IDEA Project No. 24549

KN229976-ARC FLASH STUDY

FF05

Fort Frontenac

Department of National Defence

Issued Date: 2025-03-14

INTEGRATED DESIGN
ENGINEERING + ARCHITECTURE

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Table of Contents

1. Executive Summary 3
1.1. Study Introduction 4
1.2. Recommendations 4
2. Short Circuit Study 6
2.1. Methodology 6
2.2. Information Provided 6
2.3. Assumptions 6
2.4. Input Information 6
2.5. Results 7
2.6. Observations and Recommendations 10
3. Protective Device Coordination Study 10
3.1. Methodology 10
3.2. Time Current Plots 11
3.3. Recommended Device Ratings and Settings 15
4. Arc Flash Incident Energy Report 19
4.1. Personal Protective Equipment 19
4.2. Job Safety Planning 20
4.3. Shock Risk Assessment 21
4.4. Rated Personnel Protective Equipment 22
4.5. Methodology 24
4.6. Arc Incident Energy Summary 26
4.7. Arc Flash Labels 28
5. Infrared Thermographic Scanning Report 29
6. Phase Balancing Analysis and Equipment Testing 30
7. Visual and Mechanical Inspections 30
Appendix A – Single Line Diagram 32
Appendix B – Eaton Thermal Scan Report 36
Appendix C – Remaining Thermal Scan Images 45
Appendix D – Site Checklist 55
Appendix E – Site Panel Information 60
Appendix F – Kingston Utilities Information 70
Appendix G – Arc Flash Labels 72
Appendix H – Cost Estimate 81

RECORD OF REVISIONS			
REVISION	**DATE**	**BY**	**COMMENTS**
0	2025-01-22	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 FF05 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 FF05 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**:

Fuse F_TRN-1 fails as it represents the Bay-O-Net fuses which are not designed to protect against the short circuit current.

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

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

Revise fuse size of fuse F_TRN-1 from 30A to 50A.

Revise the instantaneous trip setting of breaker CB_FF05 in DP-PRN-1 from High to Low.

Revise the instantaneous trip setting of breaker main CB_DP_FF05 in DP-FF05 from 10X to 5.1X.

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

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

DP-PRN-1 is most likely protected from the transformers current limiting fuses, however access to these was not available. Maintenance is recommended on the transformer complete with changing the fuses. Recommend changing with fuses that can limit the current at DP-PRN-1.

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

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

Panel P-1 has a defective breaker or loose connection. Sounds of arcing could be heard. Investigate connection and provide new breaker as required.

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 P-1:

1. Relocate owners equipment in front of panel.
2. Provide new panel screws.

Panel P-2:

1. Perform Panel Clean.
2. Investigate breakers when power is allowed to be shut off. Replace 15A 1P breaker.
3. Provide lamacoid label for panel.

Panel P-3:

1. Tape feeder conductors to properly identify phasing.
2. Provide lamacoid label for panel.

Panel P-4:

1. Tape or heat shrink feeder conductors to properly identify phasing.
2. Provide lamacoid label for panel.
3. Provide knockout covers.

General Building:

1. Lamacoid/label all equipment as per single line diagram
2. Print and Frame Single Line Diagram as 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					Length m	Conductor
					Z Ohms / Unit Length	R Ohms / Unit Length	X Ohms / Unit Length	L H / Unit Length	Y S / Unit Length		
CBL_FF05	0.6	1	1/C	600	0.04528	0.023	0.039	0.0001035	0	35	CU
CBL_P-1	0.6	1	1/C	2	0.20796	0.2	0.057	0.0001512	0	150	CU
CBL_P-2	0.6	1	1/C	2	0.20796	0.2	0.057	0.0001512	0	110	CU
CBL_P-3	0.6	1	1/C	2	0.20796	0.2	0.057	0.0001512	0	60	CU
CBL_P-4	0.6	1	1/C	3	0.25687	0.25	0.059	0.0001565	0	15	CU
CBL_P1-TRN1	5	1	1/C	1/0	0.13777	0.1281	0.0507	0.0001345	0	40	CU

Buses/ Panels/ Switch Gear:

ID	Nominal kV	Type	Bracing Symm. kA	Bracing Asymm. kA	Bracing Peak kA
BUS_HV-SG	4.16	Switchgear		26	43.88
BUS_TRN-1	4.16	Cable Bus		22	37.13
DP-FF05	0.208	Panelboard	10	10	
DP-PRN-1	0.208	Panelboard	60	60	
P-1	0.208	Panelboard	10	10	
P-2	0.208	Panelboard	10	10	
P-3	0.208	Panelboard	10	10	
P-4	0.208	Panelboard	10	10	

Circuit Breakers

ID	kV	Type	Bus	Rated Int. Adj. kA	Rated Int. kA
CB_DP-FF05	0.208	Molded Case	DP-FF05	25	25
CB_FF05	0.208	Molded Case	DP-PRN-1	42	42
CB_P-1	0.208	Molded Case	DP-FF05	10	10
CB_P-2	0.208	Molded Case	DP-FF05	10	10
CB_P-3	0.208	Molded Case	DP-FF05	10	10
CB_P-4	0.208	Molded Case	DP-FF05	10	10

Fuses:

ID	kV	Type	Bus	Rated Int. Adj. kA	Rated Int. kA
F_HV-SG	4.16	Fuse	BUS_HV-SG	26	26
F_P1	4.16	Fuse	BUS_HV-SG	26	26
F_TRN-1	4.16	Fuse	BUS_TRN-1	3.5	3.5

Switches:

ID	kV	Type	Bus	Rated Mom. Asymm. kA
SW1_TRN-1	4.16	SPST Switch	BUS_TRN-1	22
SW_HV-SG	4.16	SPST Switch	BUS_HV-SG	26
SW_P1	4.16	SPST Switch	BUS_HV-SG	26
SW_TRN-1	4.16	SPST Switch	BUS_TRN-1	22

2.5. Results

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

Project:	Arc Flash Study Fort Frontenac	ETAP		Page:	1
Location:	Fort Frontenac, Kingston	24.0.0C		Date:	01-21-2025
Contract:	KN229976			SN:	IDEAINC-01
Engineer:	Nicholas Frayn	Study Case:	SC	Revision:	Rev1
Filename:	24549 - DCC Arc Flash - FF05			Config.:	Normal

