IDEA Project No. 24549

KN229976-ARC FLASH STUDY

FF10

Fort Frontenac

Department of National Defence

Issued Date: 2025-03-14

INTEGRATED DESIGN
ENGINEERING + ARCHITECTURE

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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 FF10 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 FF10 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 the instantaneous trip setting of breaker CB_P-AA (600V) in DP-Main from 5 to 7.5.

Revise the size of breaker CB_P-2A-1 in DP-Main from 100 to 50.

Revise the size of breaker CB_P-2A-2 in DP-Main from 100 to 90.

Revise the size of breaker CB_P-AA in DP-Main from 200 to 125 and the new instantaneous trip rating to 3.2X.

Replace High Voltage Switchgear to incorporate breaker and relay protection for FF-10 transformer.

Since the switchgear is being replaced, the transformer is very old and should also be replaced.

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

No recommendations from this section.

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

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

Circuits 18/20 of P-6/P-BOILER may be overloaded. Investigate loading of this circuit.

Circuit 59 of panel P-2C is overloaded at 12.7A. Investigate this circuit and consider splitting up the load or revising to a 20A circuit.

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

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

No recommendations from this section.

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

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

Panel DP-MAIN:

1. Tag panel to be monitoring. Perform thermal scan every 1 to 2 years as progressed rusting and moisture can cause faulty connections.
2. Provide new appropriate panel cover to suit added breakers.
3. Replace panel

Panel P-AA (208Y/120V):

1. Tag panel to be monitoring. Perform thermal scan every 1 to 2 years as progressed rusting and moisture can cause faulty connections.
2. Perform Panel Clean.
3. Replace panel

Panel P-2B:

1. Tape or heat shrink feeder wires to properly mark phasing.

Panel P-2C:

1. Megger the main feeder to determine integrity of insulation. Replace if faulty. Tag panel to be monitored. Perform thermal scan every 1 to 2 years to ensure further damage doesn't occur.

Panel P-2E:

1. Tag panel to be monitoring. Perform thermal scan every 1 to 2 years as progressed rusting and moisture can cause faulty connections.
2. Provide strapping to properly secure conduits above the panel.
3. Replace panel

Panel P-6/P-Boiler:

1. Investigate downstream loads on panel and how the panel is being used. Recommend removing panel if it is only used as a raceway.

Panel P-7:

1. Tag panel to be monitoring. Perform thermal scan every 1 to 2 years as progressed rusting and moisture can cause faulty connections.
2. Provide new panel directory and circuit labelling.
3. Remove tape from breaker
4. Replace panel

General Building Notes:

1. Recommend creating a new nomenclature system for this building and providing lamacoid labels for all panels, circuit breakers, transformers and disconnect panels. Print new panel directories for the panels and perform circuit tracing to confirm unlabelled loads.
2. Print and Frame Single Line Diagram as required by CEC.

Service Transformer TX-MAIN for FF10:

1. Replace cabinet seal
2. Modify fence to be outside of 1m clearance required by CEC.

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_BOILER RM	0.6	1	1/C	2	0.20796	0.2	0.057	0.0001512	0	60	CU
CBL_Chiller	0.6	1	3/C	2	0.68235	0.6743	0.1045	0.0002772		150	CU
CBL_DS-TX2	1	1	3/C	3	0.84798	0.8412	0.107	0.0002838	0	50	CU
CBL_M_SF	0.6	1	1/C	12	2.00116	2	0.068	0.0001804		50	CU
CBL_P-1	0.6	1	1/C	12	2.00116	2	0.068	0.0001804		50	CU
CBL_P-2	0.6	1	1/C	12	2.00116	2	0.068	0.0001804		50	CU
CBL_P-2B	0.6	1	1/C	3	0.25687	0.25	0.059	0.0001565	0	40	CU
CBL_P-2C	0.6	1	1/C	3	0.25687	0.25	0.059	0.0001565	0	50	CU
CBL_P-2D	0.6	1	1/C	3	0.25687	0.25	0.059	0.0001565	0	50	CU
CBL_P-2E	0.6	1	1/C	3	0.25687	0.25	0.059	0.0001565	0	20	CU
CBL_P-3	0.6	1	1/C	12	2.00116	2	0.068	0.0001804		50	CU
CBL_P-4	0.6	1	1/C	12	2.00116	2	0.068	0.0001804		50	CU
CBL_P-5	0.6	1	1/C	12	2.00116	2	0.068	0.0001804		50	CU
CBL_P-AA(600V)	0.6	1	1/C	3/0	0.09458	0.079	0.052	0.0001379	0	200	CU
CBL_P7	0.6	1	1/C	2/0	0.11365	0.1	0.054	0.0001432	0	40	CU
CBL_SF1	0.6	1	1/C	6	0.49416	0.49	0.064	0.0001698		250	CU
CBL_TX-1 PRI	0.6	1	1/C	3	0.25687	0.25	0.059	0.0001565	0	60	CU
CBL_TX-1 SEC	0.6	1	1/C	1	0.16985	0.16	0.057	0.0001512	0	10	CU
CBL_TX-2 PRI	0.6	1	1/C	3	0.25687	0.25	0.059	0.0001565	0	10	CU
CBL_TX-2 SEC	0.6	1	1/C	250	0.07497	0.054	0.052	0.0001379	0	25	CU
CBL_TX-3 PRI	0.6	1	1/C	1	0.16985	0.16	0.057	0.0001512	0	25	CU
CBL_TX-3 SEC	0.6	2	1/C	3/0	0.09458	0.079	0.052	0.0001379	0	40	CU
CBL_TX-MAIN SEC	0.6	2	1/C	500	0.04743	0.027	0.039	0.0001035	0	110	CU

Buses/ Panels/ Switch Gear:

ID	Nominal kV	Type	Bracing Symm. kA	Bracing Asymm. kA	Bracing Peak kA
BUS_HV_SWG_FF10	4.16	Switchgear		22	37.13
DP-MAIN	0.6	Panelboard	22	22	
P-2A-1	0.208	Panelboard	14	14	
P-2A-2	0.208	Panelboard	14	14	
P-2B	0.208	Panelboard	10	10	
P-2C	0.208	Panelboard	10	10	
P-2D	0.208	Panelboard	10	10	
P-2E	0.208	Panelboard	10	10	
P-6	0.208	Panelboard	10	10	
P-7	0.6	Panelboard	10	10	
PANEL-AA	0.208	Panelboard	100	100	
PANEL-AA (600V)	0.6	Panelboard	14	14	

Circuit Breakers

ID	kV	Type	Bus	Rated Int. Adj. kA	Rated Int. kA
CB_BOILER RM	0.208	Molded Case	PANEL-AA	100	100
CB_CHILLER	0.6	Molded Case	PANEL-AA (600V)	18	18
CB_DP-MAIN	0.6	Molded Case	DP-MAIN	22	22
CB_METER	0.6	Molded Case	DP-MAIN	22	22
CB_P-1	0.6	Molded Case	PANEL-AA (600V)	18	18
CB_P-2	0.6	Molded Case	PANEL-AA (600V)	18	18
CB_P-2A-1	0.6	Molded Case	DP-MAIN	14	14
CB_P-2A-2	0.6	Molded Case	DP-MAIN	18	18
CB_P-2B	0.208	Molded Case	P-2A-2	10	10
CB_P-2C	0.208	Molded Case	P-2A-2	10	10
CB_P-2D	0.208	Molded Case	P-2A-2	10	10
CB_P-2E	0.208	Molded Case	PANEL-AA	100	100
CB_P-3	0.6	Molded Case	PANEL-AA (600V)	18	18
CB_P-4	0.6	Molded Case	PANEL-AA (600V)	18	18
CB_P-5	0.6	Molded Case	PANEL-AA (600V)	18	18
CB_P-AA	0.6	Molded Case	DP-MAIN	22	22
CB_P-AA MCB	0.208	Molded Case	PANEL-AA	100	100
CB_P-AA(600V)	0.6	Molded Case	DP-MAIN	25	25
CB_SF	0.6	Molded Case	PANEL-AA (600V)	18	18
CB_SF1	0.6	Molded Case	PANEL-AA (600V)	18	18
CB_SPARE	0.208	Molded Case	PANEL-AA	100	100
CC_P7	0.6	Molded Case	DP-MAIN	22	22

Fuses:

ID	kV	Bus	Rated Int. Adj. kA	Rated Int. kA
F_HV_SWG_FF10	4.16	BUS_HV_SWG_FF10	26	26

Switches:

ID	kV	Type	Bus	Rated Mom. Asymm. kA
SW1	4.16	SPST Switch	BUS_HV_SWG_FF10	26

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:
Location:
Contract:
Engineer:
Filename: 24549 - DCC Arc Flash - FF10

ETAP
24.0.0C

Study Case: SC

Page: 1
Date: 01-09-2025
SN: IDEAINC-01
Revision: Base
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_SWG_FF10	4.160	BUS_HV_SWG_FF10	Switchgear	9.787	1.7	1.024	10.017	15.976		22.000	37.130
	4.160	SW1	SPST Switch	9.787	1.7	1.024	10.017	15.976		26.000	
DP-MAIN	0.600	DP-MAIN	Panelboard	7.195	3.7	1.167	8.395	14.500	22.000	22.000	
P-2A-1	0.208	P-2A-1	Panelboard	2.135	1.6	1.021	2.180	3.459	14.000	14.000	
P-2A-2	0.208	P-2A-2	Panelboard	5.110	1.8	1.028	5.254	8.449	14.000	14.000	
P-2B	0.208	P-2B	Panelboard	3.825	1.1	1.003	3.835	5.686	10.000	10.000	
P-2C	0.208	P-2C	Panelboard	3.577	1.0	1.002	3.582	5.258	10.000	10.000	
P-2D	0.208	P-2D	Panelboard	3.577	1.0	1.002	3.582	5.258	10.000	10.000	
P-2E	0.208	P-2E	Panelboard	5.271	1.6	1.021	5.382	8.541	10.000	10.000	
P-6	0.208	P-6	Panelboard	4.176	1.1	1.004	4.194	6.287	10.000	10.000	
P-7	0.600	P-7	Panelboard	6.740	2.9	1.110	7.482	12.781	10.000	10.000	
PANEL-AA	0.208	PANEL-AA	Panelboard	6.156	2.6	1.089	6.704	11.359	100.000	100.000	
PANEL-AA (600V)	0.600	PANEL-AA (600V)	Panelboard	5.514	2.0	1.044	5.757	9.453	14.000	14.000	

- 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:
Location:
Contract:
Engineer:
Filename: 24549 - DCC Arc Flash - FF10

ETAP
24.0.0C

Study Case: SC

Page: 2
Date: 01-09-2025
SN: IDEAINC-01
Revision: Base
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_SWG_FF10	4.160	F_HV_SWG_FF10	Fuse		9.787	1.7	1.000	9.787	4.760	6.65	26.000	26.000
DP-MAIN	0.600	CB_DP-MAIN	Molded Case		7.195	3.7	1.000	7.195	0.600	20.00	22.000	22.000
		CB_P-AA(600V)	Molded Case		7.195	3.7	1.000	7.195	0.600	20.00	25.000	25.000
		CB_P-2A-1	Molded Case		7.195	3.7	1.032	7.428	0.600	30.00	14.000	14.000
		CB_P-2A-2	Molded Case		7.195	3.7	1.032	7.428	0.600	30.00	18.000	18.000
		CB_P-AA	Molded Case		7.195	3.7	1.000	7.195	0.600	20.00	22.000	22.000
		CB_METER	Molded Case		7.195	3.7	1.000	7.195	0.600	20.00	22.000	22.000
		CB_P7	Molded Case		7.195	3.7	1.000	7.195	0.600	20.00	22.000	22.000
P-2A-1	0.208				2.135	1.6						
P-2A-2	0.208	CB_P-2B	Molded Case		5.110	1.8	1.002	5.120	0.240	50.00	10.000	10.000
		CB_P-2C	Molded Case		5.110	1.8	1.002	5.120	0.240	50.00	10.000	10.000
		CB_P-2D	Molded Case		5.110	1.8	1.002	5.120	0.240	50.00	10.000	10.000
P-2B	0.208				3.825	1.1						
P-2C	0.208				3.577	1.0						
P-2D	0.208				3.577	1.0						
P-2E	0.208				5.271	1.6						
P-6	0.208				4.176	1.1						
P-7	0.600				6.740	2.9						
PANEL-AA	0.208	CB_P-AA MCB	Molded Case		6.156	2.6	1.000	6.156	0.240	20.00	100.000	100.000
		CB_BOILER RM	Molded Case		6.156	2.6	1.000	6.156	0.240	20.00	100.000	100.000
		CB_P-2E	Molded Case		6.156	2.6	1.000	6.156	0.240	20.00	100.000	100.000
		CB_SPARE	Molded Case		6.156	2.6	1.000	6.156	0.240	20.00	100.000	100.000
PANEL-AA (600V)	0.600	CB_P-3	Molded Case		5.514	2.0	1.000	5.514	0.600	30.00	18.000	18.000
		CB_P-5	Molded Case		5.514	2.0	1.000	5.514	0.600	30.00	18.000	18.000
		CB_P-4	Molded Case		5.514	2.0	1.000	5.514	0.600	30.00	18.000	18.000
		CB_SF1	Molded Case		5.514	2.0	1.000	5.514	0.600	30.00	18.000	18.000
		CB_P-1	Molded Case		5.514	2.0	1.000	5.514	0.600	30.00	18.000	18.000
		CB_P-2	Molded Case		5.514	2.0	1.000	5.514	0.600	30.00	18.000	18.000
		CB_SF	Molded Case		5.514	2.0	1.000	5.514	0.600	30.00	18.000	18.000

Project:	**ETAP**	Page:	3
Location:	24.0.0C	Date:	01-09-2025
Contract:		SN:	IDEAINC-01
Engineer:	Study Case: SC	Revision:	Base
Filename: 24549 - DCC Arc Flash - FF10		Config.:	Normal

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.
PANEL-AA (600V)		CB_CHILLER	Molded Case		5.514	2.0	1.000	5.514	0.600	30.00	18.000	18.000

- 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.

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.

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.

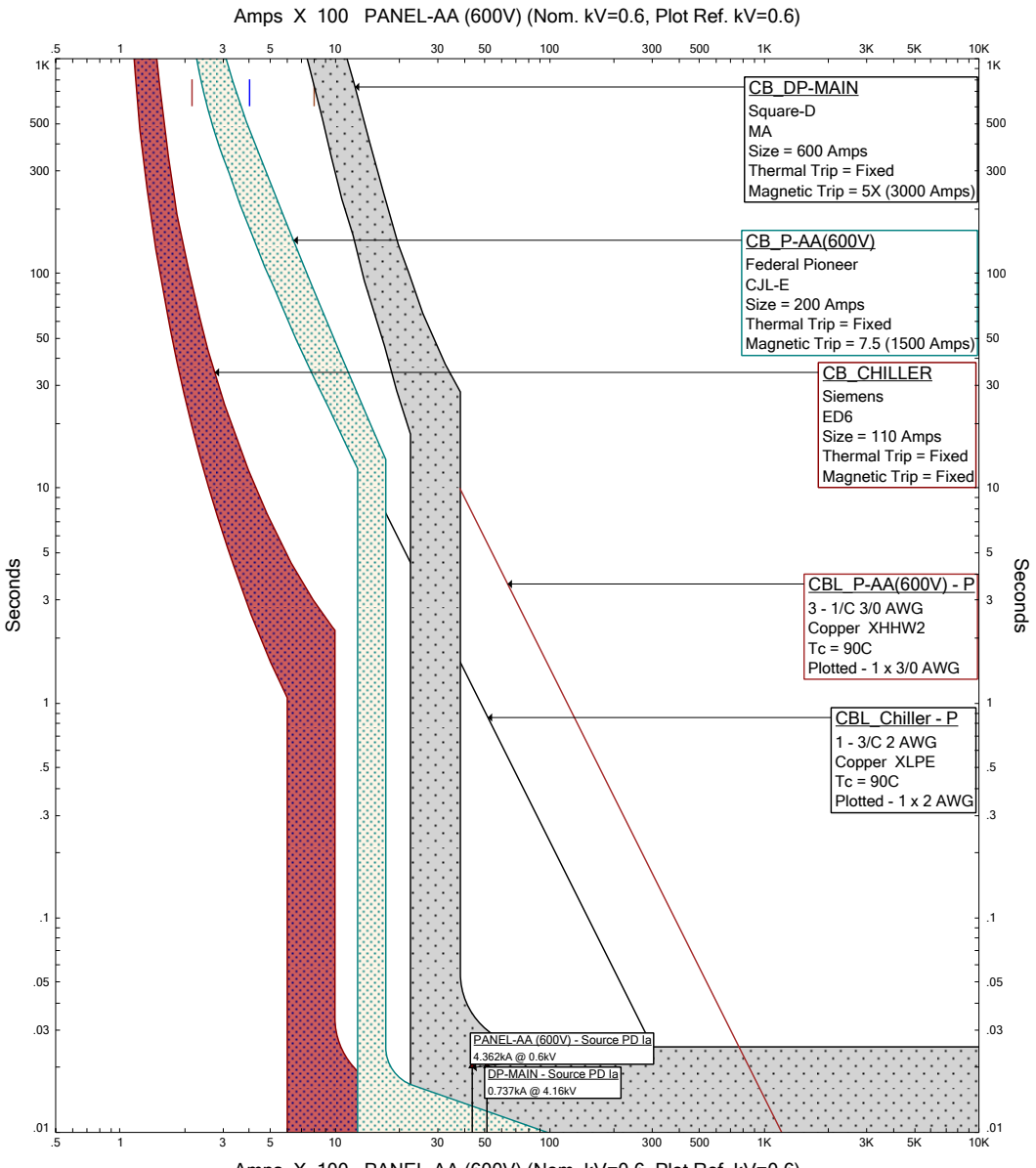
3.1. Methodology

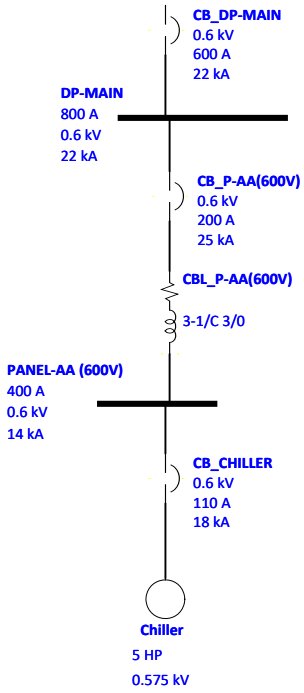
The Protective Device Coordination Study is performed utilizing the ETAP Power System Software. From the modeled distribution system, time-current characteristics curves for protective devices, cables, motors and transformers are plotted on logarithmic time plots (log-log axis). This view is used to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





