)	3
6. MLO or MCB	FUSED
7. MCB Rating (If Applicable)	FUSED AT 200A FUSES ARE SMU-40 S&C ELECTRIC FUSES
8. Short Circuit Current Rating (kA)	25KA STANDARD SPEED FUSES
9. Corrosion/Rust/Leaks Present?	RUST ON INTERIOR OF DOOR MAIN SWITCH, SW1 AND SW2
10. Panel Location (Floor #, Room #)	OUTSIDE BEHIND FF05
11. Physical Damage Present?	NO
12. Evidence of Moisture or Intrusions?	MINOR RUST AT REAR VENT
13. General Condition of Components	GOOD
14. Bus Bar Condition	GOOD
15. Verify Panel Labeling	GOOD
16. Verify Panel Directories	YES
17. Condition of Cable Connections	GOOD
18. CEC Violations Present?	NO
19. Insulation Bushing at Entrance	NO
20. Appropriate Anchoring Present?	YES
21. Evidence of Arcing?	NO
22. Notes	

SW1
FUSED AT 150 E
SW2
FUSED AT 150 E

FUSES ARE THE SAME
S&C ELECTRIC CANADA
KV NOMINAL 4.8
KV NOMINAL 5.5
AMPS INT 25,000
STANDARD SPEED
TCC 153-2

Primary Conductor Testing

1. Voltage Phase A to Neutral	NO VOLTAGE DUE TO KINGSTON UTILITIES SHUTDOWN
2. Voltage Phase B to Neutral	
3. Voltage Phase C to Neutral	
4. Voltage Phase A to B	
5. Voltage Phase A to C	
6. Voltage Phase B to C	
7. Current Phase A	
8. Current Phase B	
9. Current Phase C	
10. Current on Neutral	
11. Current on Ground	
12. Notes	

Appendix E – Kingston Utilities Information

Short Circuit Study Report

Service Address: 317 St, Kingston, Ontario

Study Location: Primary side of the transformer for 317 Ontario St.

Date: September 12, 2024

Max. Short-circuit Info.

LLL,Amp	LLG,Amp	LL,Amp	LG,Amp
13242	11920	11499	7720
R1, ohm	X1,ohm	R0,ohm	X0,ohm
0.0336	0.1875	0.0773	0.5954

Min. Short-circuit Info.

LLL,Amp	LLG,Amp	LL,Amp	LG,Amp
2256	2242	1954	1786
R1, ohm	X1,ohm	R0,ohm	X0,ohm
0.5000	0.9517	0.3532	1.9399

This report was prepared by Utilities Kingston on behalf of Kingston Hydro for IDEA. The material in it reflects Utilities Kingston's best judgement in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on decisions to be mad based on it, are the responsibility of such third parties, Utilities Kingston accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Appendix F – Arc Flash Labels

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**36**	**in**	Shock Hazard when covers removed	**4160**	**VAC**
Incident Energy in cal/cm²	**0.3**				
Arc Flash Boundary	**1.4**	**ft**	Limited approach	**5.0**	**ft**
			Restricted approach	**2.2**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**1**	

Equipment: **BUS_HV-SG** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**36**	**in**	Shock Hazard when covers removed	**4160**	**VAC**
Incident Energy in cal/cm²	**0.4**				
Arc Flash Boundary	**1.5**	**ft**	Limited approach	**5.0**	**ft**
			Restricted approach	**2.2**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**1**	

Equipment: **BUS_TRN-1** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**36**	**in**	Shock Hazard when covers removed	**4160**	**VAC**
Incident Energy in cal/cm²	**0.4**				
Arc Flash Boundary	**1.4**	**ft**	Limited approach	**5.0**	**ft**
			Restricted approach	**2.2**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**1**	

Equipment: **BUS_TRN-2** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**18**	**in**	Shock Hazard when covers removed	**208**	**VAC**
Incident Energy in cal/cm²	**9.7**				
Arc Flash Boundary	**5.6**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

Equipment: **DP** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**18**	**in**	Shock Hazard when covers removed	**600**	**VAC**
Incident Energy in cal/cm²	**0.1**				
Arc Flash Boundary	**0.4**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**0**	