Momentary Duty Summary Report

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

Bus		Device		Momentary Duty					Device Capability		
ID	kV	ID	Type	Symm. kA rms	X/R Ratio	M.F.	Asymm. kA rms	Asymm. kA Peak	Symm. kA rms	Asymm. kA rms	Asymm. kA Peak
BUS_HV-SG	4.160	BUS_HV-SG	Switchgear	13.242	5.6	1.284	17.003	29.392		26.000	43.880
	4.160	SW_HV-SG	SPST Switch	13.242	5.6	1.284	17.003	29.392		26.000	
	4.160	SW_P1	SPST Switch	13.242	5.6	1.284	17.003	29.392		26.000	
BUS_TRN-1	4.160	BUS_TRN-1	Cable Bus	13.029	4.9	1.245	16.219	28.086		22.000	37.130
	4.160	SW1_TRN-1	SPST Switch	13.029	4.9	1.245	16.219	28.086		22.000	
	4.160	SW_TRN-1	SPST Switch	13.029	4.9	1.245	16.219	28.086		22.000	
DP-FF05	0.208	DP-FF05	Panelboard	8.018	3.2	1.129	9.053	15.542	10.000	10.000	
DP-PRN-1	0.208	DP-PRN-1	Panelboard	8.936	3.5	1.153	10.304	17.769	60.000	60.000	
	4.160	SW_HV-SG	SPST Switch	13.242	5.6	1.284	17.003	29.392		26.000	
P-1	0.208	P-1	Panelboard	2.902	0.7	1.000	2.902	4.140	10.000	10.000	
P-2	0.208	P-2	Panelboard	3.580	0.8	1.000	3.581	5.151	10.000	10.000	
P-3	0.208	P-3	Panelboard	4.961	1.1	1.003	4.975	7.390	10.000	10.000	
P-4	0.208	P-4	Panelboard	6.953	1.8	1.032	7.176	11.610	10.000	10.000	

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

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

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

Project:	Arc Flash Study Fort Frontenac	ETAP		Page:	2
Location:	Fort Frontenac, Kingston	24.0.0C		Date:	01-21-2025
Contract:	KN229976			SN:	IDEAINC-01
Engineer:	Nicholas Frayn	Study Case:	SC	Revision:	Rev1
Filename:	24549 - DCC Arc Flash - FF05			Config.:	Normal

Interrupting Duty Summary Report

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

Bus		Device			Interrupting Duty				Device Capability				
ID	kV	ID	Type	CPT (Cy)	Symm. kA rms	X/R Ratio	M.F.	Adj. Sym. kA rms	kV	Test PF	Rated Int.	Adjusted Int.	
BUS_HV-SG	4.160	F_HV-SG	Fuse		13.242	5.6	1.000	13.242	4.760	6.65	26.000	26.000	
		F_P1	Fuse		13.242	5.6	1.000	13.242	4.760	6.65	26.000	26.000	
BUS_TRN-1	4.160	F_TRN-1	Fuse		13.029	4.9	1.000	13.029	4.160	6.65	3.500	3.500	*
DP-FF05	0.208	CB_DP-FF05	Molded Case		8.018	3.2	1.000	8.018	0.240	20.00	25.000	25.000	
		CB_P-2	Molded Case		8.018	3.2	1.100	8.821	0.240	50.00	10.000	10.000	
		CB_P-1	Molded Case		8.018	3.2	1.100	8.821	0.240	50.00	10.000	10.000	
		CB_P-3	Molded Case		8.018	3.2	1.100	8.821	0.240	50.00	10.000	10.000	
		CB_P-4	Molded Case		8.018	3.2	1.100	8.821	0.240	50.00	10.000	10.000	
DP-PRN-1	0.208	CB_FF05	Molded Case		8.936	3.5	1.000	8.936	0.240	20.00	42.000	42.000	
P-1	0.208				2.902	0.7							
P-2	0.208				3.580	0.8							
P-3	0.208				4.961	1.1							
P-4	0.208				6.953	1.8							

- 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

Fuses for transformer TRN-1 were not accessible. The style of fuses are Bay-O-Net fuses and current limiting installed within the transformer, and due to the lack of maintenance records on these transformers, Drycore Electric and Kingston Utilities recommended to not remove these fuses due to the high chance of failure upon reinstallation. The recommendation is to replace these fuses. Standard values from manufacturers loaded within the ETAP software were used. The recommendation is to replace these fuses with the size indicated in the report, at the short circuit and continuous amperage rating indicated within the report. Short circuit to be 14kA or greater for current limiting fuses. Continuous rating to be 50A for TRN-1.

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.