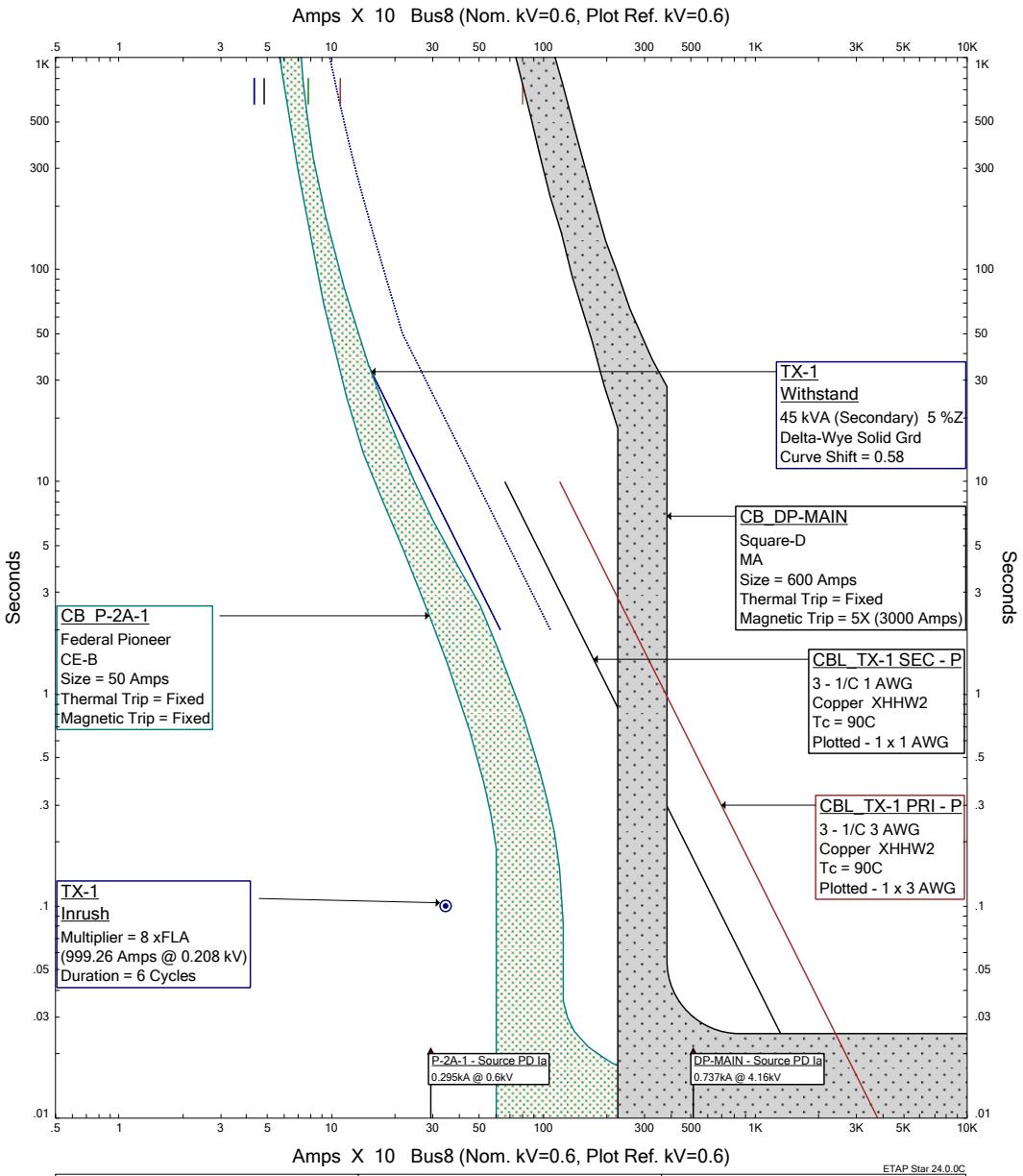
ETAP Star 24.0.0C

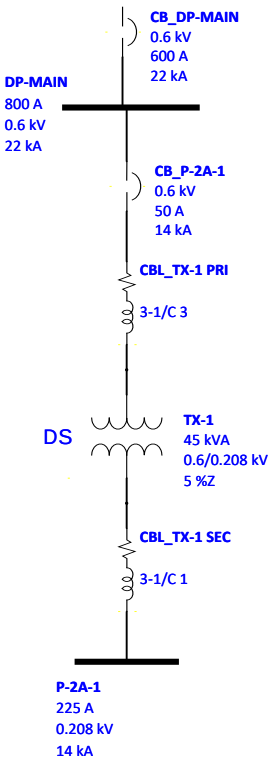
IDEA INTEGRATED DESIGN ENGINEERING + ARCHITECTURE

DP-MAIN to CHILLER

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

Date: 01-09-2025
SN: IDEAINC-01
Rev: Rev 1
Fault: Phase





Amps X 10 Bus8 (Nom. kV=0.6, Plot Ref. kV=0.6)