Equipment: **DP-PRN-2** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**18**	**in**	Shock Hazard when covers removed	**208**	**VAC**
Incident Energy in cal/cm²	**4.8**				
Arc Flash Boundary	**3.6**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

Equipment: **P-A** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**18**	**in**	Shock Hazard when covers removed	**208**	**VAC**
Incident Energy in cal/cm²	**7.2**				
Arc Flash Boundary	**4.6**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

Equipment: **P-A1** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**18**	**in**	Shock Hazard when covers removed	**208**	**VAC**
Incident Energy in cal/cm²	**0.0**				
Arc Flash Boundary	**0.1**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

Equipment: **P-A12** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**18**	**in**	Shock Hazard when covers removed	**208**	**VAC**
Incident Energy in cal/cm²	**0.2**				
Arc Flash Boundary	**0.5**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

Equipment: **P-AA** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**18**	**in**	Shock Hazard when covers removed	**208**	**VAC**
Incident Energy in cal/cm²	**2.9**				
Arc Flash Boundary	**2.6**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

Equipment: **P-B** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**18**	**in**	Shock Hazard when covers removed	**208**	**VAC**
Incident Energy in cal/cm²	**2.4**				
Arc Flash Boundary	**2.3**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

Equipment: **P-C** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**18**	**in**	Shock Hazard when covers removed	**208**	**VAC**
Incident Energy in cal/cm²	**2.9**				
Arc Flash Boundary	**2.6**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

Equipment: **P-D** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**18**	**in**	Shock Hazard when covers removed	**208**	**VAC**
Incident Energy in cal/cm²	**2.3**				
Arc Flash Boundary	**2.3**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

Equipment: **P-E** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**18**	**in**	Shock Hazard when covers removed	**208**	**VAC**
Incident Energy in cal/cm²	**2.9**				
Arc Flash Boundary	**2.6**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

Equipment: **P-F** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**18**	**in**	Shock Hazard when covers removed	**600**	**VAC**
Incident Energy in cal/cm²	**0.1**				
Arc Flash Boundary	**0.3**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**0**	

Equipment: **SPLITTER-1** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**18**	**in**	Shock Hazard when covers removed	**208**	**VAC**
Incident Energy in cal/cm²	**9.5**				
Arc Flash Boundary	**5.5**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

Equipment: **SPLITTER-2** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**18**	**in**	Shock Hazard when		
Incident Energy in cal/cm²	**0.4**		covers removed	**208**	**VAC**
Arc Flash Boundary	**0.8**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

Equipment: **QO** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Risque d’éclats d’arcs et de choc électrique ÉPI approprié requis

PROTECTION D’ÉCLATS D’ARCS			PROTECTION DE CHOC ÉLECTRIQUE		
Distance de travail	**36**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**0.3**		couvercles enlevés	**4160**	**VAC**
Périmètre d’éclats d’arcs	**1.4**	**ft**	Périmètre d’accès limite	**5.0**	**ft**
			Périmètre d’accès restreint	**2.2**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**1**	

Équipement: **BUS_HV-SG** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Risque d’éclats d’arcs et de choc électrique ÉPI approprié requis

PROTECTION D’ÉCLATS D’ARCS			PROTECTION DE CHOC ÉLECTRIQUE		
Distance de travail	**36**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**0.4**		couvercles enlevés	**4160**	**VAC**
Périmètre d’éclats d’arcs	**1.5**	**ft**	Périmètre d’accès limite	**5.0**	**ft**
			Périmètre d’accès restreint	**2.2**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**1**	

Équipement: **BUS_TRN-1** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Risque d’éclats d’arcs et de choc électrique ÉPI approprié requis

PROTECTION D’ÉCLATS D’ARCS			PROTECTION DE CHOC ÉLECTRIQUE		
Distance de travail	**36**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**0.4**		couvercles enlevés	**4160**	**VAC**
Périmètre d’éclats d’arcs	**1.4**	**ft**	Périmètre d’accès limite	**5.0**	**ft**
			Périmètre d’accès restreint	**2.2**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**1**	

Équipement: **BUS_TRN-2** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Risque d’éclats d’arcs et de choc électrique ÉPI approprié requis