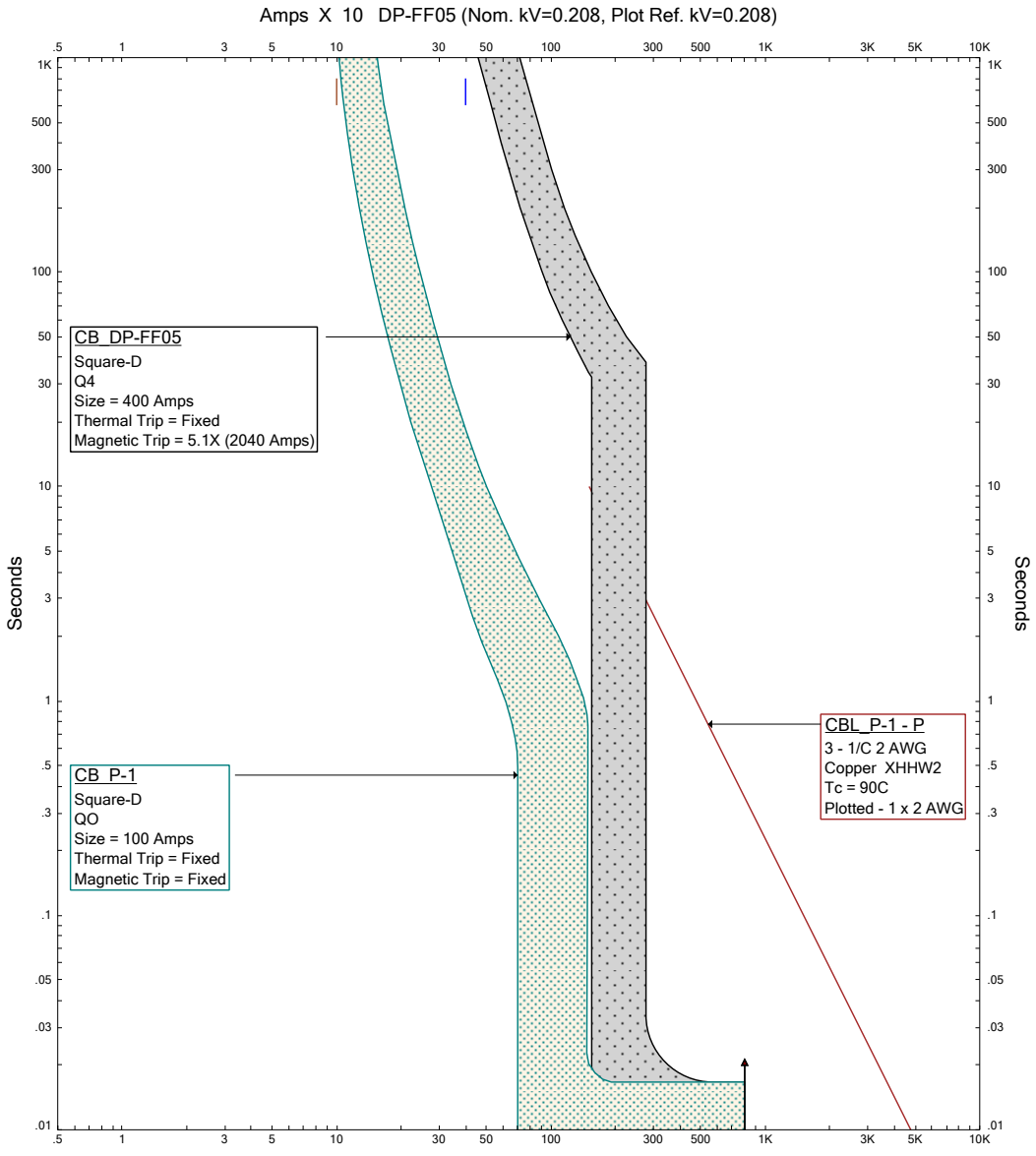
3.1. Methodology

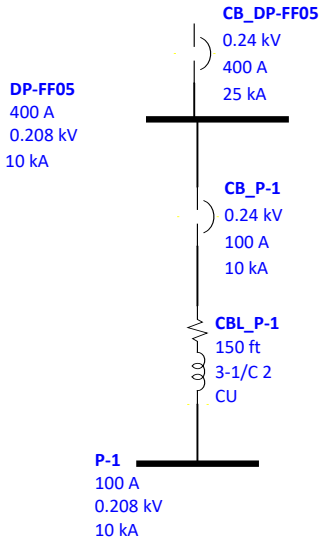
The Protective Device Coordination Study is performed utilizing the ETAP Power System Software. From the modeled distribution system, time-current characteristics curves for protective devices, cables, motors and transformers are plotted on logarithmic time plots (log-log axis). This view is used to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