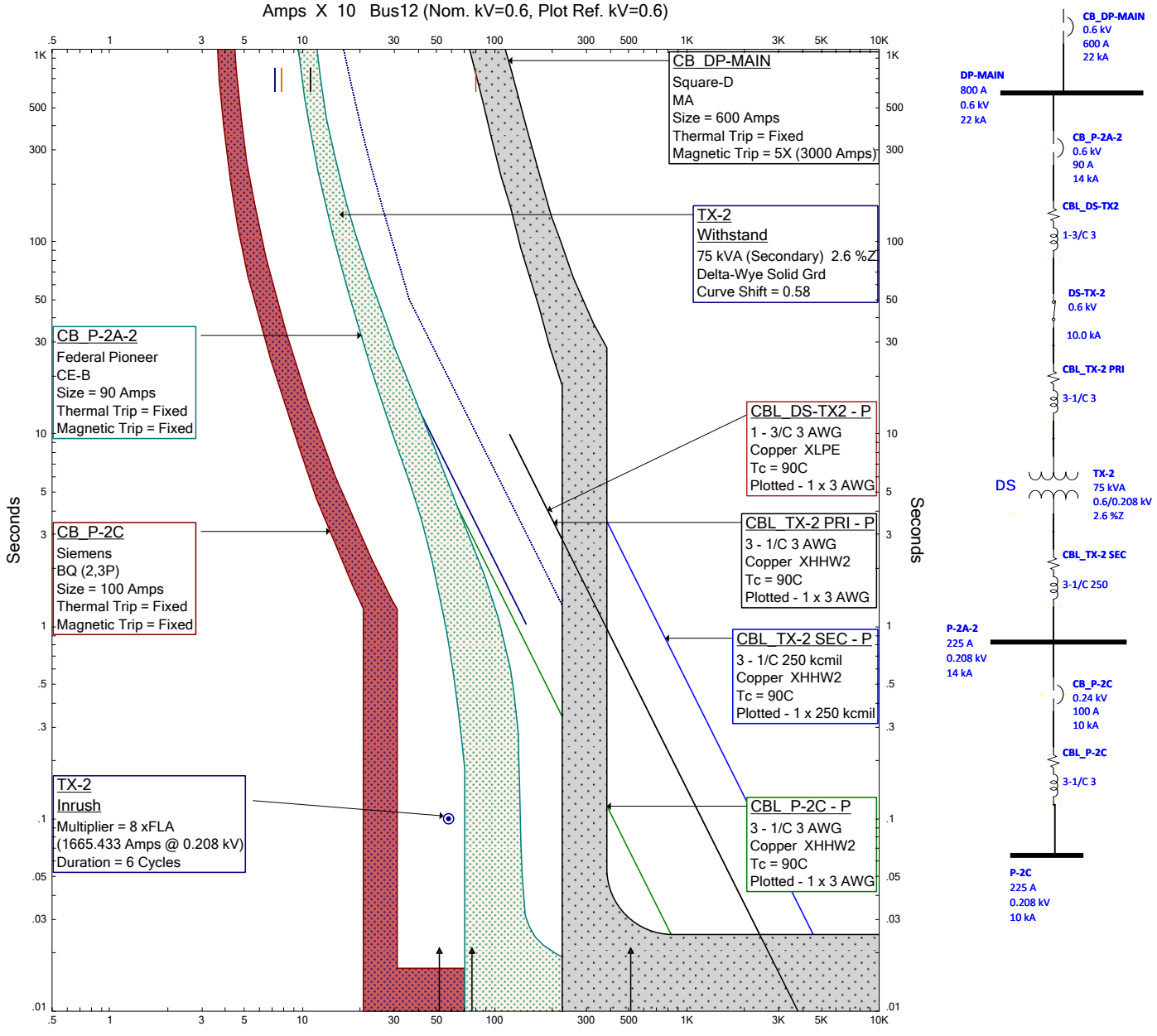
ETAP Star 24.0.0C

IDEA INTEGRATED DESIGN ENGINEERING + ARCHITECTURE

DP-MAIN to P-2A-1

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

Date: 01-09-2025
SN: IDEAINC-01
Rev: Rev 1
Fault: Phase



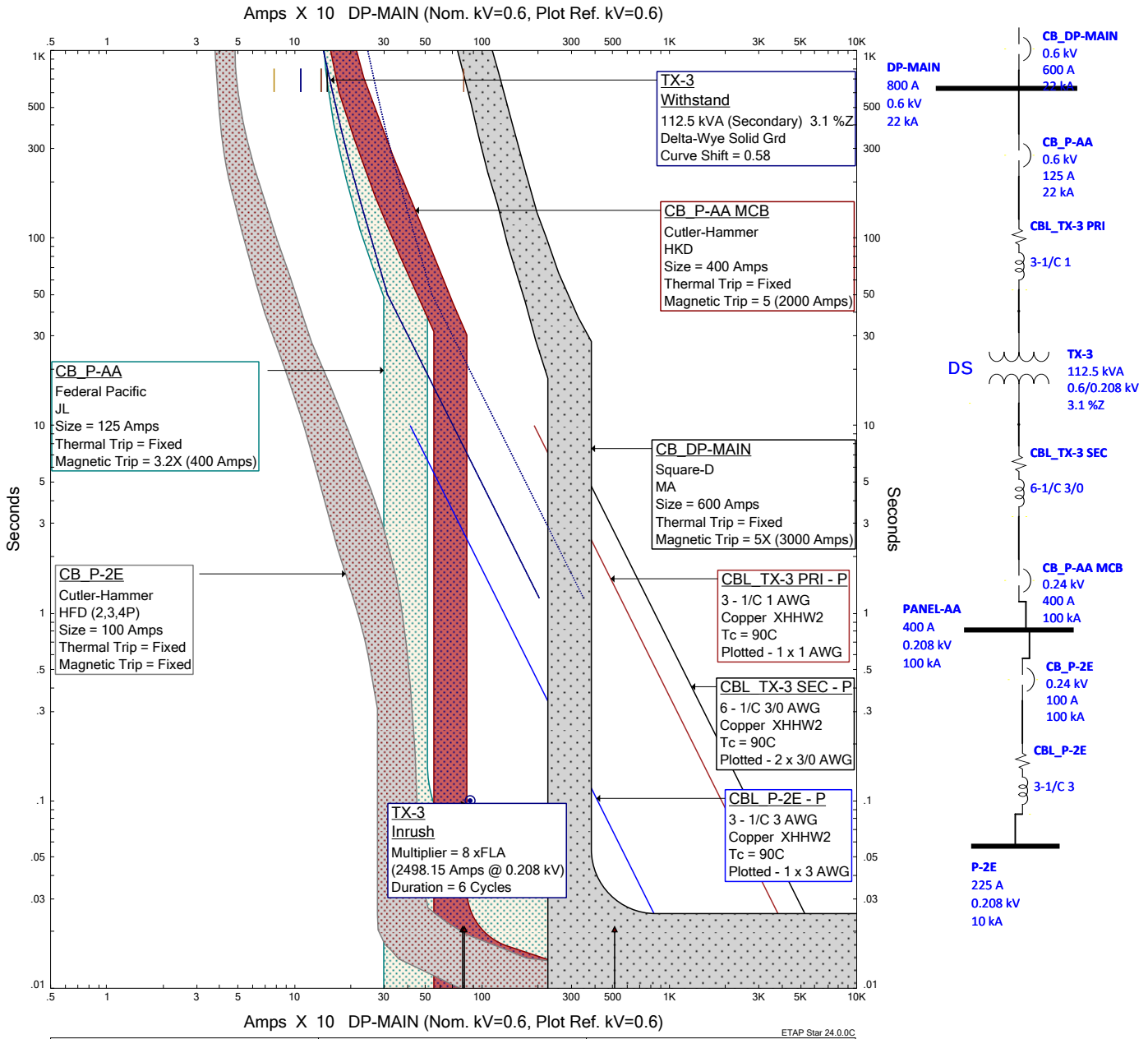
ETAP Star 24.0.0C

IDEA INTEGRATED DESIGN ENGINEERING + ARCHITECTURE

DP-MAIN to P2C

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

Date: 01-09-2025
SN: IDEAINC-01
Rev: Rev 1
Fault: Phase



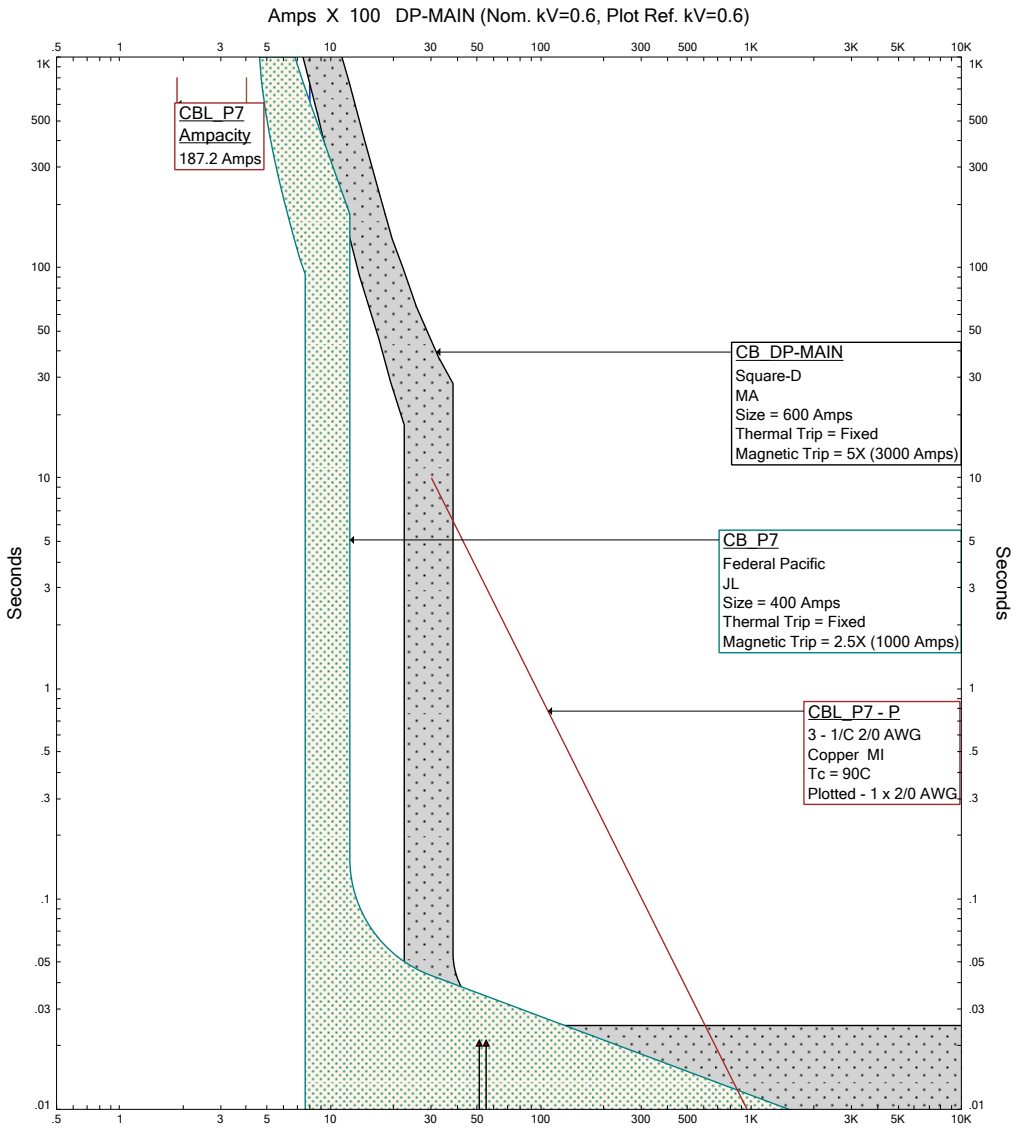
ETAP Star 24.0.0C

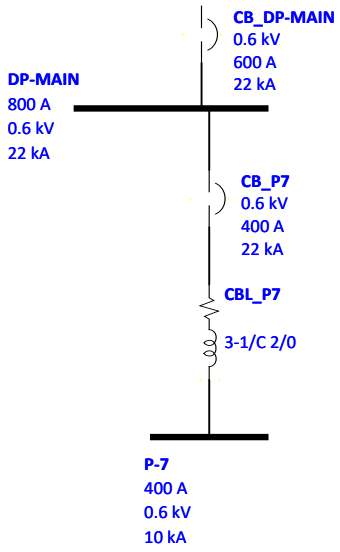
IDEA INTEGRATED DESIGN ENGINEERING + ARCHITECTURE

DP-MAIN to P-2E

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

Date: 01-09-2025
SN: IDEAINC-01
Rev: Rev 1
Fault: Phase



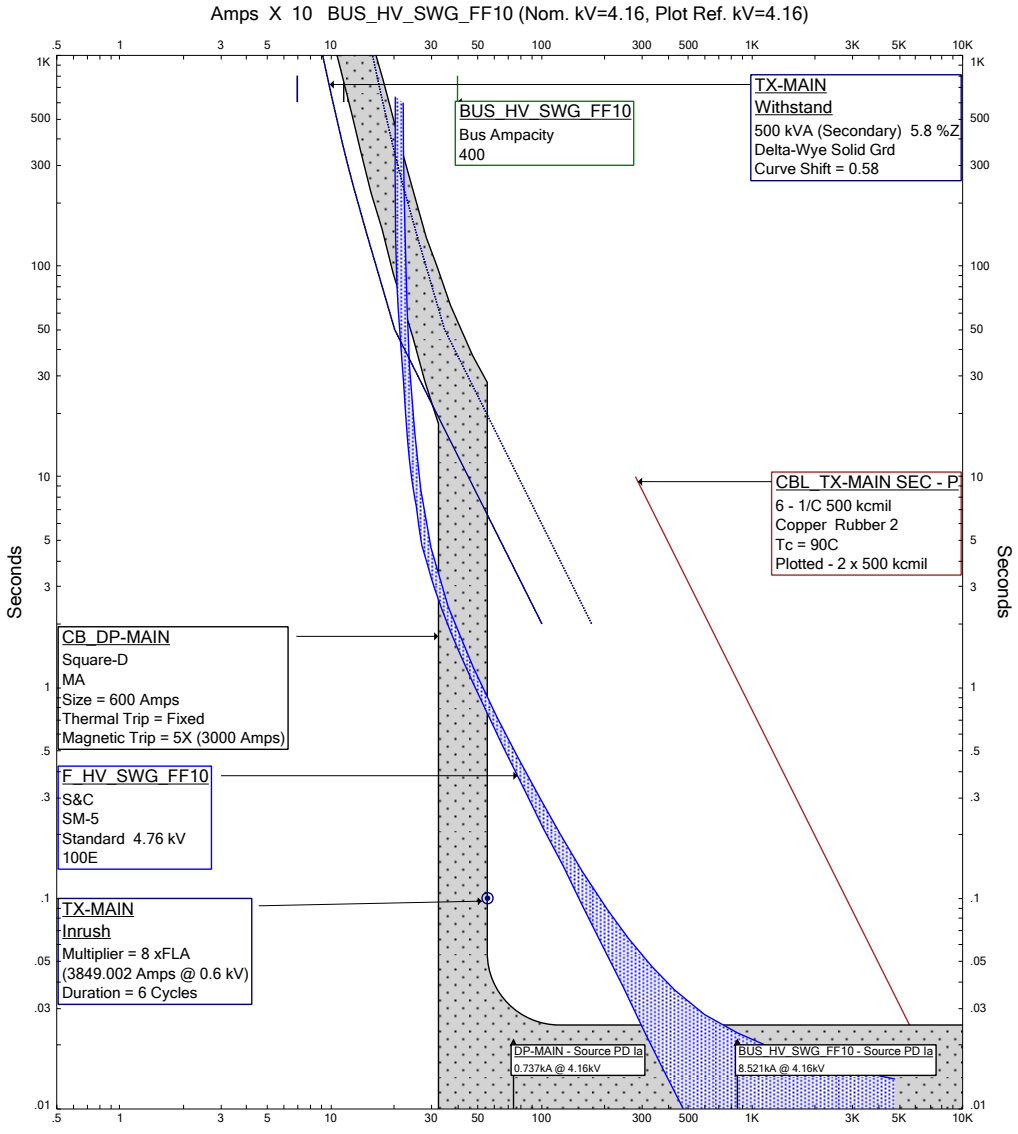


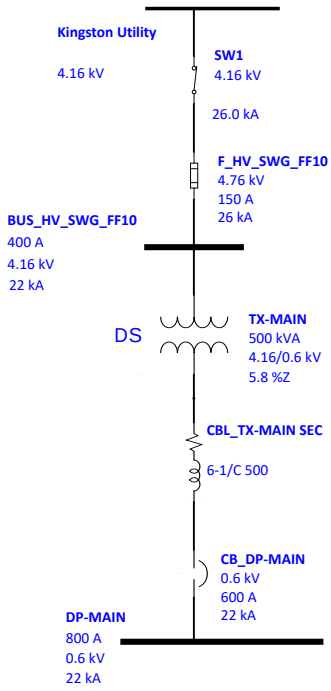
ETAP Star 24.0.0C

DP-MAIN to P-7

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

Date: 01-09-2025
SN: IDEAINC-01
Rev: Rev 1
Fault: Phase





ETAP Star 24.0.0C

IDEA INTEGRATED DESIGN ENGINEERING + ARCHITECTURE

HV_SWG_FF10 to DP-MAIN

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

Date: 01-09-2025
SN: IDEAINC-01
Rev: Rev 1
Fault: Phase

3.3. Recommended Device Ratings and Settings

Protective Device Settings Report

Project:	Arc Flash Study Fort Frontenac	**Date:**	01-09-2025
Location:	Fort Frontenac, Kingston	**Revision:**	Rev 1 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**
	Kingston Utility	F_HV_SWG_FF10	Base	S&C	SM-5	4.76	Standard	100E	150

Notes:

1 Rev 1 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-MAIN	CB_DP-MAIN	Base	Square-D	MA	600	Fixed	600.000	5X	3000.000
	DP-MAIN	CB_P-AA(600V)	Base	Federal Pioneer	CJL-E	200	Fixed	200.000	5	1000.000
1	DP-MAIN	CB_P-AA(600V)	Rev 1	Federal Pioneer	CJL-E	200	Fixed	200.000	7.5	1500.000
	DP-MAIN	CB_P-2A-1	Base	Federal Pioneer	CE-B	100	Fixed	100.000	Fixed	
1	DP-MAIN	CB_P-2A-1	Rev 1	Federal Pioneer	CE-B	50	Fixed	50.000	Fixed	
	DP-MAIN	CB_P-2A-2	Base	General Electric	THED (15-100A)	100	Fixed	100.000	Fixed	
1	DP-MAIN	CB_P-2A-2	Rev 1	Federal Pioneer	CE-B	90	Fixed	90.000	Fixed	
	DP-MAIN	CB_P-AA	Base	Federal Pacific	NJL	200	Fixed	200.000	3X	600.000
1	DP-MAIN	CB_P-AA	Rev 1	Federal Pacific	NJL	125	Fixed	125.000	3.2X	400.000
	DP-MAIN	CB_METER	Base	Federal Pacific	NJL	400	Fixed	400.000	2.5X	1000.000
	DP-MAIN	CB_P7	Base	Federal Pacific	NJL	400	Fixed	400.000	2.5X	1000.000
	PANEL-AA (600V)	CB_P-3	Base	Siemens	ED6	15	Fixed	15.000	Fixed	
	PANEL-AA (600V)	CB_P-5	Base	Siemens	ED6	15	Fixed	15.000	Fixed	
	PANEL-AA (600V)	CB_P-4	Base	Siemens	ED6	15	Fixed	15.000	Fixed	
	PANEL-AA (600V)	CB_SF1	Base	Siemens	ED6	50	Fixed	50.000	Fixed	
	PANEL-AA (600V)	CB_P-1	Base	Siemens	ED6	15	Fixed	15.000	Fixed	
	PANEL-AA (600V)	CB_P-2	Base	Siemens	ED6	15	Fixed	15.000	Fixed	
	PANEL-AA (600V)	CB_SF	Base	Siemens	ED6	20	Fixed	20.000	Fixed	
	PANEL-AA (600V)	CB_CHILLER	Base	Siemens	ED6	110	Fixed	110.000	Fixed	
	PANEL-AA	CB_P-AA MCB	Base	Cutler-Hammer	HKD	400	Fixed	400.000	5	2000.000
	PANEL-AA	CB_150A SPARE	Base	Cutler-Hammer	HFD	150	Fixed	150.000	Fixed	
	PANEL-AA	CB_100A SPARE	Base	Cutler-Hammer	HFD	100	Fixed	100.000	Fixed	
	PANEL-AA	CB_BOILER RM	Base	Cutler-Hammer	HFD	90	Fixed	90.000	Fixed	
	PANEL-AA	CB_P-2E	Base	Cutler-Hammer	HFD	100	Fixed	100.000	Fixed	
	PANEL-AA	CB_SPARE	Base	Cutler-Hammer	HFD	90	Fixed	90.000	Fixed	
	P-2A-2	CB_P-2B	Base	Siemens	BQ	100	Fixed	100.000	Fixed	
	P-2A-2	CB_P-2C	Base	Siemens	BQ	100	Fixed	100.000	Fixed	
	P-2A-2	CB_P-2D	Base	Siemens	BQ	100	Fixed	100.000	Fixed	

Notes:

1 Rev 1 settings is different from Base

Protective Device Settings - Low Voltage Circuit Breaker with Thermal-Magnetic Trip Device										
					Breaker		Thermal		Magnetic (Inst.)	
Notes	Designated Bus	LVCB ID	Base / Revision ID	Manufacturer	Model	Size	Setting	Trip (Amps)	Setting	Trip (Amps)

* Device Rating is different from Library

Additional Observations:

1. Based on the TCC labelled “HV_SG_FF10 to DP-MAIN”, the Fuses for the high voltage switch gear and on the primary of the transformer do not protect the damage curve of the medium voltage transformer. In order to adequately protect the transformers, replacement of the medium voltage outdoor switchgear section or modification with additional protection schemes would be required.

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.

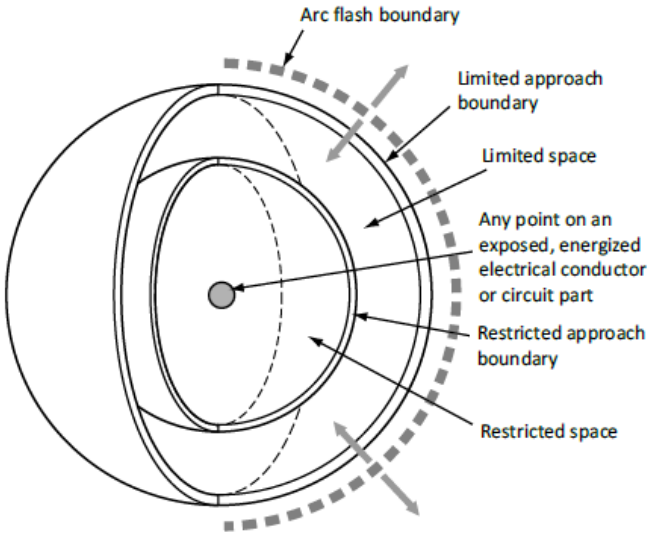
CSA Z462:24 should be reviewed in depth by each employer to create the Job Safety Plan to properly identify the information noted above.

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.

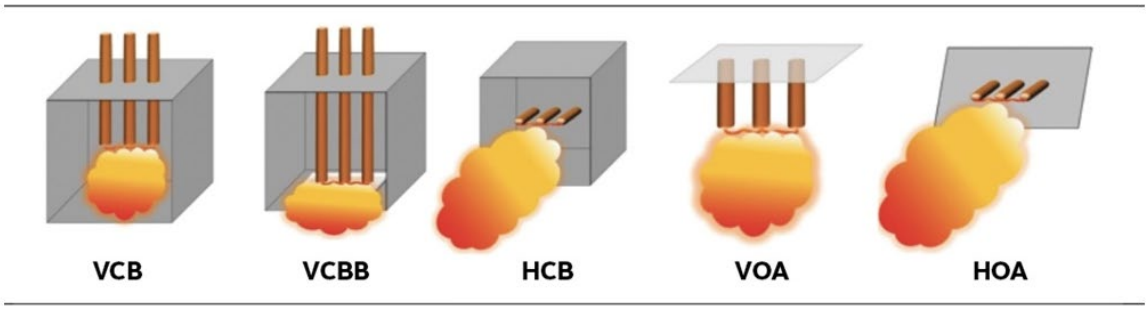
ETAP Power System Software is used to calculate the available arc flash incident energy. The software uses the IEEE 1584 calculation method to determine the available energy and Arc Flash boundary.

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
BUS_HV_SWG_FF10	4.160	Switchgear	104	9.787	9.767	8.521	F_HV_SWG_FF10	1.38	0.00	1.38	1.1	0.2	36	Level A
DP-MAIN	0.600	Panelboard	25	7.195	1.018	0.737	F_HV_SWG_FF10	30.67	0.00	30.67	4.1	5.9	18	Level A
P-2A-1	0.208	Panelboard	25	2.135	0.740	0.295	CB_P-2A-1	120.00	0.00	120.00	3.0	3.6	18	Level A
P-2A-2	0.208	Panelboard	25	5.110	1.772	0.764	CB_P-2A-2	120.00	0.00	120.00	5.6	9.7	18	Level A
P-2B	0.208	Panelboard	25	3.825	3.825	1.606	CB_P-2B	1.00	0.00	1.00	0.2	0.1	18	Level A
P-2C	0.208	Panelboard	25	3.577	3.577	1.492	CB_P-2C	1.00	0.00	1.00	0.2	0.1	18	Level A
P-2D	0.208	Panelboard	25	3.577	3.577	1.492	CB_P-2D	1.00	0.00	1.00	0.2	0.1	18	Level A
P-2E	0.208	Panelboard	25	5.271	5.271	2.280	CB_P-2E	1.20	0.00	1.20	0.3	0.1	18	Level A
P-6	0.208	Panelboard	25	4.176	4.176	1.523	CB_BOILER RM	1.80	0.00	1.80	0.3	0.1	18	Level A
P-7	0.600	Panelboard	25	6.740	6.612	5.409	CB_DP-MAIN	1.72	0.00	1.72	0.7	0.3	18	Level A
PANEL-AA	0.208	Panelboard	25	6.156	2.134	0.807	CB_P-AA	6.17	0.00	6.17	0.9	0.5	18	Level A
PANEL-AA (600V)	0.600	Panelboard	25	5.514	5.373	4.362	CB_P-AA(600V)	0.79	0.00	0.79	0.4	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.