PROTECTION D’ÉCLATS D’ARCS			PROTECTION DE CHOC ÉLECTRIQUE		
Distance de travail	**18**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**9.7**		couvercles enlevés	**208**	**VAC**
Périmètre d’éclats d’arcs	**5.6**	**ft**	Périmètre d’accès limite	**3.5**	**ft**
			Périmètre d’accès restreint	**1.0**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**00**	

Équipement: **DP** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Risque d’éclats d’arcs et de choc électrique ÉPI approprié requis

PROTECTION D’ÉCLATS D’ARCS			PROTECTION DE CHOC ÉLECTRIQUE		
Distance de travail	**18**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**0.1**		couvercles enlevés	**600**	**VAC**
Périmètre d’éclats d’arcs	**0.4**	**ft**	Périmètre d’accès limite	**3.5**	**ft**
			Périmètre d’accès restreint	**1.0**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**0**	

Équipement: **DP-PRN-2** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Risque d’éclats d’arcs et de choc électrique ÉPI approprié requis

PROTECTION D’ÉCLATS D’ARCS			PROTECTION DE CHOC ÉLECTRIQUE		
Distance de travail	**18**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**4.8**		couvercles enlevés	**208**	**VAC**
Périmètre d’éclats d’arcs	**3.6**	**ft**	Périmètre d’accès limite	**3.5**	**ft**
			Périmètre d’accès restreint	**1.0**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**00**	

Équipement: **P-A** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Risque d’éclats d’arcs et de choc électrique ÉPI approprié requis

PROTECTION D’ÉCLATS D’ARCS			PROTECTION DE CHOC ÉLECTRIQUE		
Distance de travail	**18**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**7.2**		couvercles enlevés	**208**	**VAC**
Périmètre d’éclats d’arcs	**4.6**	**ft**	Périmètre d’accès limite	**3.5**	**ft**
			Périmètre d’accès restreint	**1.0**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**00**	

Équipement: **P-A1** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Risque d’éclats d’arcs et de choc électrique ÉPI approprié requis

PROTECTION D’ÉCLATS D’ARCS			PROTECTION DE CHOC ÉLECTRIQUE		
Distance de travail	**18**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**0.0**		couvercles enlevés	**208**	**VAC**
Périmètre d’éclats d’arcs	**0.1**	**ft**	Périmètre d’accès limite	**3.5**	**ft**
			Périmètre d’accès restreint	**1.0**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**00**	

Équipement: **P-A12** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Risque d’éclats d’arcs et de choc électrique ÉPI approprié requis

PROTECTION D’ÉCLATS D’ARCS			PROTECTION DE CHOC ÉLECTRIQUE		
Distance de travail	**18**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**0.2**		couvercles enlevés	**208**	**VAC**
Périmètre d’éclats d’arcs	**0.5**	**ft**	Périmètre d’accès limite	**3.5**	**ft**
			Périmètre d’accès restreint	**1.0**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**00**	

Équipement: **P-AA** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Risque d’éclats d’arcs et de choc électrique ÉPI approprié requis

PROTECTION D’ÉCLATS D’ARCS			PROTECTION DE CHOC ÉLECTRIQUE		
Distance de travail	**18**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**2.9**		couvercles enlevés	**208**	**VAC**
Périmètre d’éclats d’arcs	**2.6**	**ft**	Périmètre d’accès limite	**3.5**	**ft**
			Périmètre d’accès restreint	**1.0**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**00**	

Équipement: **P-B** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Risque d’éclats d’arcs et de choc électrique ÉPI approprié requis

PROTECTION D’ÉCLATS D’ARCS			PROTECTION DE CHOC ÉLECTRIQUE		
Distance de travail	**18**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**2.4**		couvercles enlevés	**208**	**VAC**
Périmètre d’éclats d’arcs	**2.3**	**ft**	Périmètre d’accès limite	**3.5**	**ft**
			Périmètre d’accès restreint	**1.0**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**00**	

Équipement: **P-C** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Risque d’éclats d’arcs et de choc électrique ÉPI approprié requis

PROTECTION D’ÉCLATS D’ARCS			PROTECTION DE CHOC ÉLECTRIQUE		
Distance de travail	**18**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**2.9**		couvercles enlevés	**208**	**VAC**
Périmètre d’éclats d’arcs	**2.6**	**ft**	Périmètre d’accès limite	**3.5**	**ft**
			Périmètre d’accès restreint	**1.0**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**00**	