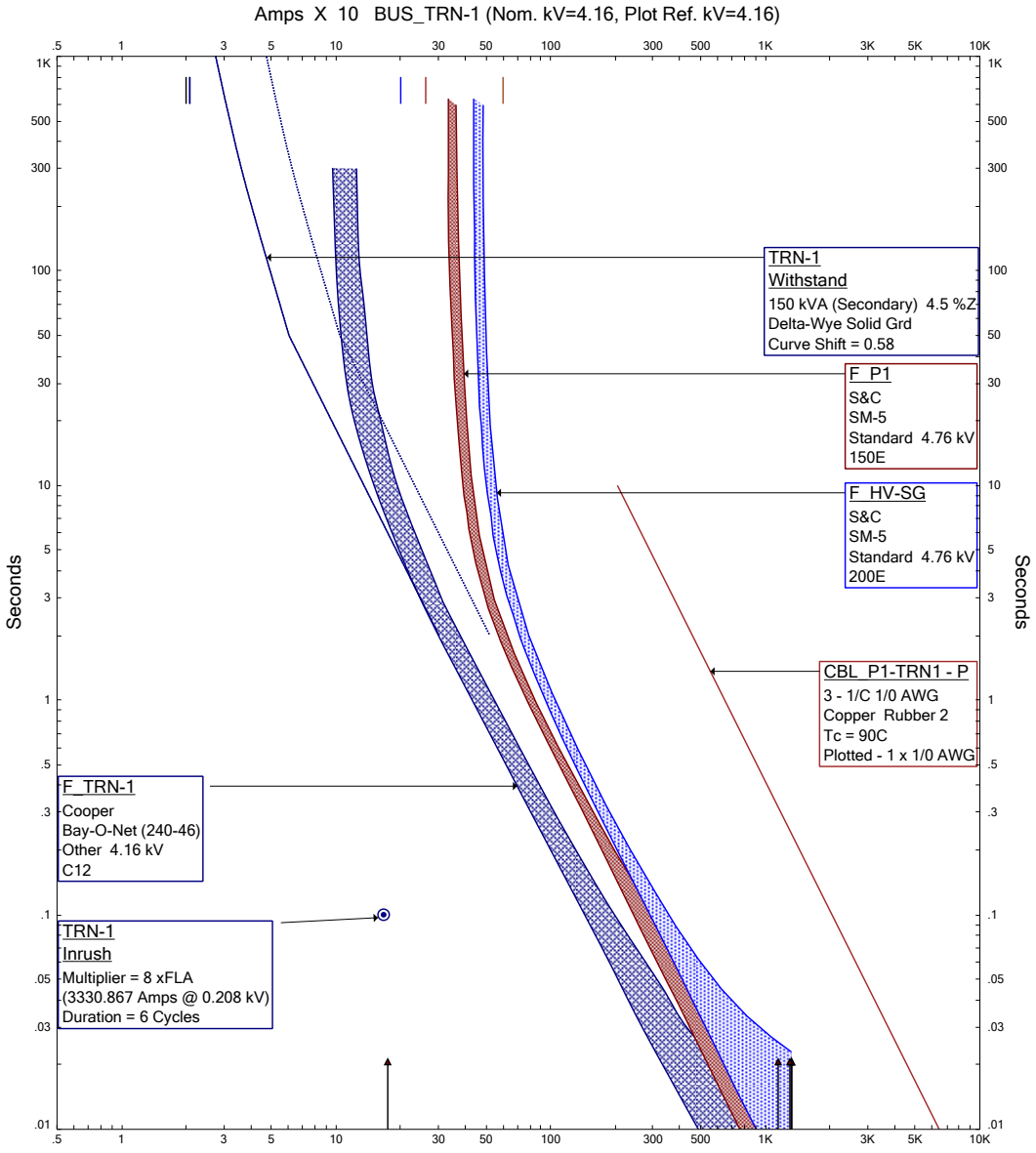


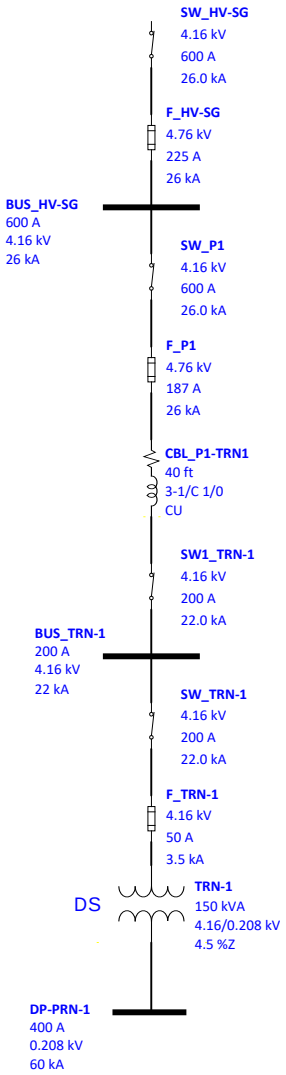
ETAP Star 24.0.0C

DP-FF05 to P1

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

Date: 01-21-2025
SN: IDEAINC-01
Rev: Rev1
Fault: Phase





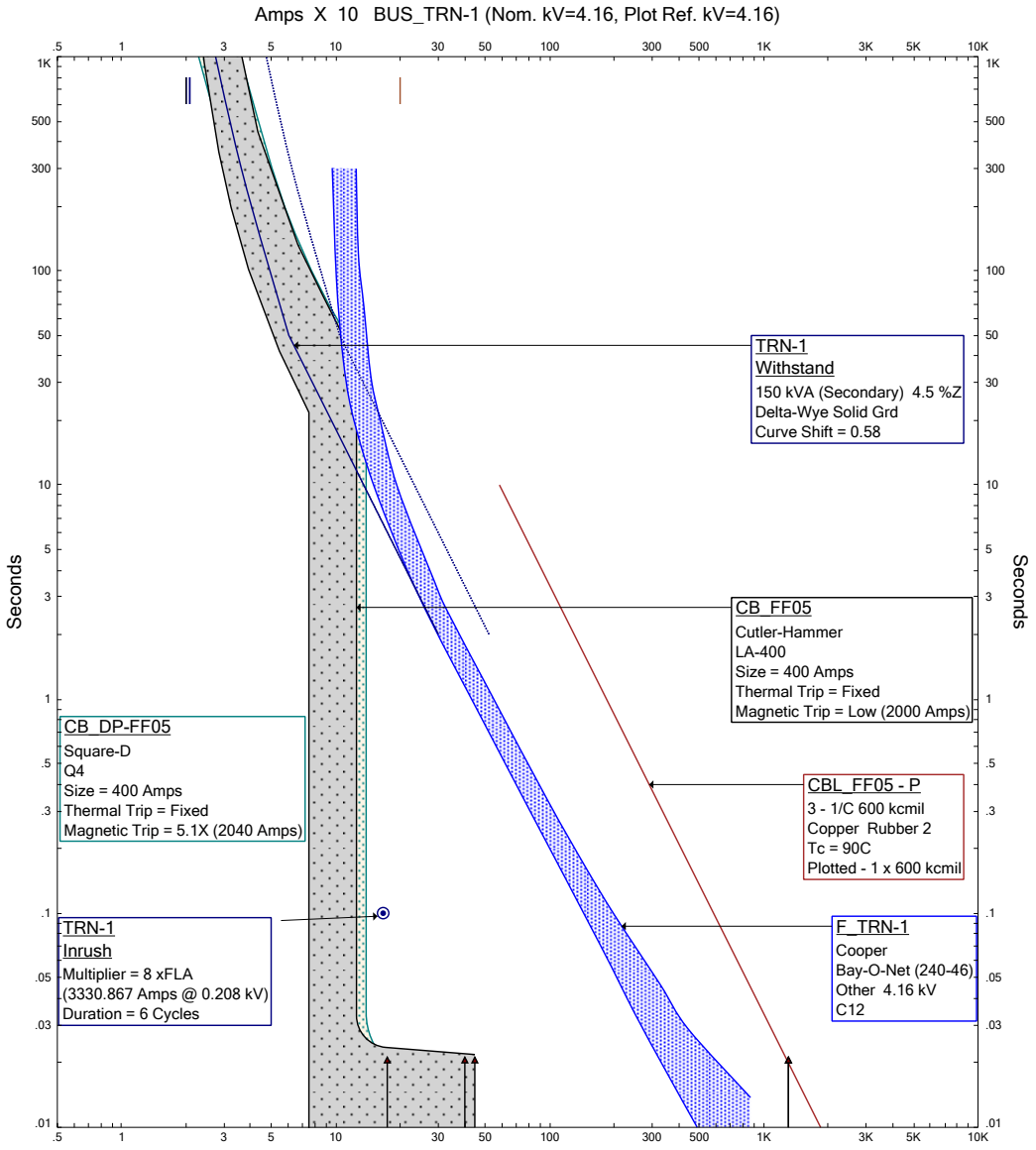
ETAP Star 24.0.0C

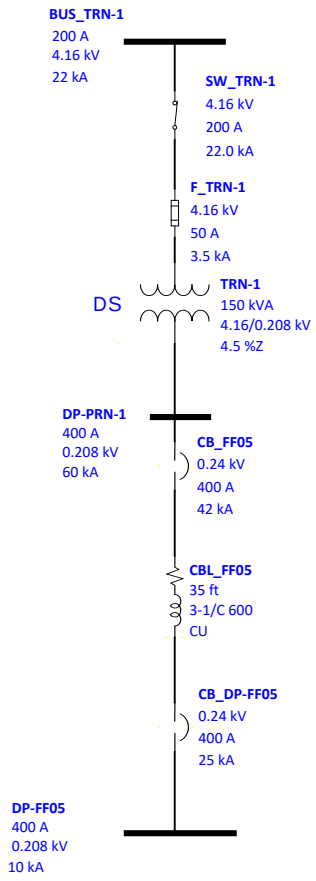
IDEA INTEGRATED DESIGN ENGINEERING + ARCHITECTURE

HV_SG to DP-PRN-1

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

Date: 01-21-2025
SN: IDEAINC-01
Rev: Rev1
Fault: Phase





ETAP Star 24.0.0C

IDEA INTEGRATED DESIGN ENGINEERING + ARCHITECTURE

TRN-1 to DP-FF05

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

Date: 01-21-2025
SN: IDEAINC-01
Rev: Rev1
Fault: Phase

3.3. Recommended Device Ratings and Settings

Protective Device Settings Report

Project:	Arc Flash Study Fort Frontenac	**Date:**	01-22-2025
Location:	LIB\EtapLib2400.lib	**Revision:**	Rev1 vs Base
Contract:	KN229976	When Revision vs Base/Revision is Reported:	
Filename:	H:\2024 Projects\24549 DCC Arc Flash\03 ELEC\ETAP Files\24549 - DCC Arc Flash -	= Revision color	

Protective Device Settings - Fuse									
Notes	**Designated Bus**	**Fuse ID**	**Base / Revision ID**	**Manufacturer**	**Model**	**Max kV**	**Speed**	**Size**	**Cont. Amp**
	Hydro Kingston	F_HV-SG	Base	S&C	SM-5	4.76	Standard	200E	225
	BUS_HV-SG	F_P1	Base	S&C	SM-5	4.76	Standard	150E	187
	BUS_TRN-1	F_TRN-1	Base	Cooper	Bay-O-Net (240-46)	4.16	Other	C10	30
1	BUS_TRN-1	F_TRN-1	Rev1	Cooper	Bay-O-Net (240-46)	4.16	Other	C12	50

Notes:

1 Rev1 settings is different from Base

* Device Rating is different from Library

Protective Device Settings - Low Voltage Circuit Breaker with Thermal-Magnetic Trip Device										
Notes	Designated Bus	LVCB ID	Base / Revision ID	Manufacturer	Breaker		Thermal		Magnetic (Inst.)	
					Model	Size	Setting	Trip (Amps)	Setting	Trip (Amps)
	DP-FF05	CB_P-4	Base	Square-D	QOB	100	Fixed	100.000	Fixed	
	DP-FF05	CB_P-3	Base	Square-D	QOB	100	Fixed	100.000	Fixed	
	DP-FF05	CB_P-2	Base	Square-D	QOB	100	Fixed	100.000	Fixed	
	DP-FF05	CB_P-1	Base	Square-D	QOB	100	Fixed	100.000	Fixed	
	DP-PRN-1	CB_FF05	Base	Cutler-Hammer	LA-400 (125-400A)	400	Fixed	400.000	High	4000.000
1	DP-PRN-1	CB_FF05	Rev1	Cutler-Hammer	LA-400 (125-400A)	400	Fixed	400.000	Low	2000.000
	DP-FF05	CB_DP-FF05	Base	Square-D	Q4	400	Fixed	400.000	10X	4000.000
1	DP-FF05	CB_DP-FF05	Rev1	Square-D	Q4	400	Fixed	400.000	5.1X	2040.000

Notes:

1 Rev1 settings is different from Base

* Device Rating is different from Library

4. Arc Flash Incident Energy Report

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

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

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

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

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

4.1. Personal Protective Equipment

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

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

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

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

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

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

4.2. Job Safety Planning

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

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

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

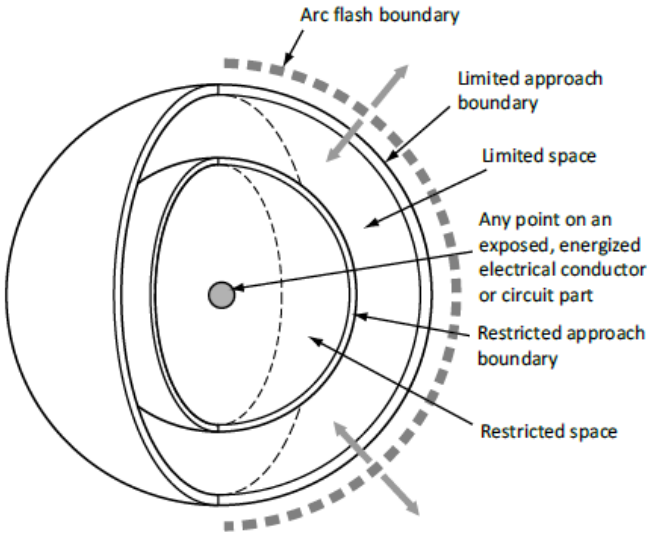
CSA Z462:24 should be reviewed in depth by each employer to create the Job Safety Plan to properly identify the information noted above.

4.3. Shock Risk Assessment

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

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

Limits of approach
(See Clause C.1.3.)



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

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

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

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

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

4.4. Rated Personnel Protective Equipment

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

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

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

Table 4 (Continued)

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

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

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

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

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

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

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

4.5. Methodology

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

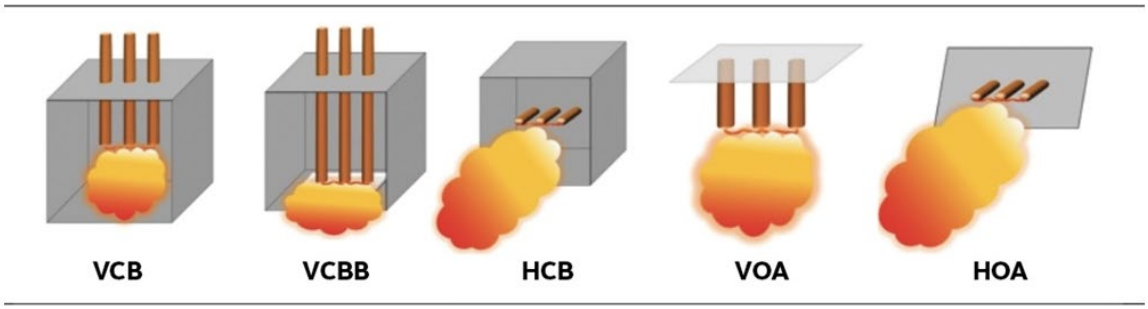
ETAP Power System Software is used to calculate the available arc flash incident energy. The software uses the IEEE 1584 calculation method to determine the available energy and Arc Flash boundary.

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

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

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

The five types are illustrated below:



arc flash direction in the various electrode/bus configurations

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

4.6. Arc Incident Energy Summary

Bus Arc Flash Hazard Analysis Summary

Faulted Bus				Fault Current			Trip Device							
ID	Nom. kV	Equipment Type	Gap (mm)	Bolted Fault (kA) Bus	Bolted Fault (kA) PD	PD Arc Fault (kA)	Source Trip Device ID	Trip (cycle)	Open (cycle)	FCT (cycle)	Arc Flash Boundary (ft)	Incident Energy (cal/cm²)	Working Distance (in)	Energy Level
BUS_HV-SG	4.160	Switchgear	104	13.242	13.242	11.487	F_HV-SG	1.53	0.00	1.53	1.4	0.3	36	Level A
BUS_TRN-1	4.160	Cable Bus	104	13.029	13.029	11.306	F_P1	1.42	0.00	1.42	1.5	0.4	36	Level A
DP-FF05	0.208	Panelboard	25	8.018	8.018	3.601	CB_FF05	1.41	0.00	1.41	0.5	0.2	18	Level A
DP-PRN-1	0.208	Panelboard	25	8.936	0.447	0.202	F_TRN-1	120.00	0.00	120.00	8.3	18.5	18	Level B
P-1	0.208	Panelboard	25	2.902	2.902	1.024	CB_P-1	120.00	0.00	120.00	3.4	4.4	18	Level A
P-2	0.208	Panelboard	25	3.580	3.580	1.287	CB_P-2	81.09	0.00	81.09	3.1	3.8	18	Level A
P-3	0.208	Panelboard	25	4.961	4.961	2.133	CB_P-3	1.00	0.00	1.00	0.3	0.1	18	Level A
P-4	0.208	Panelboard	25	6.953	6.953	3.084	CB_P-4	1.00	0.00	1.00	0.3	0.1	18	Level A

Arc Flash Analysis Results:

The results of the Arc Flash Incident Energy summary indicate all electrical equipment within the study have an Arc Flash Energy Level Classification of Level A except for DP-PRN-1. Our assumption is that the current limiting fuses that were not accessible reduce the Arc Flash Energy Level similar to TRN-2 through 4, however we could not model this without the existing information. In unison with replacing TRN-1 bay-o-net fuses and current limiting fuses, the recommendation is to design and select current limiting fuses to reduce the arc flash level at this panel.