4.7. Arc Flash Labels

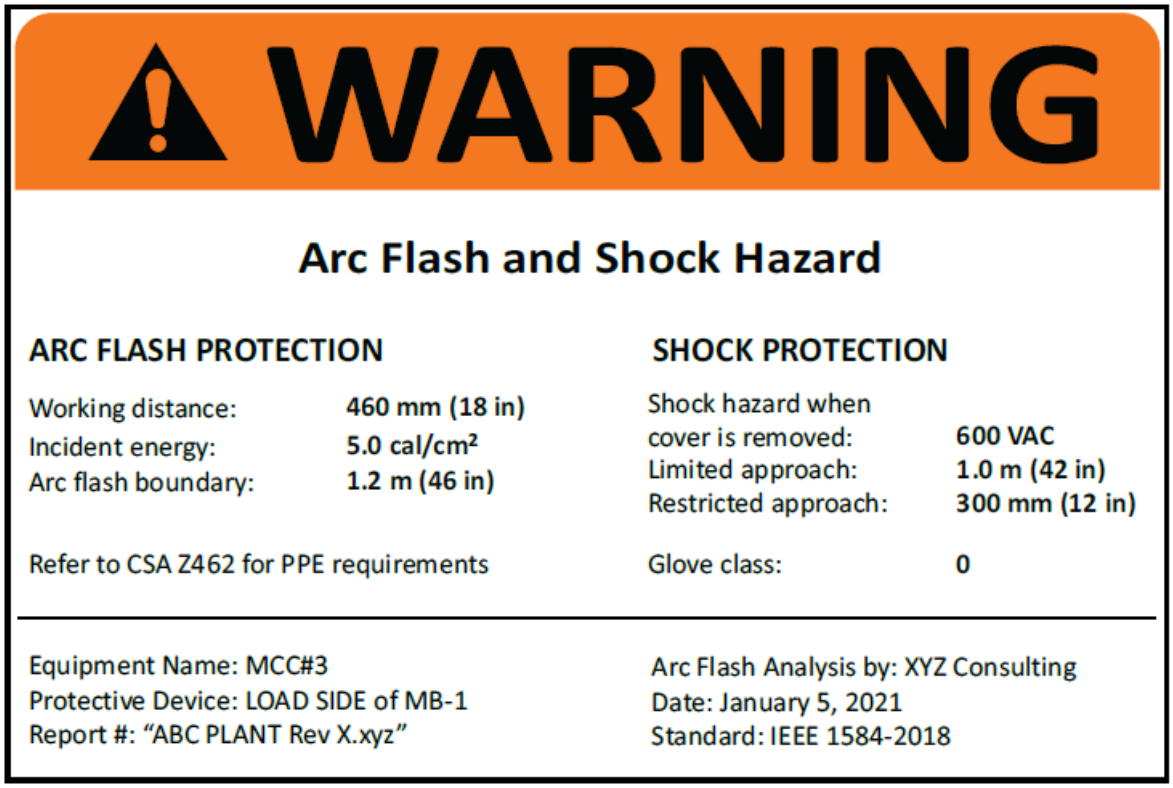
With the incident energy, arc flash boundary, and PPE requirements determined, the information is to be affixed to the equipment in the form of an Arc Flash Label. The Arc Flash labels contain the following information:

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 report produced by Eaton highlights any anomalies that were present during thermal scanning. Both a standard photo and infrared photo was taken of the equipment. With an anomaly present, current reading were taken at the point of interest complete with additional photos of the equipment in question. The probable cause of the anomaly is listed complete with the recommended solution. The report is broken up into two sections:

1. Equipment with Anomalies (Eaton Report- Appendix B)
2. Remaining Equipment with no Anomalies (Remaining Thermal Images - in Appendix C)

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 FF10 including all current and voltage readings can be found in Appendix E.

1. All three phase and single phase panels are appropriately balanced from the readings obtained on-site.
2. 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 FF10 including all physical observations can be found in Appendix D&E.

Observations:

Panel DP-MAIN:

1. Minor rusting and presence of moisture.
2. Panel Cover was modified and cut to add breakers. A small gap is present that a screw driver or tool can fit through.

Recommendation:

1. **Tag panel to be monitoring. Perform thermal scan every 1 to 2 years as progressed rusting and moisture can cause faulty connections.**
2. **Replace panel due to age modified enclosure and moisture.**

Panel P-AA (208Y/120V):

1. Minor rusting and presence of moisture.
2. Excessive dirt and debris has built up on the panel.

Recommendation:

1. **Tag panel to be monitoring. Perform thermal scan every 1 to 2 years as progressed rusting and moisture can cause faulty connections.**
2. **Perform Panel Clean.**
3. **Replace panel**

Panel P-2B:

1. Phasing is not marked on the feeder wires.

Recommendation:

1. **Tape or heat shrink feeder wires to properly mark phasing.**

Panel P-2C:

1. Evidence of previous short circuit scaring on main feeder and main lug.

Recommendation:

1. **Megger the main feeder to determine integrity of insulation. Replace if faulty. Tag panel to be monitored. Perform thermal scan every 1 to 2 years to ensure further damage doesn't occur.**

Panel P-2E:

1. Evidence of moisture at bottom of panel. Damage is minimal.
2. Conduits above panel are not strapped

Recommendation:

1. **Tag panel to be monitoring. Perform thermal scan every 1 to 2 years as progressed rusting and moisture can cause faulty connections.**
2. **Provide strapping to properly secure conduits above the panel.**
3. **Replace panel**

Panel P-6/P-Boiler:

1. Neutral bar has wires attached that are no longer in use.
2. MI cables have been cut inside and outside of the panel but not removed.
3. Panel appears to be used as a raceway as only white wires are landed on the breakers.

Recommendation:

1. **Investigate downstream loads on panel and how the panel is being used. Recommend removing panel if it is only used as a raceway.**

Panel P-7:

1. Minor evidence of moisture and rusting present.
2. Panel labels and directory are not present.
3. Lock out violation – tag is taped over breaker

Recommendation:

1. **Tag panel to be monitoring. Perform thermal scan every 1 to 2 years as progressed rusting and moisture can cause faulty connections.**
2. **Provide new panel directory and circuit labelling.**
3. **Remove tape from breaker**
4. **Replace panel**

General Building Notes:

1. Panel nomenclature and circuit labelling are confusing and lacking within this building.

2. Single Line Diagram missing from Electrical Room

Recommendation:

1. **Recommend creating a new nomenclature system for this building and providing lamacoid labels for all panels, circuit breakers, transformers and disconnect panels. Print new panel directories for the panels and perform circuit tracing to confirm unlabelled loads.**
2. **Print and Frame Single Line Diagram as required by CEC.**

Service Transformer TX-MAIN for FF10:

1. Seal to connection cabinet is weathered and brittle.
2. Fence around enclosure is within 1 meter of wire connection cabinet.

Recommendation:

1. **Replace cabinet seal**
2. **Modify fence to be outside of 1m clearance required by CEC.**

Appendix A – Single Line Diagram



Government of Canada | Gouvernement du Canada

LEVEL OF SECURITY | NIVEAU DE SÉCURITÉ
UNCLASS | NON CLASSIFIÉ

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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

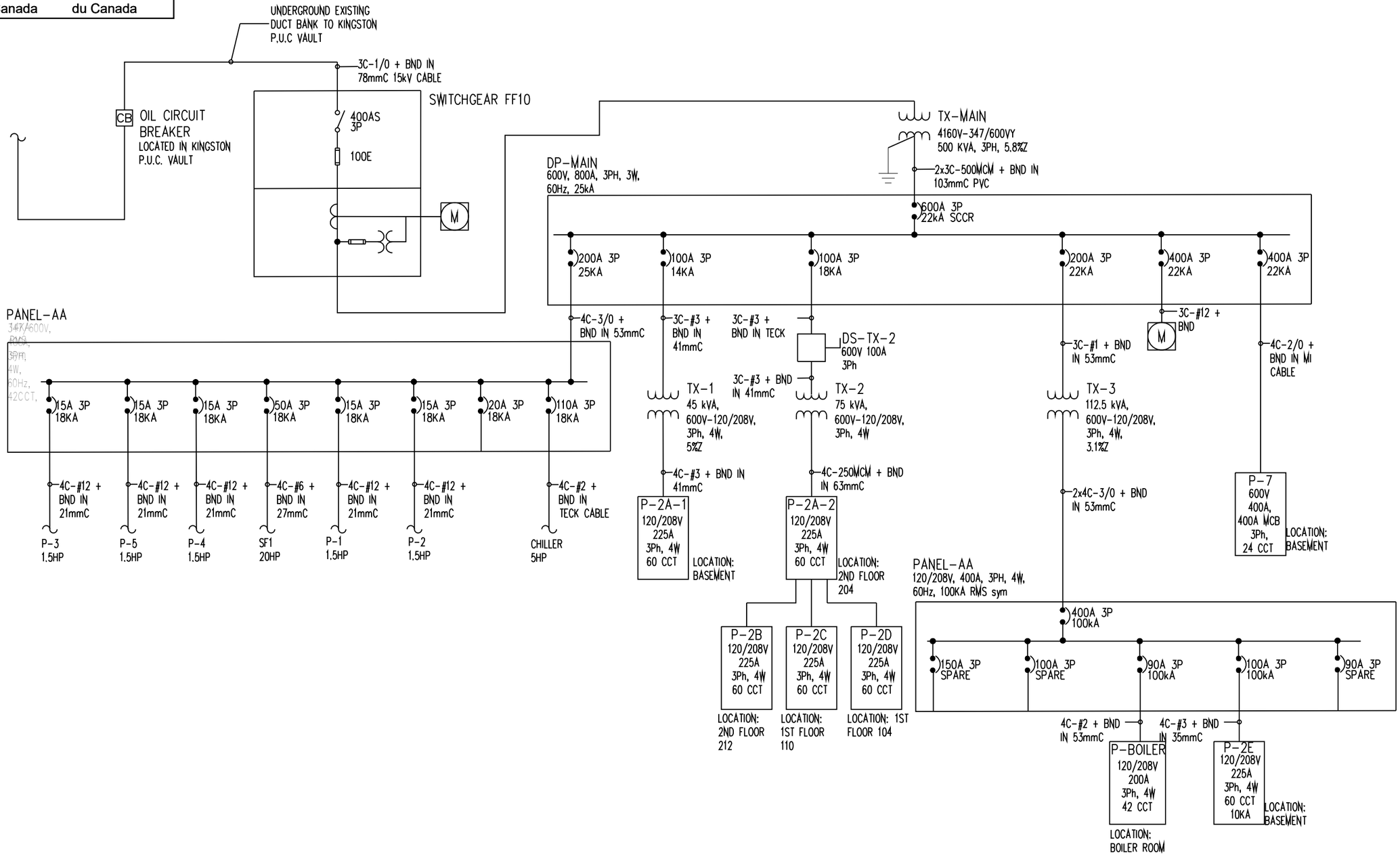
DWG. NO. | NO. DESSIN
K-B35-9306/91-500

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

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

PROJECT: / PROJET:	ARC FLASH STUDY FORT FRONTENAC KN299976
SUBJECT: / SUJET:	SINGLE LINE DIAGRAM FF10
DATE:	2025-03-14

APPROVED:	N.F.	
APPROUVÉ PAR:	N.F.	
SCALE: / ÉCHELLE:	N/A	
WBS NO.: / NO. OTP:	N.700114.23.15	
PF NO.: / NO. DP:	PF500659505	10/10
DWG NO.: / NO. DESSIN:	K-B35-9306/91-509	

Appendix B – Eaton Thermal Scan Report

Eaton Industries (Canada) Company
Eaton Electrical Services and Systems
100-1407 John Counter Blvd.
Kingston, ON K7K 6A9

November 11, 2024

Drycore Electric
1-5480 Canotek Road,
Ottawa, ON
K1B 5N2

Attention: Fort Frontenac IR Scan 2024

Subject: EOTJ244465

Ref: IR Scan Report

We are pleased to submit our report confirming the results of the Infrared Scanning conducted at Fort Frontenac in Kingston, ON. The survey was conducted the week of October 28th to November 1st, 2024.

Some thermal anomalies were found in the electrical system at this time. The details are included in this report. Any anomalies deemed serious, proper personal were notified immediately to take corrective action.

Thank you for your continued interests in our products and services.

Please do not hesitate to call our office should you require further information in this or any other matter.

Sincerely,

John McDonald
Field Service Representative
Eaton Industries Canada Company
mobile: (613) 305-8447
JohnHMcDonald@eaton.com

Eaton Industries (Canada) Company
Eaton Electrical Services and Systems
100-1407 John Counter Blvd.
Kingston, ON K7K 6A9

Job Summary:

Project Name:	Fort Frontenac IR Scan 2024
Eaton Job Number:	EOTJ244465
Service Location:	Fort Frontenac, 317 Ontario St, Kingston, ON
Performed For:	Drycore Electric, 1-5480 Canotek Road, Ottawa, ON K1B 5N2
Customer Order Number:	**24- 348-0918**
Customer Contact:	Andrew Beuman
Service Performed by:	Eaton Industries (Canada) Company Eaton Electrical Services and Systems 1407 John Counter BLVD, #100 Kingston, Ontario
Field Service Representative:	John McDonald
Prepared By:	John McDonald
Date of Report:	November 11, 2024
Date of Service:	October 28th through November 1st, 2024

Eaton Industries (Canada) Company
Eaton Electrical Services and Systems
100-1407 John Counter Blvd.
Kingston, ON K7K 6A9

Test Procedures:

Infrared Thermographic Inspection

The intent of the thermographic survey is to identify potential electrical and/or mechanical defects in the equipment as surveyed and recommend probable solutions to defects encountered. By evaluating the equipment in this manner, a proactive maintenance program is developed which decreases the potential of equipment failure and increases personnel safety.

The thermal abnormalities identified during this inspection are presented on individual report pages complete with the thermal and real life image. In order to determine the severity of the defect, the temperature rise from the normal component to the faulty component is recorded along with the measured load.

Electrical thermographic inspections should be conducted during normal full load conditions. When the devices are not under sufficient load at the time of inspection the client must take this into consideration when assessing the urgency to response. For example, if a device has a 10°C temperature rise at 1/3 load and the load increases later to 3/4 load, the temperature rise will be by the square of the current increase. In this example the urgency would go from a priority level “D” (investigate at next scheduled maintenance period) response to priority level “B” (repair as soon as possible) response.

The following guide will help determine the urgency of response.

Temperature Rise – Phase to Phase	**Priority**	**Response**
Greater than 50°C	**A**	**Immediate Repair Required**
30°C to 50°C	**B**	**Repair As Soon As Possible**
10°C to 29°C	**C**	**Attended to at First Opportunity**
1°C to 10°C	**D**	**Investigate at Next Scheduled Maintenance**

Only the customer can determine the priority of response and the importance of the defective equipment.

For every defect identified, always inspect connected components for stress or thermal damage to insulation.