Équipement: **P-D** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Risque d’éclats d’arcs et de choc électrique ÉPI approprié requis

PROTECTION D’ÉCLATS D’ARCS			PROTECTION DE CHOC ÉLECTRIQUE		
Distance de travail	**18**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**2.3**		couvercles enlevés	**208**	**VAC**
Périmètre d’éclats d’arcs	**2.3**	**ft**	Périmètre d’accès limite	**3.5**	**ft**
			Périmètre d’accès restreint	**1.0**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**00**	

Équipement: **P-E** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Risque d’éclats d’arcs et de choc électrique ÉPI approprié requis

PROTECTION D’ÉCLATS D’ARCS			PROTECTION DE CHOC ÉLECTRIQUE		
Distance de travail	**18**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**2.9**		couvercles enlevés	**208**	**VAC**
Périmètre d’éclats d’arcs	**2.6**	**ft**	Périmètre d’accès limite	**3.5**	**ft**
			Périmètre d’accès restreint	**1.0**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**00**	

Équipement: **P-F** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Risque d’éclats d’arcs et de choc électrique ÉPI approprié requis

PROTECTION D’ÉCLATS D’ARCS			PROTECTION DE CHOC ÉLECTRIQUE		
Distance de travail	**18**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**0.1**		couvercles enlevés	**600**	**VAC**
Périmètre d’éclats d’arcs	**0.3**	**ft**	Périmètre d’accès limite	**3.5**	**ft**
			Périmètre d’accès restreint	**1.0**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**0**	

Équipement: **SPLITTER-1** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Risque d’éclats d’arcs et de choc électrique ÉPI approprié requis

PROTECTION D’ÉCLATS D’ARCS			PROTECTION DE CHOC ÉLECTRIQUE		
Distance de travail	**18**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**9.5**		couvercles enlevés	**208**	**VAC**
Périmètre d’éclats d’arcs	**5.5**	**ft**	Périmètre d’accès limite	**3.5**	**ft**
			Périmètre d’accès restreint	**1.0**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**00**	

Équipement: **SPLITTER-2** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Risque d’éclats d’arcs et de choc électrique ÉPI approprié requis

PROTECTION D’ÉCLATS D’ARCS			PROTECTION DE CHOC ÉLECTRIQUE		
Distance de travail	**18**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**0.4**		couvercles enlevés	**208**	**VAC**
Périmètre d’éclats d’arcs	**0.8**	**ft**	Périmètre d’accès limite	**3.5**	**ft**
			Périmètre d’accès restreint	**1.0**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**00**	