4.7. Arc Flash Labels

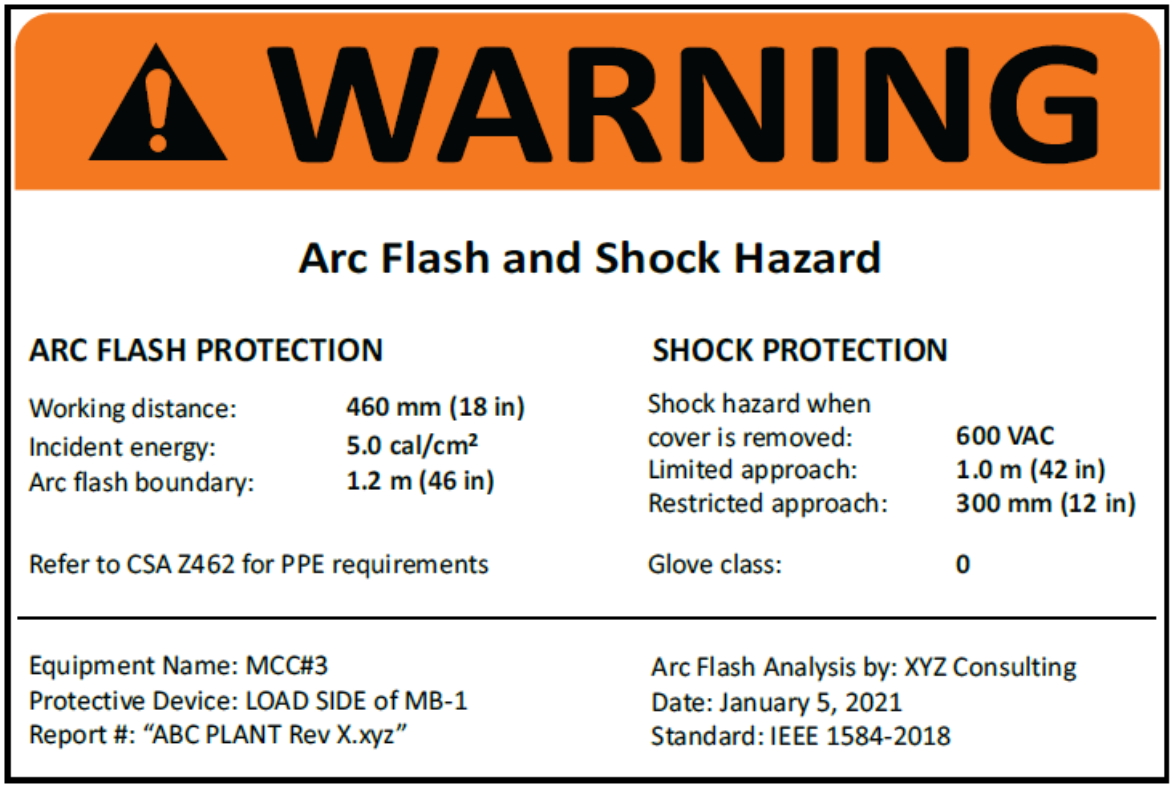
With the incident energy, arc flash boundary, and PPE requirements determined, the information is to be affixed to the equipment in the form of an Arc Flash Label. The Arc Flash labels contain the following information:

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 FF05 including all current and voltage readings can be found in Appendix E.

Observations:

1. All three 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 FF05 including all physical observations can be found in Appendix D&E.

Observations:

Panel P-1:

1. 1 meter of clearance not met infront of panel.
2. Missing cover screws.

Recommendation:

1. **Relocate owners' equipment in front of panel.**
2. **Provide new panel screws.**

Panel P-2:

1. Excessive dirt and debris inside of panel.
2. One breaker was creating arcing sound. Breaker could not be located without trouble shooting panel by turning off breakers.
3. No Panel identification

Recommendation:

1. **Perform Panel Clean.**
2. **Investigate breakers when power is allowed to be shut off. Replace 15A 1P breaker.**
3. **Provide lamacoid label for panel.**

Panel P-3:

1. No tape on feeder conductors to identify phasing.
2. No Panel identification.

Recommendation:

1. **Tape or heat shrink feeder conductors to properly identify phasing.**
2. **Provide lamacoid label for panel.**

Panel P-4:

1. No tape on feeder conductors to identify phasing.
2. No Panel identification.
3. Panel missing knockouts.

Recommendation:

1. **Tape or heat shrink feeder conductors to properly identify phasing.**
2. **Provide lamacoid label for panel.**
3. **Provide knockout covers.**

General Building:

1. Electrical equipment lacks labelling throughout the building.
2. Single Line Diagram missing from Electrical Room

Recommendation:

1. **Lamacoid/label all equipment as per single line diagram**
2. **Print and Frame Single Line Diagram as 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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IDEA
INTEGRATED DESIGN
ENGINEERING + ARCHITECTURE