Eaton Industries (Canada) Company
Eaton Electrical Services and Systems
100-1407 John Counter Blvd.
Kingston, ON K7K 6A9

Electrical Services & Systems

Equipment Scanned List

EOTJ244499

Drycore Electric, Fort Frontenac

Eaton Industries (Canada) Company
Eaton Electrical Services and Systems
100-1407 John Counter Blvd.
Kingston, ON K7K 6A9

Building FF10				
Basement Electrical Room				
	PNL	P-2E	2290	
	PNL	P-2A	2292	
	PNL	Normandy Hall	2304	
Old Vault				
	XFRMR	Transformer	2294	Scanned From Exterior
	PNL	DP-Main	2306	
Boiler Room				
	PNL	P-Boiler Panel	2298	See Incident Analysis Form
	PNL	Panel – AA	2302	
Room 127 on Roof				
	START	SF1	2308	
	START	P1	2310	
Hallway By Door 114				
	PNL	Panel 2D	2312	
2nd Floor				
	DISC	Unlabeled Disconnect	2314	
	XFRMR	Transformer	2316	Scanned From Exterior

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Eaton Electrical Services and Systems
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	PNL	Panel 2B	2318	
Room 204				
	PNL	Panel 2A	2320	
Room 104				
	PNL	Panel 2C	2322	See Incident Analysis Form

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Eaton Electrical Services and Systems
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Kingston, ON K7K 6A9

Electrical Services & Systems

INCIDENT ANALYSIS FORMS

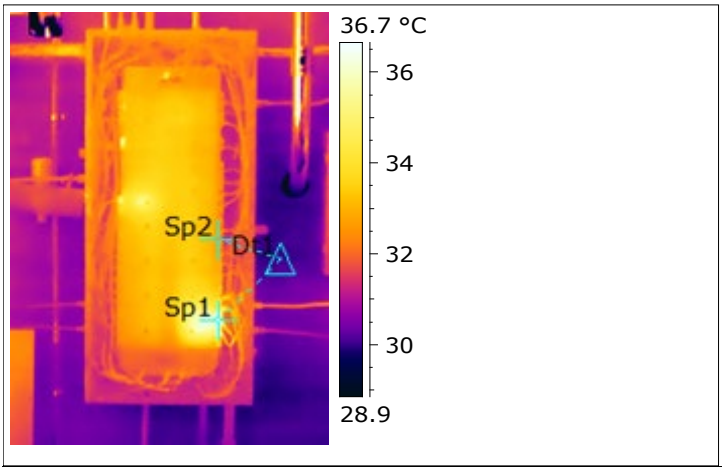
EOTJ244499

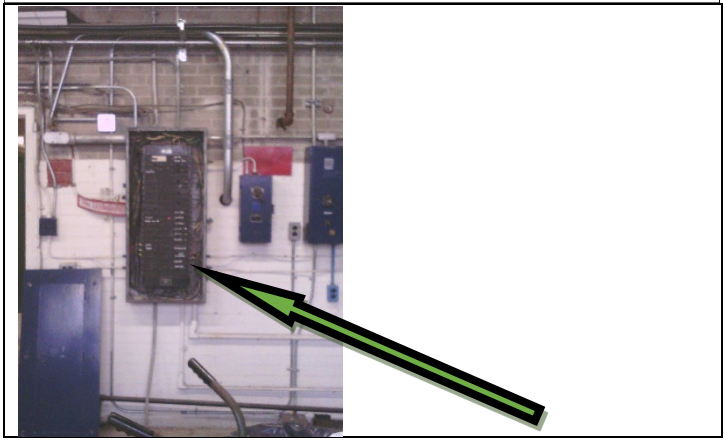
Drycore Electric, Fort Frontenac

Eaton Industries (Canada) Company
Eaton Electrical Services and Systems
100-1407 John Counter Blvd.
Kingston, ON K7K 6A9

Customer	Drycore Electric
Location	Fort Frontenac
Area	Building FF10 Boiler Room
Component	P-Boiler Panel

Phase	Load In Amps
A Phase	N/A
B Phase	N/A
C Phase	N/A
Neutral	N/A





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Date	2024-11-01
Image Time	10:01:27 AM
Image Camera Type	FLIR T530
Image Serial Number	79310355
Emissivity	0.85
Object Distance	3.8 m
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Sp2 Temperature	32.4 °C
Sp3 Temperature	-
Sp4 Temperature	-
Dt1 Rise Above Ref.	6.2 °C

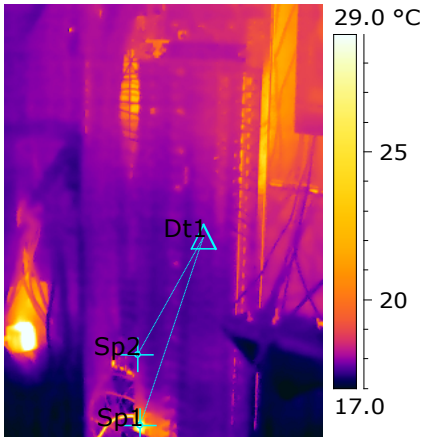
Probable Cause:	CCTS 18 & 20 may be overloaded
Corrective Action:	Investigate further
Date Repaired:	
Repaired By:	

Notes: 0 amps were measured on both conductors at the time of the scan. This may be a
cyclical load and was likely cooling down during the time of scanning.
Priority D

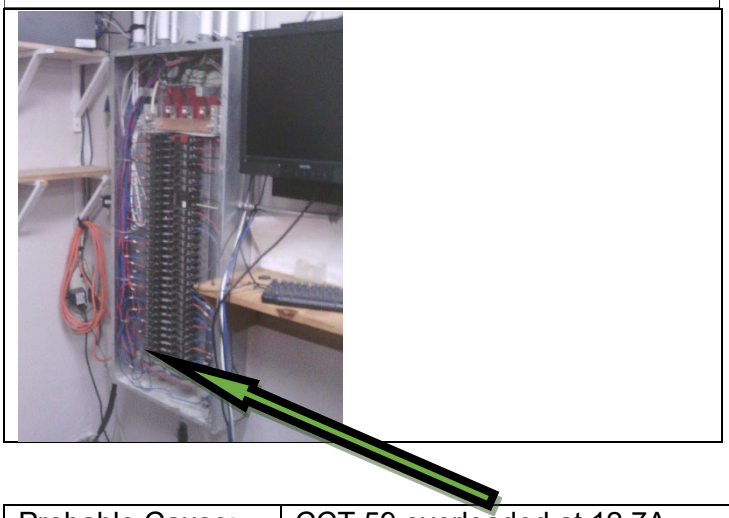
Eaton Industries (Canada) Company
Eaton Electrical Services and Systems
100-1407 John Counter Blvd.
Kingston, ON K7K 6A9

Customer	Drycore Electric
Location	Fort Frontenac
Area	Building FF10 Room 104
Component	Panel 2C

Phase	Load In Amps
A Phase	N/A
B Phase	N/A
C Phase	N/A
Neutral	N/A



File name	FLIR2322.jpg
Date	2024-11-01
Image Time	12:04:22 PM
Image Camera Type	FLIR T530
Image Serial Number	79310355
Emissivity	0.85
Object Distance	2.0 m
Sp1 Temperature	28.8 °C
Sp2 Temperature	17.8 °C
Sp3 Temperature	-
Sp4 Temperature	-
Dt1 Rise Above Ref.	11.0 °C



Probable Cause:	CCT 59 overloaded at 12.7A.
Corrective Action:	Investigate further, split circuit or investigate protecting this at 20A
Date Repaired:	
Repaired By:	

Notes: Make sure the loads can be protected at 20A and consult CEC / OESC table D3
before changing to a 20A breaker. Otherwise reduce circuit loading or split the circuit.
Priority C

Appendix C – Remaining 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
ELECTRIC • ÉLECTRIQUE

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

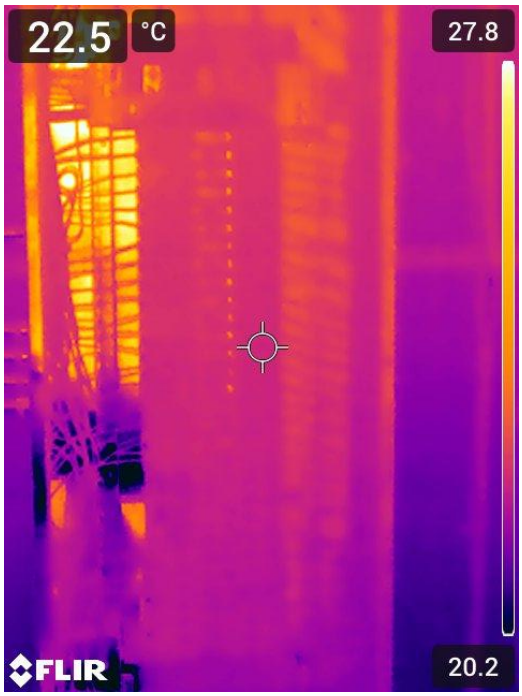
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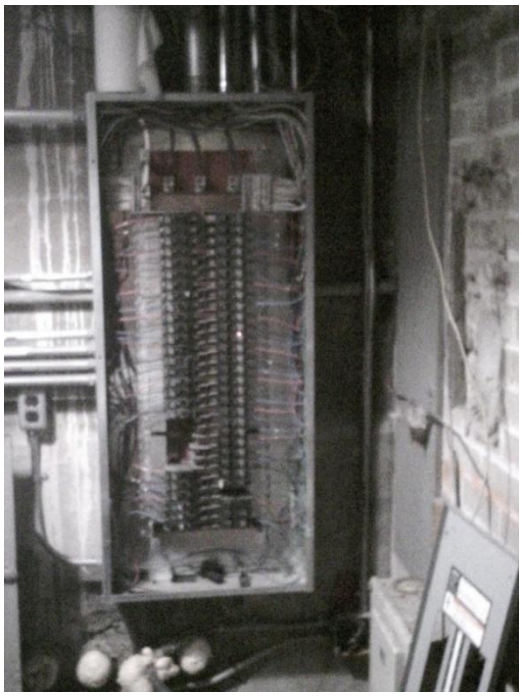
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Floor/ Room Number	Equipment Type	Equipment Identification	IR File Number	Picture File Number
BUILDING FF10				
Basement Electrical Room	PANEL	P-2E	2290	2291
	PANEL	P-2A	2292	2293
	PANEL	Normandy Hall	2304	2305
Old Vault	Transformer	TX-3	2294	2295
	PANEL	DP-MAIN	2306	2307
Boiler Room	PANEL	P-Boiler Panel	2298	2299
	PANEL	AA Panel	2302	2303
Room 127	STARTER	SF1	2308	2309
	STARTER	P1	2310	2311
Hall by 114	PANEL	2D Panel	2312	2313
2nd Floor	DISC	DS-TX-2	2314	2315
	Transformer	TX-2	2316	2317
	PANEL	2B Panel	2318	2319
Room 204	PANEL	2A Panel	2320	2321
Room 104	PANEL	2C Panel	2322	2323

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Location	Building FF10 BASEMENT ELECTRICAL RM
Component	P-2E PANEL
IR File Name	FLIR2290
Picture File Name	FLIR2291
Date	FRIDAY November 1st
Image time	10:46 AM



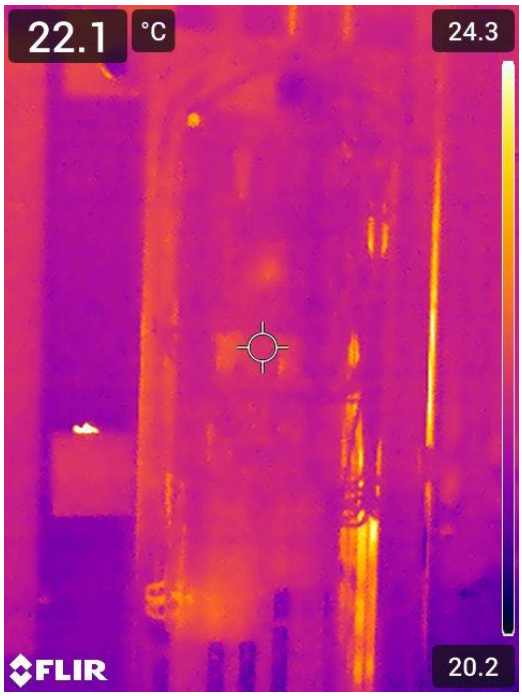


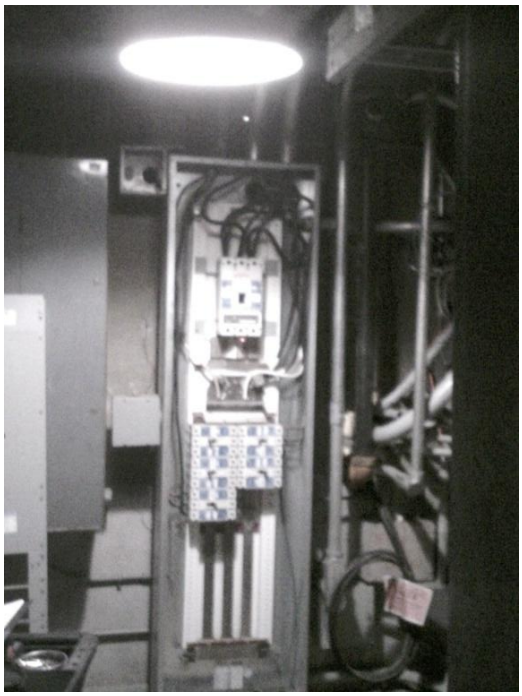
PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	2.6	**A-N**	124
B PHASE	2.3	**B-N**	126
C PHASE	3.3	**C-N**	126
NEUTRAL	2.4	**A-B**	217
		A-C	216
		B-C	221

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DRYCORE
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Location	Building FF10 BASEMENT ELECTRICAL RM
Component	P-2A PANEL
IR File Name	FLIR2292
Picture File Name	FLIR2293
Date	FRIDAY November 1st
Image time	10:46 AM



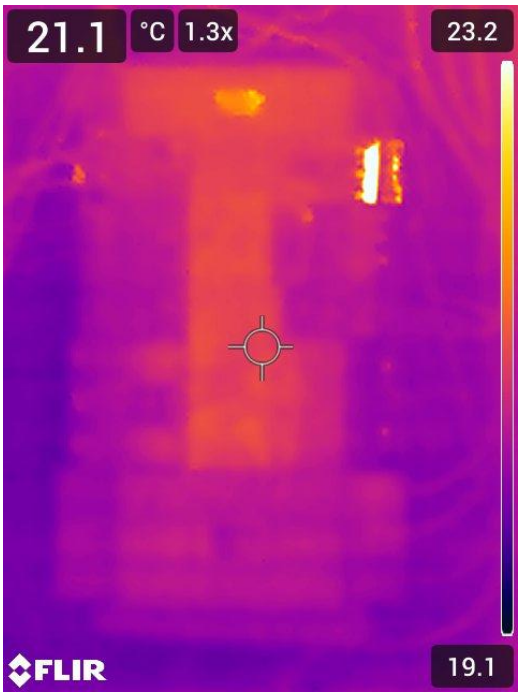


PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	20	**A-N**	347
B PHASE	15	**B-N**	348
C PHASE	18	**C-N**	347
NEUTRAL	5	**A-B**	601
		A-C	600
		B-C	601

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DRYCORE
ELECTRIC • ÉLECTRIQUE

Location	Building FF10 BASEMENT ELECTRICAL RM
Component	NORMANDY HALL PANEL
IR File Name	FLIR2304
Picture File Name	FLIR2305
Date	FRIDAY November 1st
Image time	11:11 AM



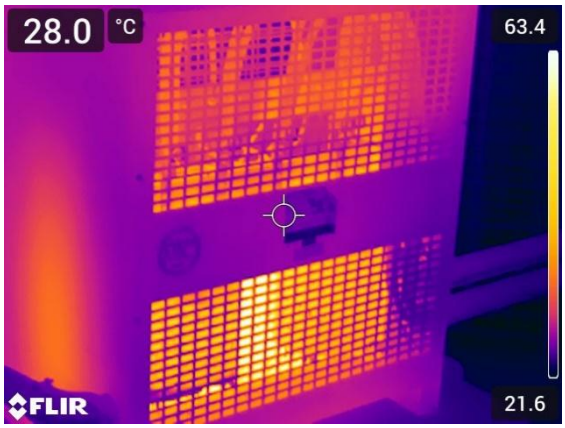


PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	6.1	**A-N**	350
B PHASE	4.9	**B-N**	355
C PHASE	5.3	**C-N**	350
NEUTRAL	N/A	**A-B**	626
		A-C	624
		B-C	626

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DRYCORE
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Location	Building FF10 OLD VAULT
Component	TRANSFORMER TX-3
IR File Name	FLIR2294
Picture File Name	FLIR2295
Date	FRIDAY November 1st
Image time	10:57 AM

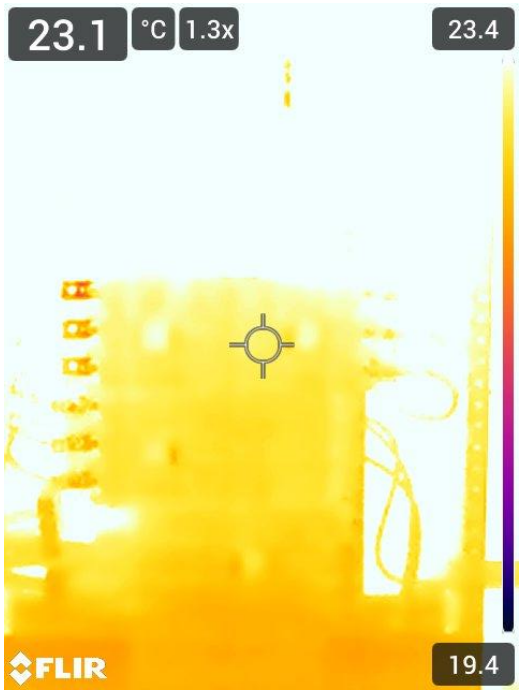




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Location	Building FF10 OLD VAULT
Component	DP-MAIN PANEL
IR File Name	FLIR2306
Picture File Name	FLIR2307
Date	FRIDAY November 1st
Image time	11:13 AM



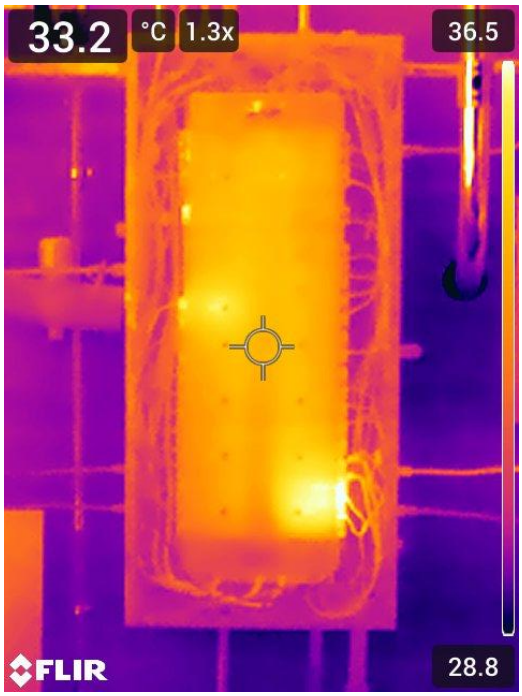


PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	33.5	**A-N**	358
B PHASE	59.4	**B-N**	360
C PHASE	34.9	**C-N**	358
NEUTRAL	N/A	**A-B**	622
		A-C	620
		B-C	624