Equipment: **QO** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF02

Appendix G – Cost Estimate

Project: **Arc Flash Study Fort Frontenac - KN229976** Date: 14-Mar-24

Phase **Class D Budget Cost Estimate - Building FF02** File Ref: 24549

SECTIONAL COST SUMMARY

Group Item	Element	Element Subtotal	Subtotal	-20.00%	20.00%
1	**TRN-2**		**$ 3,650**	**$ 2,920.0**	**$ 4,380.0**
1.1	Revise size of fuses in TRN-2 (Bay-o-net and CLF) from 250A to 50A	$ 3,000		$ 2,400.0	$ 3,600.0
1.2	Re-apply penetrox to transformer cable connections	$ 650		$ 520.0	$ 780.0
2	**DP-PRN-2**		**$ 1,830**	**$ 1,464.0**	**$ 2,196.0**
2.1	Apply for field inspection for Esafe rating	$ 1,000		$ 800.0	$ 1,200.0
2.2	Provide new grounding lug	$ 570		$ 456.0	$ 684.0
2.3	Revise instantaneous trip setting of breaker CB-FF02 from LO to HI	$ 260		$ 208.0	$ 312.0
3	**DS-MAIN**		**$ 560**	**$ 448.0**	**$ 672.0**
3.1	Revise fuse sizes from 300A to 400A	$ 560		$ 448.0	$ 672.0
4	**TX-150kVA**		**$ 560**	**$ 448.0**	**$ 672.0**
4.1	Revise style of fuse in DS-150kVA Tx from time delay to fast acting	$ 560		$ 448.0	$ 672.0
5	**Panel DP**		**$ 450**	**$ 360.0**	**$ 540.0**
5.1	Cover open panel sections with new filler sections	$ 150		$ 120.0	$ 180.0
5.2	Remove equipment in front of panel to provide 1m clearance	$ -		$ -	$ -
5.3	Provide strapping to properly secure EMT above panel	$ 300		$ 240.0	$ 360.0
6	**Panel P-A**		**$ 360**	**$ 288.0**	**$ 432.0**
6.1	Remove equipment in front of panel to provide 1m clearance	$ -		$ -	$ -
6.2	Replace locking mechanism on panel cover	$ 360		$ 288.0	$ 432.0
7	**Panel P-A1**		**$ 1,530**	**$ 1,224.0**	**$ 1,836.0**
7.1	Perform Phase Balancing	$ 520		$ 416.0	$ 624.0
7.2	Provide knockout covers	$ 150		$ 120.0	$ 180.0
7.3	Provide two new 2P 30A breakers and one new 1P 15A breaker to suit the panel type	$ 710		$ 568.0	$ 852.0
7.4	Provide new panel cover screws	$ 150		$ 120.0	$ 180.0
8	**Panel P-A12**		**$ 300**	**$ 240.0**	**$ 360.0**
8.1	Provide strapping to properly secure 1/2" conduit	$ 150		$ 120.0	$ 180.0
8.2	Perform panel clean	$ 150		$ 120.0	$ 180.0
9	**Panel P-AA**		**$ 5,000**	**$ 4,000.0**	**$ 6,000.0**
9.1	Replace panel in kind with gasketed panel due to installation location in exterior shed	$ 5,000		$ 4,000.0	$ 6,000.0
10	**Panel P-B**		**$ 600**	**$ 480.0**	**$ 720.0**
10.1	Remove equipment in front of panel to provide 1m clearance	$ -		$ -	$ -
10.2	Replace conduit with a larger size to suit conduit fill of cables being routed to the ceiling space. Investigate if this continues within the ceiling space. Cost does not include replacement of additional conduit found to be undersized during investigation.	$ 450		$ 360.0	$ 540.0
10.3	Perform panel clean	$ 150		$ 120.0	$ 180.0
11	**Panel P-C**		**$ 450**	**$ 360.0**	**$ 540.0**
11.1	Provide strapping to properly secure EMT above panel	$ 300		$ 240.0	$ 360.0
11.2	Perform panel clean	$ 150		$ 120.0	$ 180.0
12	**Panel P-D**		**$ 1,050**	**$ 840.0**	**$ 1,260.0**
12.1	Install insulated bushing at panel entrance	$ 300		$ 240.0	$ 360.0
12.2	Perform panel clean	$ 150		$ 120.0	$ 180.0

Project: **Arc Flash Study Fort Frontenac - KN229976** Date: 14-Mar-24

Phase **Class D Budget Cost Estimate - Building FF02** File Ref: 24549

SECTIONAL COST SUMMARY

Group Item	Element	Element Subtotal	Subtotal	-20.00%	20.00%
12.3	Provide knockout cover	$ 150		$ 120.0	$ 180.0
12.4	Replace conduit with a larger size to suit conduit fill of cables being routed to the ceiling space. Investigate if this consinues within the ceiling space	$ 450		$ 360.0	$ 540.0
13	**Panel P-F**		**$ 300**	**$ 240.0**	**$ 360.0**
13.1	Provide strapping to properly secure EMT above panel	$ 300		$ 240.0	$ 360.0
14	**Panel P-QO**		**$ 6,000**	**$ 4,800.0**	**$ 7,200.0**
14.1	Tag panel to be monitored with IR scan every one to two years as increased corrosion can cause failed connections	$ -		$ -	$ -
14.2	Replace panel	$ 6,000		$ 4,800.0	$ 7,200.0
15	**General Building**		**$ 150**	**$ 120.0**	**$ 180.0**
15.1	Print and frame Single Line Diagram as required by CEC.	$ 150		$ 120.0	$ 180.0
	TOTAL BUDGET ESTIMATE		**$ 22,790** (+/- 20%)	$18,232	$27,348

Note: The above estimates are exclusive of the following:

Professional Design Fees

Hydro utility company charges and levies

US / Canada Tarrifs