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

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

SCALE | ÉCHELLE
1:150

LOCATION | EMPLACEMENT
388 ONTARIO STREET
KINGSTON
ONTARIO

PROJECT | PROJET
ARC FLASH STUDY
FORT FRONTENAC
KN299976

TRADE | MÉTIER	DATE
ELECTRICAL	2025-03-14

SUBJECT | SUJET
ELECTRICAL
SITE PLAN

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

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

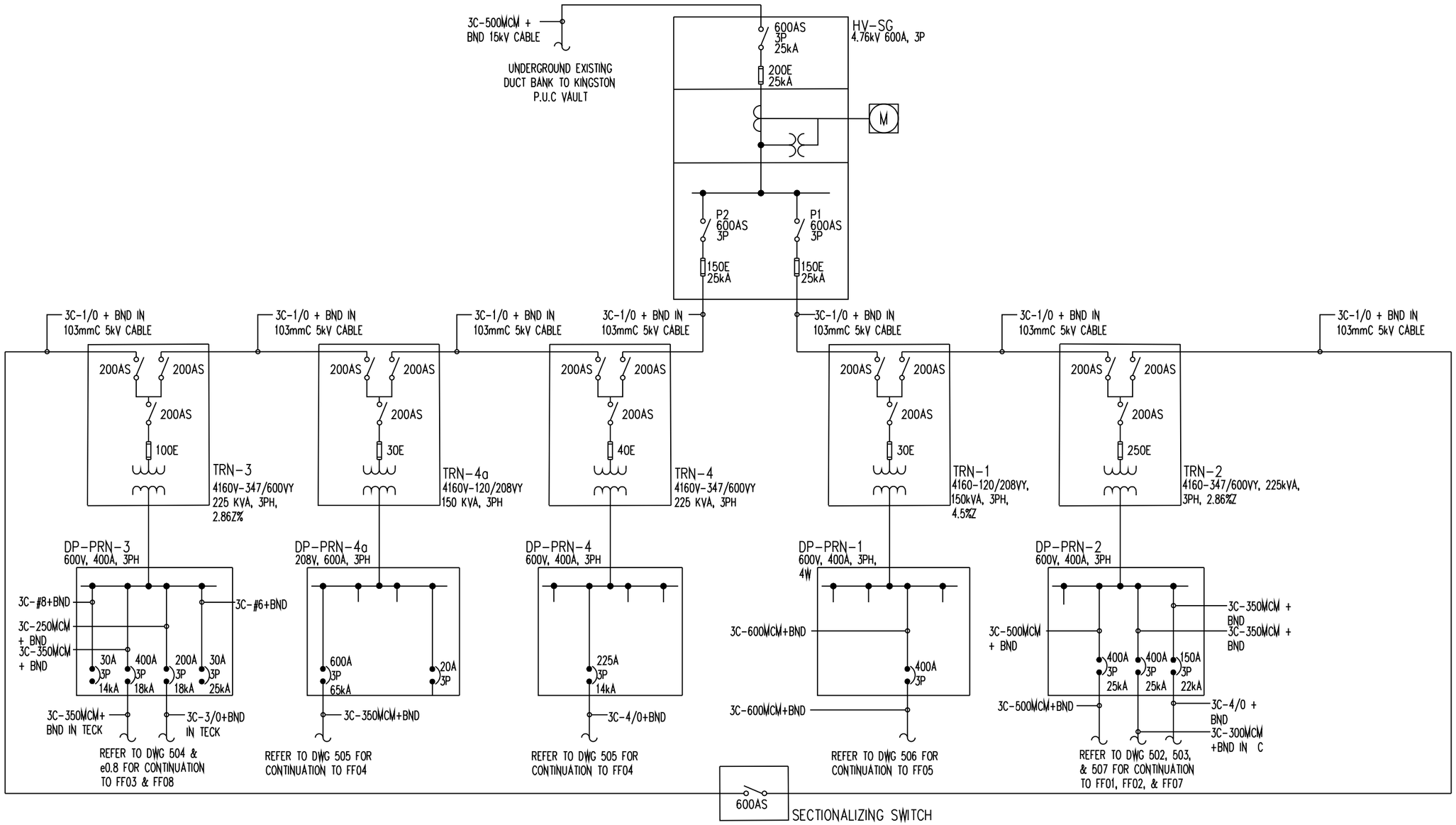
DWG. NO. | NO. DESSIN
K-B35-9306/91-500

Canada

BORDER LAST UPDATED 2012-04-01

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

Government of Canada / Gouvernement du Canada



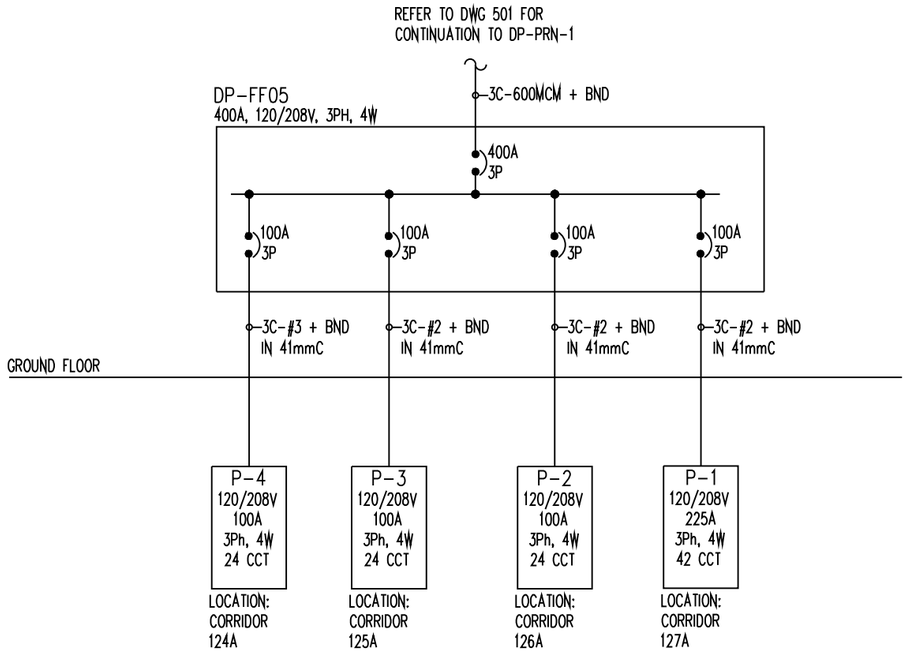
BORDER LAST UPDATED 2011-11-11

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

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

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

BORDER LAST UPDATED 2011-11-11



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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 FF05
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	7/10
DWG NO.: / NO. DESSIN:	K-B35-9306/91-506	

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 FF05				
Hallway By Door 101				
	PNL	P-4	2270	

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Eaton Electrical Services and Systems
100-1407 John Counter Blvd.
Kingston, ON K7K 6A9

Hallway By 107				
	PNL	P-3	2272	
Hallway by 111				
	PNL	P-2	2274	
Hallway By 113				
	PNL	P-1	2276	Arcing Sounds - 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

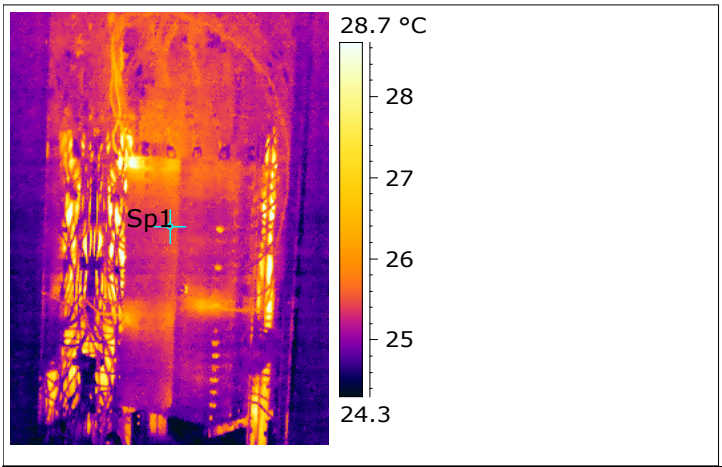
EOTJ244499

Drycore Electric, Fort Frontenac

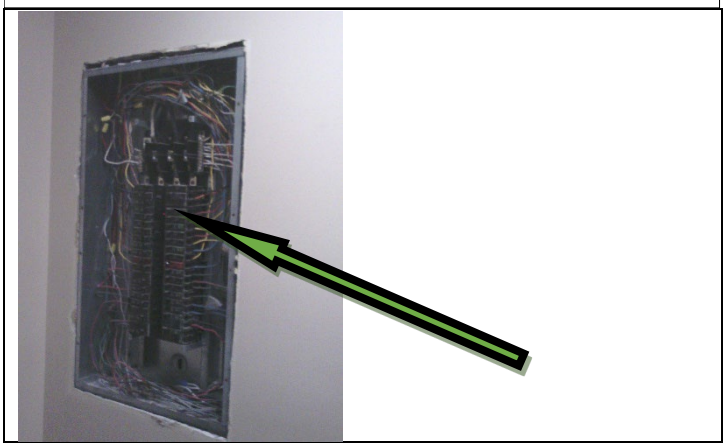
Eaton Industries (Canada) Company
Eaton Electrical Services and Systems
100-1407 John Counter Blvd.
Kingston, ON K7K 6A9

Customer	Drycore Electric
Location	Fort Frontenac
Area	Building FF05 Hallway by 113
Component	Panel P-1

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



File name	FLIR2276.jpg
Date	2024-11-01
Image Time	8:39:48 AM
Image Camera Type	FLIR T530
Image Serial Number	79310355
Emissivity	0.85
Object Distance	1.6 m
Sp1 Temperature	25.4 °C
Sp2 Temperature	-
Sp3 Temperature	-
Sp4 Temperature	-



Probable Cause:	Defective circuit breaker or loose connections – arcing noises
Corrective Action:	Investigate all connections and determine ohmic value of all breakers
Date Repaired:	
Repaired By:	

Notes: This is not a thermal anomaly. Sounds of arcing were heard by both the Drycore
Electrician and EATON.