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Location	Building FF10 BOILER ROOM
Component	P-BOILER PANEL
IR File Name	FLIR2298
Picture File Name	FLIR2299
Date	FRIDAY November 1st
Image time	11:01 AM



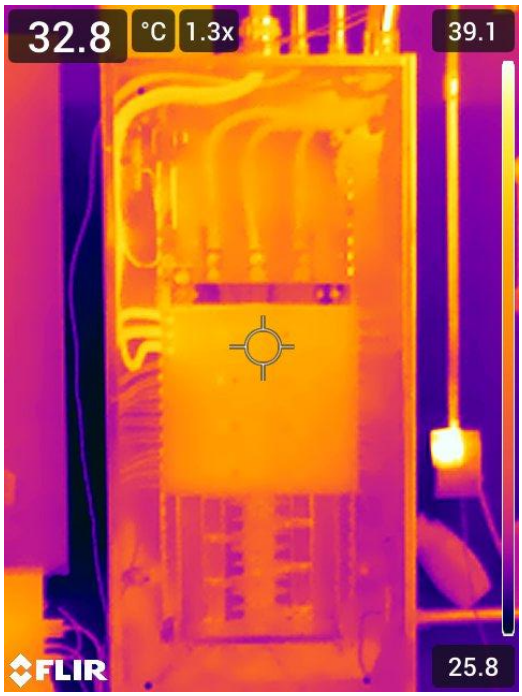


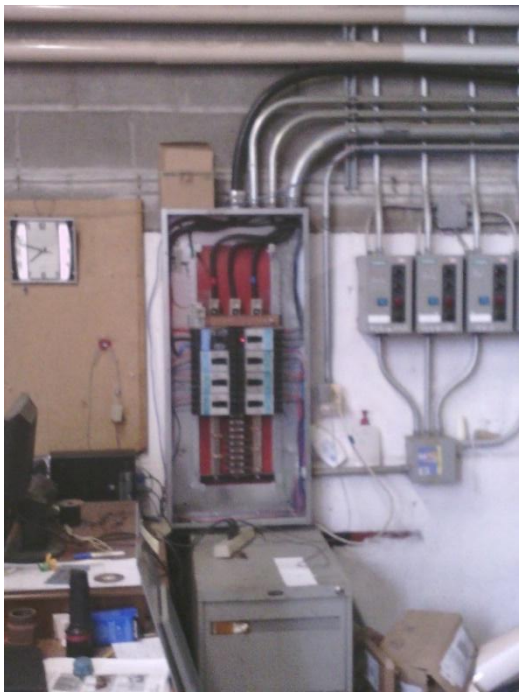
PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	12.8	**A-N**	126
B PHASE	15.7	**B-N**	126
C PHASE	18.8	**C-N**	124
NEUTRAL	6	**A-B**	220
		A-C	217
		B-C	216

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Location	Building FF10 BOILER ROOM
Component	AA PANEL
IR File Name	FLIR2302
Picture File Name	FLIR2303
Date	FRIDAY November 1st
Image time	11:08 AM



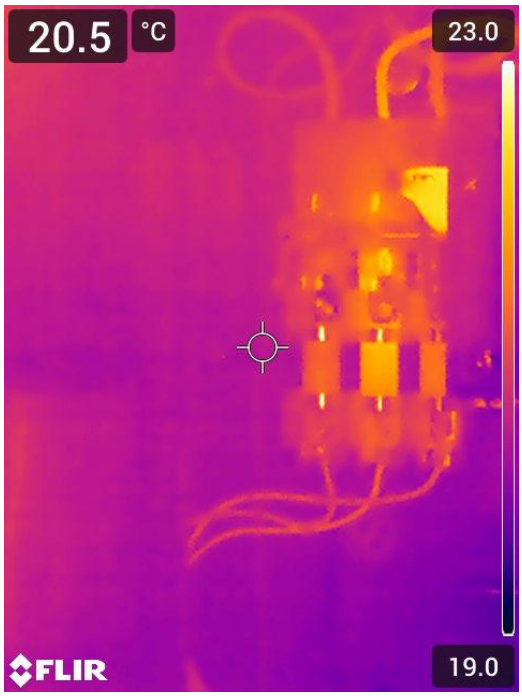


PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	47.2	**A-N**	358
B PHASE	28.3	**B-N**	359
C PHASE	8.9	**C-N**	358
NEUTRAL	N/A	**A-B**	622
		A-C	621
		B-C	623

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Location	Building FF10 ROOM 127
Component	SF1 STARTER
IR File Name	FLIR2308
Picture File Name	FLIR2309
Date	FRIDAY November 1st
Image time	11:58 AM





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Location	Building FF10 ROOM 127
Component	P1 STARTER
IR File Name	FLIR2310
Picture File Name	FLIR2311
Date	FRIDAY November 1st
Image time	11:58 AM

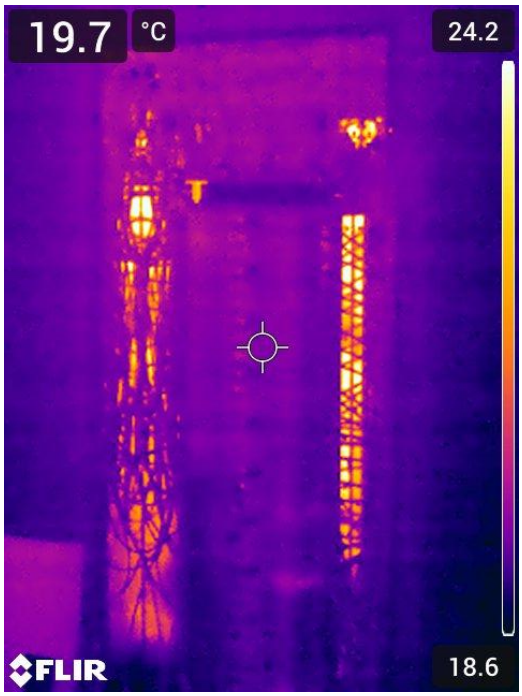




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Location	Building FF10 HALL BY RM 114
Component	PANEL 2D
IR File Name	FLIR2312
Picture File Name	FLIR2313
Date	FRIDAY November 1st
Image time	12:19 PM



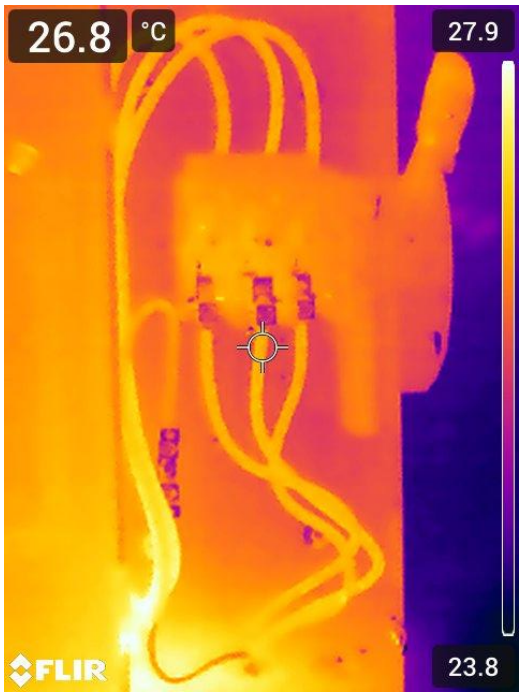


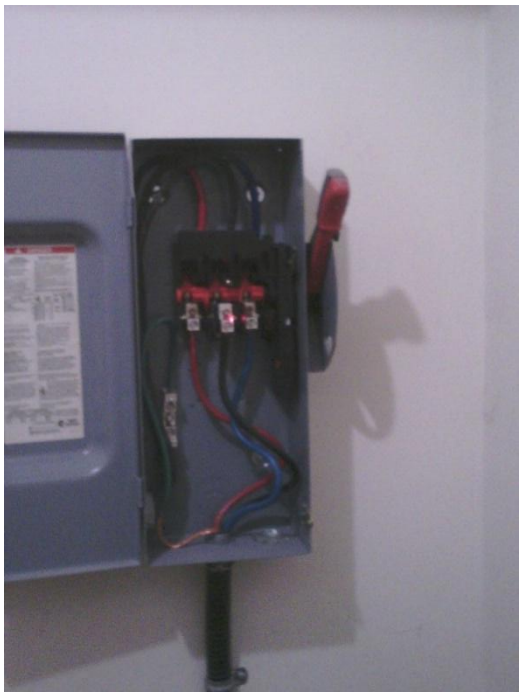
PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	1.7	**A-N**	124
B PHASE	5.1	**B-N**	124
C PHASE	2.6	**C-N**	124
NEUTRAL	5.7	**A-B**	216
		A-C	216
		B-C	216

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Location	Building FF10 HALL BY RM 114
Component	DS-TX-2 DISCONNECT
IR File Name	FLIR2314
Picture File Name	FLIR2315
Date	FRIDAY November 1st
Image time	12:19 PM





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Location	Building FF10 2ND FLOOR
Component	TRANSFORMER TX-2
IR File Name	FLIR2316
Picture File Name	FLIR2317
Date	FRIDAY November 1st
Image time	12:29 PM

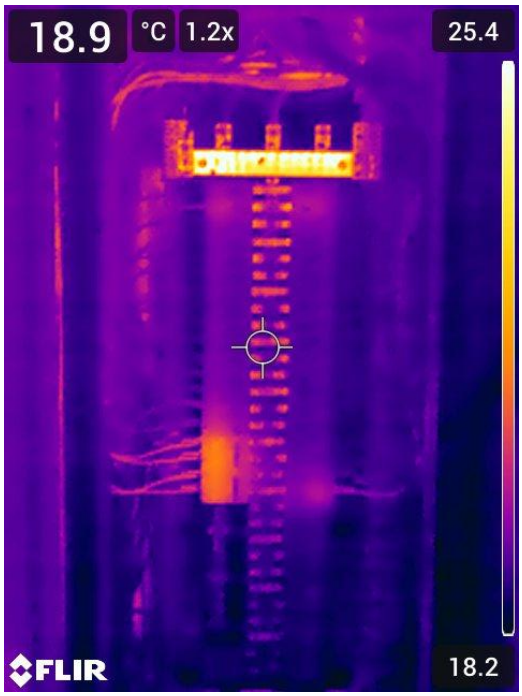


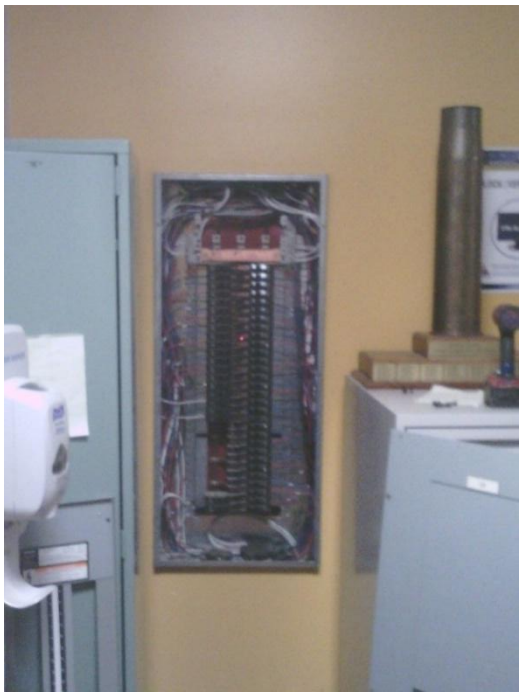


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Location	Building FF10 2ND FLOOR
Component	PANEL 2B
IR File Name	FLIR2318
Picture File Name	FLIR2319
Date	FRIDAY November 1st
Image time	12:38 PM



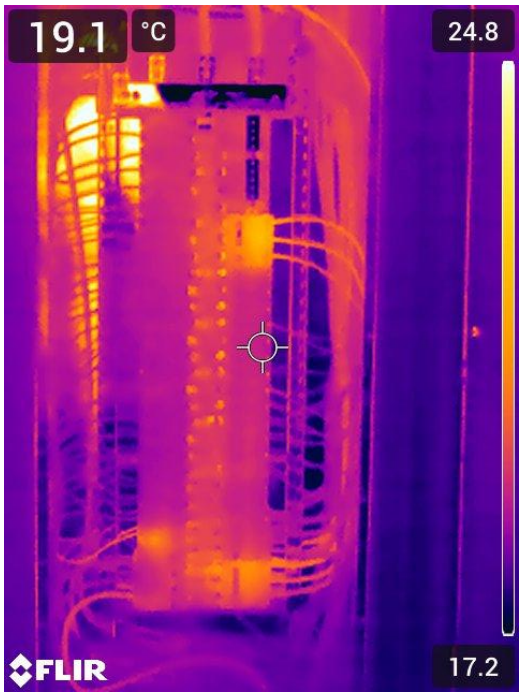


PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	15.5	**A-N**	123
B PHASE	11.5	**B-N**	123
C PHASE	7	**C-N**	124
NEUTRAL	2.6	**A-B**	213
		A-C	214
		B-C	214

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DRYCORE
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Location	Building FF10 ROOM 204
Component	PANEL 2A
IR File Name	FLIR2320
Picture File Name	FLIR2321
Date	FRIDAY November 1st
Image time	12:49 PM





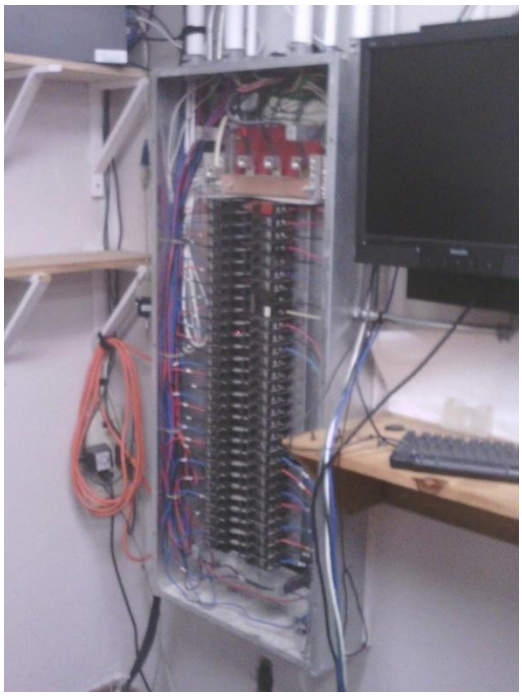
PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	27	**A-N**	122
B PHASE	32	**B-N**	122
C PHASE	29	**C-N**	123
NEUTRAL	13	**A-B**	213
		A-C	218
		B-C	214

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Location	Building FF10 ROOM 104
Component	PANEL 2C
IR File Name	FLIR2322
Picture File Name	FLIR2323
Date	FRIDAY November 1st
Image time	1:04 PM





PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	3.7	**A-N**	123
B PHASE	2.5	**B-N**	123
C PHASE	18.3	**C-N**	123
NEUTRAL	14.6	**A-B**	214
		A-C	214
		B-C	215

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Appendix D – Site Checklist

FF10

Line #	Tasks	Confirmation of Completion	Results/Notes
1	DP-MAIN		
2	Refer to panel information sheet & perform visual testing for DP-MAIN	☐	PANEL REQUIRES AN ESAFE AS COVER IS MODIFIED
3	Remove panel coverplate	☐	
4	Perform thermal scanning, record photo's for report	☐	
5	Refer to panel information sheet and perform panel testing	☐	
6	Trace and verify all down stream equipment	☐	
7			
8	*Confirm breaker ratings, SCCR ratings, Trip plug settings for the following:*		
9	MCB	☐	
10	Breaker 1 112.5 KVA TRANSFORMER	☐	200A
11	Breaker 2 SPARE	☐	SPARE
12	Breaker 3 POWER METRE	☐	400A
13	Breaker 4 NORMANDY HALL	☐	400A
14	Breaker 5 75KVA TRANSFORMER	☐	100A 18KA
15	Breaker 6 45KVA TRANSFORMER 2ND FLOOR	☐	100A 14KA
16	PNL AA		200A 25KA
17	*Confirm the following wire sizes, number of cables per phase, & cable type (Cu/Al):*		
18	TX-MAIN to DP-MAIN	☐	500 MCM CU 2 WIRES PER PHASE
19	DP-MAIN to PANEL AA	☐	3/0 CU WIRE 1 WIRE PER PHASE
20	DP-MAIN to TX-1	☐	#3 CU WIRE 1 WIRE PER PHASE
21	DP-MAIN to DS-TX-2	☐	#3 CU WIRE 1 WIRE PER PHASE
22	DP-MAIN to TX-3	☐	#1 CU WIRE 1 WIRE PER PHASE
23	DP-MAIN to Meter	☐	#12 CU WIRE 1 WIRE PER PHASE
24	DP-MAIN to NORMANDY HALL	☐	2/0 CU MI CABLE 1 WIRE PER PHASE
25			
26	*Confirm the following lengths of wire, conduit type, & conduit size:*		
27	TX-MAIN to DP-MAIN	☐	110' THROUGH 4" PVC
28	DP-MAIN to PANEL AA	☐	200' THROUGH 2" EMT
29	DP-MAIN to TX-1	☐	60' THROUGH 1 1/2" EMT
30	DP-MAIN to DS-TX-2	☐	50' TECK CABLE
31	DP-MAIN to TX-3	☐	25' THROUGH 2" EMT
32	DP-MAIN to Meter	☐	5' WIRE THROUGH NIPPLE
33	DP-MAIN to NORMANDY HALL	☐	40' MI CABLE
34			
35	PANEL-AA		
36	Refer to panel information sheet & perform visual testing for PANEL-AA	☐	
37	Remove panel coverplate	☐	
38	Perform thermal scanning, record photo's for report	☐	
39	Refer to panel information sheet and perform panel testing	☐	
40	Trace and verify all down stream equipment	☐	
41			
42	*Confirm breaker ratings, SCCR ratings, Trip plug settings for the following:*		
43	Breaker 1	☐	110A 18KA
44	Breaker 2	☐	50A 18KA
45	Breaker 3	☐	20A 18KA
46	Breaker 4	☐	15A 18KA

47	Breaker 5	☐	15A 18KA
48	Breaker 6	☐	15A 18KA
49	Breaker 7	☐	15A 18KA
50	Breaker 8	☐	15A 18KA
51			
52	*Confirm the following wire sizes, number of cables per phase, & cable type (Cu/Al):*		
53	PANEL-AA to P-1	☐	#12 CU WIRE 1 WIRE PER PHASE
54	PANEL-AA to P-2	☐	#12 CU WIRE 1 WIRE PER PHASE
55	PANEL-AA to P-3	☐	#12 CU WIRE 1 WIRE PER PHASE
56	PANEL-AA to P-4	☐	#12 CU WIRE 1 WIRE PER PHASE
57	PANEL-AA to P-5	☐	#12 CU WIRE 1 WIRE PER PHASE
58	PANEL-AA to SF1	☐	#6 CU WIRE 1 WIRE PER PHASE
59	~~PANEL-AA to SF1~~	☐	
60	PANEL-AA to CHILLER	☐	#2 CU WIRE 1 WIRE PER PHASE
61			
62	*Confirm the following lengths of wire, conduit type, & conduit size:*		
63	PANEL-AA to P-1	☐	
64	PANEL-AA to P-2	☐	50' THROUGH 3/4" EMT
65	PANEL-AA to P-3	☐	50' THROUGH 3/4" EMT
66	PANEL-AA to P-4	☐	50' THROUGH 3/4" EMT
67	PANEL-AA to P-5	☐	50' THROUGH 3/4" EMT
68	PANEL-AA to SF1	☐	250' THROUGH 1" EMT
69	PANEL-AA to SF1	☐	
70	PANEL-AA to CHILLER	☐	150' TECK CABLE
71			
72	TX-1		
73	Perform thermal scanning, record photo's for report	☐	
74	Confirm wire size, number of cables per phase, & cable type (Cu/Al) from TX-1 to P-2B	☐	#3 CU WIRE 1 WIRE PER PHASE
75	Confirm wire length, conduit type, & conduit size from TX-1 to P-2B	☐	60' THROUGH 1 1/2" EMT
76	Confirm kVA rating	☐	45 KVA
77	Confirm winding configurations	☐	DELTA/ WYE
78	Confirm impedance rating & X/R ratio	☐	5%
79			
80	P-2B		
81	Refer to panel information sheet & perform visual testing for P-2B	☐	
82	Remove panel coverplate	☐	
83	Perform thermal scanning, record photo's for report	☐	
84	Refer to panel information sheet and perform panel testing	☐	
85	Confirm all breaker ratings	☐	10KA
86	Confirm all breaker SCCR ratings	☐	
87			
88	DS-TX-2		
89	Confirm amperage rating	☐	100A
90	Confirm voltage rating	☐	600V
91	Remove cover plate	☐	
92	Perform thermal scanning, record photo's for report	☐	
93	Confirm if fused or unfused	☐	UNFUSED
94	Confirm fuse ratings (if applicable)	☐	
95	Confirm fuse type, series, & manufacturer	☐	
96	Confirm SCCR rating	☐	
97			
98	TX-2		
99	Perform thermal scanning, record photo's for report	☐	

100	Confirm wire size, number of cables per phase, & cable type (Cu/Al) from DS-TX-2 to TX-2	☐	#3 CU WIRE 1 WIRE PER PHASE
101	Confirm wire size, number of cables per phase, & cable type (Cu/Al) from TX-2 to ~~P-2D~~ P2-A	☐	250 MCM CU WIRE 1 WIRE PER PHASE
102	Confirm wire length, conduit type, & conduit size from DS-TX-2 to TX-2	☐	10' OF WIRE THROUGH 1 1/2" METALIC FLEX
103	Confirm wire length, conduit type, & conduit size from TX-2 to P-2D P-2A	☐	25' THROUGH 2 1/2" EMT
104	Confirm kVA rating	☐	75 KVA
105	Confirm winding configurations	☐	DELTA/ WYE
106	Confirm impedance rating & X/R ratio	☐	UNREADABLE
107			
108	P-2D		
109	Refer to panel information sheet & perform visual testing for P-2D	☐	
110	Remove panel coverplate	☐	
111	Perform thermal scanning, record photo's for report	☐	
112	Refer to panel information sheet and perform panel testing	☐	
113	Confirm all breaker ratings	☐	10KA
114	Confirm all breaker SCCR ratings	☐	
115			
116	TX-3		
117	Perform thermal scanning, record photo's for report	☐	
118	Confirm wire size, number of cables per phase, & cable type (Cu/Al) from TX-3 to PANEL-AA	☐	3/0 CU WIRE 2 WIRES PER PHASE
119	Confirm wire length, conduit type, & conduit size from TX-3 to PANEL-AA	☐	40' THROUGH 2" RIGID
120	Confirm kVA rating	☐	112.5KVA
121	Confirm winding configurations	☐	DELTA/ WYE
122	Confirm impedance rating & X/R ratio	☐	3.1 600/208V
123			
124	PANEL-AA		
125	Refer to panel information sheet & perform visual testing for PANEL-AA	☐	
126	Remove panel coverplate	☐	
127	Perform thermal scanning, record photo's for report	☐	
128	Refer to panel information sheet and perform panel testing	☐	
129	Trace and verify all down stream equipment	☐	
130			
131	*Confirm breaker ratings, SCCR ratings, Trip plug settings for the following:*		
132	MCB	☐	400A 100KA
133	Breaker 1	☐	150A SPARE NO CONDUCTORS
134	Breaker 2	☐	100A 100KA
135	Breaker 3	☐	100A 100KA NO CONDUCTORS
136	Breaker 4	☐	90A 100KA
137	Breaker 5	☐	90A 100KA BOILER RM PANEL
138			SPARE
139	*Confirm the following wire sizes, number of cables per phase, & cable type (Cu/Al):*		
140	PANEL-AA to BOILER ROOM	☐	#2 CU WIRE 1 WIRE PER PHASE
141	PANEL-AA to P-2E	☐	#3 CU WIRE 1 WIRE PER PHASE
142	PANEL-AA to P-4 DOES NOT EXIST	☐	
143			
144	*Confirm the following lengths of wire, conduit type, & conduit size:*		
145	PANEL-AA to BOILER ROOM	☐	60' THROUGH 2" RIGID

146	PANEL-AA to P-2E	☐	20' THROUGH 1 1/4" EMT
147	PANEL-AA to P-4 DOESN'T EXIST	☐	
148			
149	P-2E		
150	Refer to panel information sheet & perform visual testing for P-2E	☐	
151	Remove panel coverplate	☐	
152	Perform thermal scanning, record photo's for report	☐	
153	Refer to panel information sheet and perform panel testing	☐	
154	Confirm all breaker ratings	☐	10KA
155	Confirm all breaker SCCR ratings	☐	
156			
157	P-4 DOESN'T EXIST		
158	Confirm of panels existance and perform the following if applicable:	☐	
159	Refer to panel information sheet & perform visual testing for P-4	☐	
160	Remove panel coverplate	☐	
161	Perform thermal scanning, record photo's for report	☐	
162	Refer to panel information sheet and perform panel testing	☐	
163	Confirm all breaker ratings	☐	
164	Confirm all breaker SCCR ratings	☐	
165			
166	P-6 DOESN'T EXIST		
167	Trace and confirm where panel P-6 is being fed from	☐	
168	Refer to panel information sheet & perform visual testing for P-6	☐	
169	Remove panel coverplate	☐	
170	Perform thermal scanning, record photo's for report	☐	
171	Refer to panel information sheet and perform panel testing	☐	
172	Confirm all breaker ratings	☐	
173	Confirm all breaker SCCR ratings	☐	
174			
175	P-7 DOESN'T EXIST		
176	Trace and confirm where panel P-7 is being fed from	☐	
177	Refer to panel information sheet & perform visual testing for P-7	☐	
178	Remove panel coverplate	☐	
179	Perform thermal scanning, record photo's for report	☐	
180	Refer to panel information sheet and perform panel testing	☐	
181	Confirm all breaker ratings	☐	
182	Confirm all breaker SCCR ratings	☐	
183			
184	Equipment/General		POWER MEASURMENTS 10N 7330
185	Obtain specifications for meter fed from DP-MAIN	☐	WWW.PWRM.COM
186	Confirm HP rating for P-1	☐	
187	Confirm HP rating for P-2	☐	1.5HP
188	Confirm HP rating for P-3	☐	1.5HP
189	Confirm HP rating for P-4	☐	1.5HP
190	Confirm HP rating for P-5	☐	1.5HP
191	Confirm HP rating for CHILLER	☐	5HP 600V
192	Confirm HP rating for SF1 (if applicable)	☐	20HP 600V
193	Confirm HP rating for SF1 (if applicable)	☐	
194	Ensure all relays are located and captured	☐	

195	Measure current on all phases of any piece of equipment found to be anomalous during thermal scans	☐	

Appendix E – 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.

FF10

Distribution Panel – DP-MAIN:

Visual Testing

1.	Make/Model/Age of Equipment	Federal Pioneer/
2.	Voltage Rating	600V
3.	Amperage Rating	800A
4.	Number of Circuits	24 CCT
5.	Phase (1/3)	3
6.	MLO or MCB	MCB
7.	MCB Rating (If Applicable)	600A
8.	Short Circuit Current Rating (kA)	
9.	Corrosion/Rust/Leaks Present?	MINIMAL RUST
10.	Panel Location (Floor #, Room #)	Basement OLD VAULT
11.	Physical Damage Present?	NO
12.	Evidence of Moisture or Intrusions?	MINIMAL
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	GOOD
18.	CEC Violations Present?	NO
19.	Insulation Bushing at Entrance	NO, PVC INCOMMING
20.	Appropriate Anchoring Present?	YES
21.	Evidence of Arcing?	NONE
22.	Notes	

Panel Testing

1.	Voltage Phase A to Neutral	358
2.	Voltage Phase B to Neutral	360
3.	Voltage Phase C to Neutral	358
4.	Voltage Phase A to B	622
5.	Voltage Phase A to C	620
6.	Voltage Phase B to C	624
7.	Current Phase A	33.5
8.	Current Phase B	59.4
9.	Current Phase C	34.9
10.	Current on Neutral	NO NEUTRAL
11.	Current on Ground	.1
12.	Notes	

Distribution Panel – PANEL-AA (347/600V):

Visual Testing

1.	Make/Model/Age of Equipment	Siemens/CDP-7/27-Years
2.	Voltage Rating	347/600V
3.	Amperage Rating	400A
4.	Number of Circuits	42cct
5.	Phase (1/3)	3
6.	MLO or MCB	MLO
7.	MCB Rating (If Applicable)	
8.	Short Circuit Current Rating (kA)	14kA
9.	Corrosion/Rust/Leaks Present?	NO
10.	Panel Location (Floor #, Room #)	Basement
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	GOOD
18.	CEC Violations Present?	NO
19.	Insulation Bushing at Entrance	YES
20.	Appropriate Anchoring Present?	YES
21.	Evidence of Arcing?	NONE
22.	Notes	

Panel Testing

1.	Voltage Phase A to Neutral	358
2.	Voltage Phase B to Neutral	359
3.	Voltage Phase C to Neutral	358
4.	Voltage Phase A to B	622
5.	Voltage Phase A to C	621
6.	Voltage Phase B to C	623
7.	Current Phase A	47.2
8.	Current Phase B	28.3
9.	Current Phase C	8.9
10.	Current on Neutral	
11.	Current on Ground	0
12.	Notes	

Distribution Panel – PANEL-AA (120/208V):

Visual Testing

1.	Make/Model/Age of Equipment	Westinghouse/PL-3A/28-Years
2.	Voltage Rating	120/208V
3.	Amperage Rating	400A
4.	Number of Circuits	42cct
5.	Phase (1/3)	3
6.	MLO or MCB	MCB
7.	MCB Rating (If Applicable)	400A
8.	Short Circuit Current Rating (kA)	100KA
9.	Corrosion/Rust/Leaks Present?	RUST
10.	Panel Location (Floor #, Room #)	Basement
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	GOOD
18.	CEC Violations Present?	NO
19.	Insulation Bushing at Entrance	YES
20.	Appropriate Anchoring Present?	GOOD
21.	Evidence of Arcing?	NONE
22.	Notes	CLEANING REQUIRED

Panel Testing

1.	Voltage Phase A to Neutral	126
2.	Voltage Phase B to Neutral	123
3.	Voltage Phase C to Neutral	125
4.	Voltage Phase A to B	216
5.	Voltage Phase A to C	216
6.	Voltage Phase B to C	220
7.	Current Phase A	7.3
8.	Current Phase B	7.9
9.	Current Phase C	6.6
10.	Current on Neutral	4.9
11.	Current on Ground	
12.	Notes	

Branch Panel – P-2B:

Visual Testing

1.	Make/Model/Age of Equipment	Siemens/CDP-7/27-Years
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?	NO
10.	Panel Location (Floor #, Room #)	2ND FLOOR BY DOOR 212
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	GOOD
18.	CEC Violations Present?	PHASING ON FEED WIRES
19.	Insulation Bushing at Entrance	YES
20.	Appropriate Anchoring Present?	YES
21.	Evidence of Arcing?	NONE
22.	Notes	

Panel Testing

1.	Voltage Phase A to Neutral	123
2.	Voltage Phase B to Neutral	123
3.	Voltage Phase C to Neutral	124
4.	Voltage Phase A to B	213
5.	Voltage Phase A to C	214
6.	Voltage Phase B to C	214
7.	Current Phase A	15.5
8.	Current Phase B	11.5
9.	Current Phase C	7
10.	Current on Neutral	2.6
11.	Current on Ground	.3
12.	Notes	

Branch Panel – P-2D:

Visual Testing

		PANEL 2-C
1. Make/Model/Age of Equipment	Siemens/CDP-7/	SIEMENS AEJNCCQ
2. Voltage Rating	120/208V	120/208 V
3. Amperage Rating	225A	225A
4. Number of Circuits	60cct	60CCT
5. Phase (1/3)	3	3
6. MLO or MCB	MLO	MLO
7. MCB Rating (If Applicable)		
8. Short Circuit Current Rating (kA)	10kA	10KA
9. Corrosion/Rust/Leaks Present?	NO	NO
10. Panel Location (Floor #, Room #)	1ST FL DOOR 110	1ST ROOM 104
11. Physical Damage Present?	NO	NO
12. Evidence of Moisture or Intrusions?	NO	NO
13. General Condition of Components	GOOD	GOOD
14. Bus Bar Condition	GOOD	GOOD
15. Verify Panel Labeling	GOOD	GOOD
16. Verify Panel Directories	PRESENT	PRESENT
17. Condition of Cable Connections	GOOD	SOME SCARING FROM SHORT
18. CEC Violations Present?	NO	NO
19. Insulation Bushing at Entrance	YES	YES
20. Appropriate Anchoring Present?	YES	YES
21. Evidence of Arcing?	NONE	Some evidence of previous short scaring on main lug
22. Notes		fiber board behind with some damage

Panel Testing

1. Voltage Phase A to Neutral	124	123
2. Voltage Phase B to Neutral	124	123
3. Voltage Phase C to Neutral	124	123
4. Voltage Phase A to B	216	214
5. Voltage Phase A to C	216	214
6. Voltage Phase B to C	216	215
7. Current Phase A	1.7	3.7
8. Current Phase B	5.1	2.5
9. Current Phase C	2.6	18.3
10. Current on Neutral	5.7	14.6
11. Current on Ground	.2	
12. Notes		

Branch Panel – P-2E:

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?	NO
10.	Panel Location (Floor #, Room #)	Basement
11.	Physical Damage Present?	NO
12.	Evidence of Moisture or Intrusions?	Minimal at bottom
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	GOOD
18.	CEC Violations Present?	Straps on conduits above panel
19.	Insulation Bushing at Entrance	YES
20.	Appropriate Anchoring Present?	YES
21.	Evidence of Arcing?	NONE
22.	Notes	

Panel Testing

1.	Voltage Phase A to Neutral	124
2.	Voltage Phase B to Neutral	126
3.	Voltage Phase C to Neutral	126
4.	Voltage Phase A to B	217
5.	Voltage Phase A to C	216
6.	Voltage Phase B to C	221
7.	Current Phase A	2.6
8.	Current Phase B	2.3
9.	Current Phase C	3.3
10.	Current on Neutral	2.4
11.	Current on Ground	
12.	Notes	

Branch Panel – ~~P-4:~~ P-2A

Visual Testing

		P-2A
1. Make/Model/Age of Equipment	SIEMENS AEJNCC Q	SIEMENS AEJNCC Q
2. Voltage Rating	120/208V	120/208V
3. Amperage Rating	225A	225A
4. Number of Circuits	60	60
5. Phase (1/3)	3	3
6. MLO or MCB	MLO	MLO
7. MCB Rating (If Applicable)		
8. Short Circuit Current Rating (kA)	14KA	14KA
9. Corrosion/Rust/Leaks Present?	NO	NO
10. Panel Location (Floor #, Room #)	ROOM 204 2ND FLOOR	BASEMENT BESIDE P2E
11. Physical Damage Present?	NO	NO
12. Evidence of Moisture or Intrusions?	NO	NO
13. General Condition of Components	GOOD	GOOD
14. Bus Bar Condition	GOOD	GOOD
15. Verify Panel Labeling	GOOD	GOOD
16. Verify Panel Directories	PRESENT	PRESENT
17. Condition of Cable Connections	GOOD	GOOD
18. CEC Violations Present?	NO	NO
19. Insulation Bushing at Entrance	YES	YES
20. Appropriate Anchoring Present?	YES	YES
21. Evidence of Arcing?	NONE	NONE
22. Notes		

Panel Testing

1. Voltage Phase A to Neutral	122	122
2. Voltage Phase B to Neutral	122	123
3. Voltage Phase C to Neutral	123	123
4. Voltage Phase A to B	213	214
5. Voltage Phase A to C	218	215
6. Voltage Phase B to C	214	214
7. Current Phase A	27	20
8. Current Phase B	32	15
9. Current Phase C	29	18
10. Current on Neutral	13	5
11. Current on Ground	.1	.1
12. Notes		

P-BOILER

Branch Panel – P-6:

Visual Testing

1. Make/Model/Age of Equipment	Amalgamated/NDP72110/
2. Voltage Rating	120/208V
3. Amperage Rating	200A
4. Number of Circuits	44cct
5. Phase (1/3)	3
6. MLO or MCB	MLO
7. MCB Rating (If Applicable)	
8. Short Circuit Current Rating (kA)	
9. Corrosion/Rust/Leaks Present?	YES
10. Panel Location (Floor #, Room #)	BOILER ROOM
11. Physical Damage Present?	NO
12. Evidence of Moisture or Intrusions?	YES
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	GOOD
18. CEC Violations Present?	Wires not removed from neutral bar, MI cables cut inside and outside panel
19. Insulation Bushing at Entrance	YES
20. Appropriate Anchoring Present?	YES
21. Evidence of Arcing?	NONE
22. Notes	White wires on breakers, panel used as raceway

Panel Testing

1. Voltage Phase A to Neutral	126
2. Voltage Phase B to Neutral	126
3. Voltage Phase C to Neutral	124
4. Voltage Phase A to B	220
5. Voltage Phase A to C	217
6. Voltage Phase B to C	216
7. Current Phase A	12.8
8. Current Phase B	15.7
9. Current Phase C	18.8
10. Current on Neutral	6
11. Current on Ground	
12. Notes	

NORMANDY HALL

Branch Panel – P-7:

Visual Testing

1.	Make/Model/Age of Equipment	Taylor Electric/
2.	Voltage Rating	600V
3.	Amperage Rating	400A
4.	Number of Circuits	24CCT
5.	Phase (1/3)	3
6.	MLO or MCB	MCB
7.	MCB Rating (If Applicable)	400A
8.	Short Circuit Current Rating (kA)	
9.	Corrosion/Rust/Leaks Present?	MINOR
10.	Panel Location (Floor #, Room #)	Basement
11.	Physical Damage Present?	NO
12.	Evidence of Moisture or Intrusions?	MINOR
13.	General Condition of Components	GOOD
14.	Bus Bar Condition	GOOD
15.	Verify Panel Labeling	NEEDS NOW LABEL
16.	Verify Panel Directories	NEEDS NEW PANEL DIRECTORY
17.	Condition of Cable Connections	GOOD
18.	CEC Violations Present?	Knockout fillers required
19.	Insulation Bushing at Entrance	YES MI CABLE FEED
20.	Appropriate Anchoring Present?	YES
21.	Evidence of Arcing?	NO
22.	Notes	Lock out violation as tag taped over breaker

Panel Testing

1.	Voltage Phase A to Neutral	350
2.	Voltage Phase B to Neutral	355
3.	Voltage Phase C to Neutral	350
4.	Voltage Phase A to B	626
5.	Voltage Phase A to C	624
6.	Voltage Phase B to C	626
7.	Current Phase A	6.1
8.	Current Phase B	4.9
9.	Current Phase C	5.3
10.	Current on Neutral	
11.	Current on Ground	
12.	Notes	

Main High Voltage Switch Gear at FF10 Location:

Visual Testing

1.	Make/Model/Age of Equipment	S&C FUSED INTERRUPTER SWITCH SM-ALDUTI TYPE INDOOR
2.	Voltage Rating	4.8KV-5.5KV AT 60HZ
3.	Amperage Rating	FUSE AMP MAX 400A REFIL UNIT SM-5
4.	Number of Circuits	1
5.	Phase (1/3)	3
6.	MLO or MCB	Fuses mounted in holders, refills in the door information as following
7.	MCB Rating (If Applicable)	CAT.NO.130 150R4 4, 16KV, AMP 100E TCC 153-4
8.	Short Circuit Current Rating (kA)	
9.	Corrosion/Rust/Leaks Present?	Some rust and corrosion at bottom of doors
10.	Panel Location (Floor #, Room #)	street side of FF10
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	YES
16.	Verify Panel Directories	GOOD
17.	Condition of Cable Connections	GOOD
18.	CEC Violations Present?	Label identifies switch as indoor, unit mounted outdoor to transformer dated 1984
19.	Insulation Bushing at Entrance	
20.	Appropriate Anchoring Present?	YES
21.	Evidence of Arcing?	NONE
22.	Notes	

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	

Transformer – TX-Main FF10:

Visual Testing

1.	Make/Model/Age of Equipment	Federal Pioneer: MFR serial 66441 dated 1983
2.	Voltage Rating	4160v 347/600V
3.	Amperage Rating	600kva 5.8% oil cooled cannot read amperage
4.	Number of Circuits	Delta Wye connection
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?	Rust and
10.	Panel Location (Floor #, Room #)	street side of FF10
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	
16.	Verify Panel Directories	
17.	Condition of Cable Connections	Connection cabinet in switch is good, did not open the
18.	CEC Violations Present?	cable termination cabinet as the seal is brittle and no clearance.
19.	Insulation Bushing at Entrance	
20.	Appropriate Anchoring Present?	YES
21.	Evidence of Arcing?	NONE
22.	Notes	Fence around enclosure is inside the 1 m of the wire connection cabinet. connection cabinet seal looks weathered and did not wish to open

Transformer Testing (Primary)

1.	Voltage Phase A to B	NO VOLTAGE DUE TO KINGSTON UTILITIES SHUTDOWN
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.		
8.	Current on Ground	
9.	Notes	

Transformer Testing (Secondary)

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 _____
_____

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Appendix F – Kingston Utilities Information

Short Circuit Study Report

Service Address: 346 St, Kingston, Ontario

Study Location: Primary side of the transformer for 346 Ontario St.

Date: September 12, 2024

Max. Short-circuit Info.

LLL,Amp	LLG,Amp	LL,Amp	LG,Amp
9767	9096	8475	4904
R1, ohm	X1,ohm	R0,ohm	X0,ohm
0.1317	0.2221	0.1972	1.0293

Min. Short-circuit Info.

LLL,Amp	LLG,Amp	LL,Amp	LG,Amp
2329	2383	2017	1997
R1, ohm	X1,ohm	R0,ohm	X0,ohm
0.5593	0.8786	0.3743	1.5661

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 G – 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	**0.2**				
Arc Flash Boundary	**1.1**	**ft**	Limited approach	**5.0**	**ft**
			Restricted approach	**2.2**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**1**	

Equipment: **BUS_HV_SWG_FF10** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

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	**5.9**				
Arc Flash Boundary	**4.1**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**0**	

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

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

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	**3.6**				
Arc Flash Boundary	**3.0**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

Equipment: **P-2A-1** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

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: **P-2A-2** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**18**	**in**	Shock Hazard when		
Incident Energy in cal/cm²	**0.1**		covers removed	**208**	**VAC**
Arc Flash Boundary	**0.2**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

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

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**18**	**in**	Shock Hazard when		
Incident Energy in cal/cm²	**0.1**		covers removed	**208**	**VAC**
Arc Flash Boundary	**0.2**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

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

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

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	**0.1**				
Arc Flash Boundary	**0.2**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

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

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

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	**0.1**				
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	**00**	

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

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

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	**0.1**				
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	**00**	

Equipment: **P-6** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

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	**0.3**				
Arc Flash Boundary	**0.7**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**0**	

Equipment: **P-7** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

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	**0.5**				
Arc Flash Boundary	**0.9**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

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

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

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: **PANEL-AA (600V)** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

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	**0.2**		couvercles enlevés	**4160**	**VAC**
Périmètre d’éclats d’arcs	**1.1**	**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_SWG_FF10** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

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	**5.9**		couvercles enlevés	**600**	**VAC**
Périmètre d’éclats d’arcs	**4.1**	**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	**0**	

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

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

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	**3.6**		couvercles enlevés	**208**	**VAC**
Périmètre d’éclats d’arcs	**3.0**	**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-2A-1** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

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: **P-2A-2** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

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	**208**	**VAC**
Périmètre d’éclats d’arcs	**0.2**	**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-2B** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

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	**208**	**VAC**
Périmètre d’éclats d’arcs	**0.2**	**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-2C** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

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	**208**	**VAC**
Périmètre d’éclats d’arcs	**0.2**	**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-2D** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

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	**208**	**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	**00**	

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

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

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	**208**	**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	**00**	

Équipement: **P-6** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

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	**0.3**		couvercles enlevés	**600**	**VAC**
Périmètre d’éclats d’arcs	**0.7**	**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: **P-7** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

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	**0.5**		couvercles enlevés	**208**	**VAC**
Périmètre d’éclats d’arcs	**0.9**	**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: **PANEL-AA** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

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: **PANEL-AA (600V)** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF10

Appendix H – Cost Estimate

Project: **Arc Flash Study Fort Frontenac - KN229976** Date: 14-Mar-25

Phase **Class D Budget Cost Estimate - Building FF10** File Ref: 24549

SECTIONAL COST SUMMARY

Group Item	Element	Element Subtotal	Subtotal	-20.00%	20.00%
1	**TX-MAIN & High Voltage Switchgear**		**$ 155,300**	**$ 124,240.0**	**$ 186,360.0**
1.1	Replace cabinet seal	$ 300		$ 4,000.0	$ 6,000.0
1.2	Modify surrounding fence to be outside of 1m clearance required by CEC	$ 5,000		$ 4,000.0	$ 6,000.0
1.3	Replace switchgear for new unit with relay protection	$ 100,000		$ 80,000.0	$ 120,000.0
1.4	Replace transformer due to age	$ 50,000		$ 40,000.0	$ 60,000.0
2	**Panel DP-MAIN**		**$ 73,660**	**$ 58,928.0**	**$ 88,392.0**
2.1	Tag panel to be monitored with IR scan every one to two years as increased corrosion can cause failed connections	$ -		$ -	$ -
2.2	Replace Panel	$ 60,000		$ 48,000.0	$ 72,000.0
2.3	Revise instantaneous trip setting of breaker CB-PAA (600V) from 5 to 7.5	$ 260		$ 208.0	$ 312.0
2.4	Revise size of breaker CB-P-2A-1 from 100A to 50A	$ 3,500		$ 2,800.0	$ 4,200.0
2.5	Revise size of breaker CB-P-2A-2 from 100A to 90A	$ 4,400		$ 3,520.0	$ 5,280.0
2.6	Revise size of breaker CB-P-AA (208Y/120V) from 200A to 125A and new instantaneous trip rating of 3.2X	$ 5,500		$ 4,400.0	$ 6,600.0
3	**Panel P-AA (208Y/120V)**		**$ 60,150**	**$ 48,120.0**	**$ 72,180.0**
3.1	Tag panel to be monitored with IR scan every one to two years as increased corrosion can cause failed connections	$ -		$ -	$ -
3.2	Perform panel clean	$ 150		$ 120.0	$ 180.0
3.3	Replace panel	$ 60,000		$ 48,000.0	$ 72,000.0
4	**Panel P-2B**		**$ 300**	**$ 240.0**	**$ 360.0**
4.1	Tape or heat shrink feeder wires for proper phase identification	$ 300		$ 240.0	$ 360.0
5	**Panel P-2C**		**$ 2,000**	**$ 1,600.0**	**$ 2,400.0**
5.1	Megger the main feeder to determine integrity of insulation. Replace if faulty. Tag panel to be monitored. Perform thermal scan every 1 to 2 years to ensure further damage doesn't occur.	$ 1,000		$ 800.0	$ 1,200.0
5.2	Circuit 59 of panel P-2C is overloaded at 12.7A. Investigate this circuit and consider splitting up the load or revising to a 20A circuit.	$ 1,000		$ 800.0	$ 1,200.0
6	**Panel P-2E**		**$ 6,300**	**$ 5,040.0**	**$ 7,560.0**
6.1	Tag panel to be monitored with IR scan every one to two years as increased corrosion can cause failed connections	$ -		$ -	$ -
6.2	Provide strapping to properly secure EMT above panel	$ 300		$ 240.0	$ 360.0
6.3	Replace panel	$ 6,000		$ 4,800.0	$ 7,200.0
7	**Panel P-6**		**$ 1,500**	**$ 1,200.0**	**$ 1,800.0**
7.1	Recommend removing panel and installing proper raceway.	$ 1,500		$ 1,200.0	$ 1,800.0
8	**Panel P-7**		**$ 61,500**	**$ 49,200.0**	**$ 73,800.0**
8.1	Tag panel to be monitored with IR scan every one to two years as increased corrosion can cause failed connections	$ -		$ -	$ -
8.2	Provide new panel directory and circuit labelling.	$ 1,500		$ 1,200.0	$ 1,800.0
8.3	Remove tape from breaker	$ -		$ -	$ -
8.4	Replace panel	$ 60,000		$ 48,000.0	$ 72,000.0
9	**P-BOILER**		**$ 550**	**$ 440.0**	**$ 660.0**
9.1	Circuits 18/20 may be overloaded. Investigate loading of circuit.	$ 550		$ 440.0	$ 660.0

Project: **Arc Flash Study Fort Frontenac - KN229976** Date: 14-Mar-25

Phase **Class D Budget Cost Estimate - Building FF10** File Ref: 24549

SECTIONAL COST SUMMARY

Group Item	Element	Element Subtotal	Subtotal	-20.00%	20.00%
10	**General Building**		**$ 950**	**$ 760.0**	**$ 1,140.0**
10.1	Print and frame Single Line Diagram as required by CEC.	$ 150		$ 120.0	$ 180.0
10.2	Recommend creating a new nomenclature system for this building and providing lamacoid labels for all panels, circuit breakers, transformers and disconnect panels. Print new panel directories for the panels and perform circuit tracing to confirm unlabelled loads.	$ 800		$ 640.0	$ 960.0
	TOTAL BUDGET ESTIMATE		**$ 362,210** (+/- 20%)	$289,768	$434,652

Note: The above estimates are exclusive of the following:
Professional Design Fees
Hydro utility company charges and levies
US / Canada Tarrifs