Appendix C – Remaining Thermal Scan Images

DRYCORE
ELECTRIC • ÉLECTRIQUE

[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

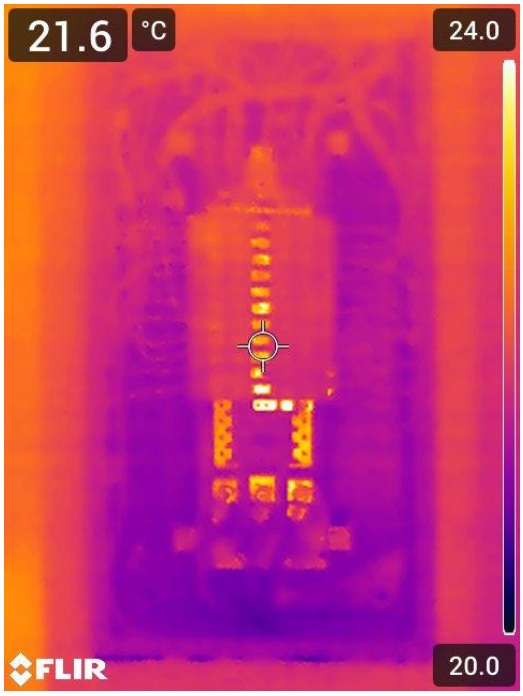
Field Representative: Andrew Beuman

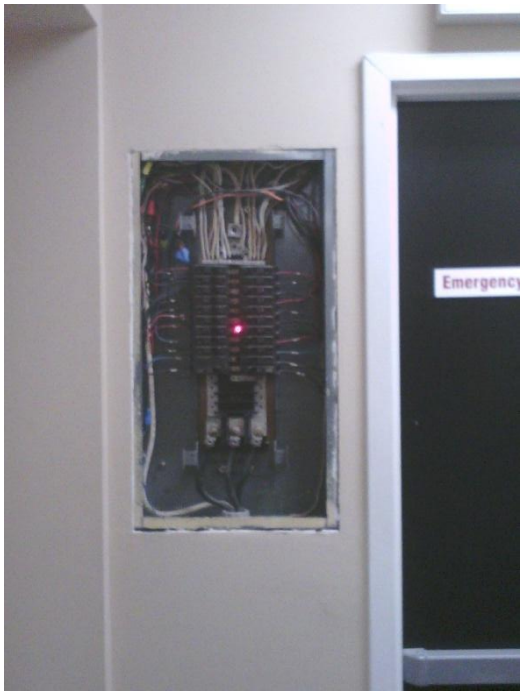
Date of Scan: October 28th to November 1st, 2024

BUILDING FF05				
Hallway by 101	PANEL	P-4 Panel	2270	2271
Hallway by 107	PANEL	P-3 Panel	2272	2273
Hallway by 111	PANEL	P-2 Panel	2274	2275
Hallway by 113	PANEL	P-1 Panel	2276	2277

DRYCORE
ELECTRIC • ÉLECTRIQUE

Location	Building FF05 HALLWAY BY 101
Component	PANEL P-4
IR File Name	FLIR2270
Picture File Name	FLIR2271
Date	FRIDAY November 1ST
Image time	9:17 AM





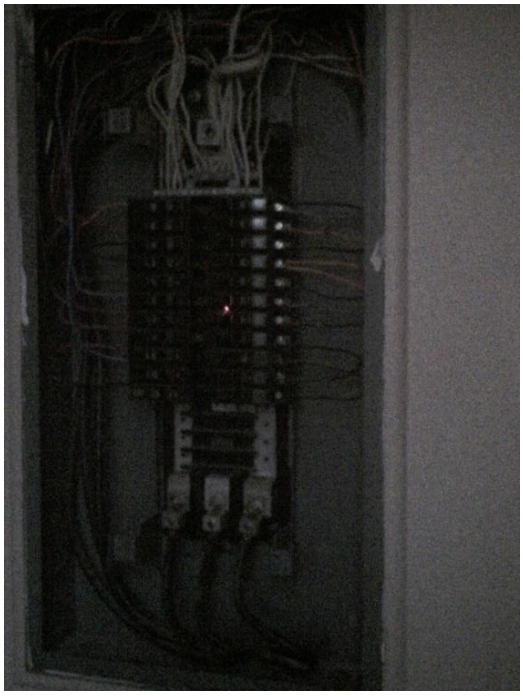
PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	2.8	**A-N**	120
B PHASE	1.2	**B-N**	121
C PHASE	2.1	**C-N**	121
NEUTRAL	2.6	**A-B**	210
		A-C	209
		B-C	210

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DRYCORE
ELECTRIC • ÉLECTRIQUE

Location	Building FF05 HALLWAY BY 107
Component	PANEL P-3
IR File Name	FLIR2272
Picture File Name	FLIR2273
Date	FRIDAY November 1ST
Image time	9:24 AM





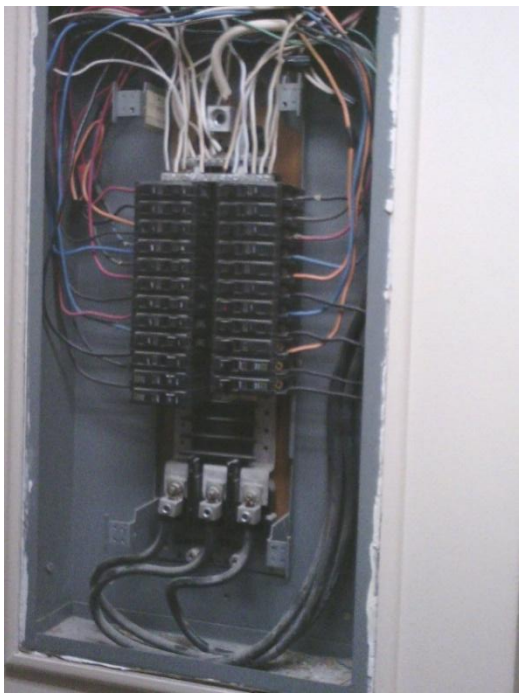
PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	4	**A-N**	121
B PHASE	3.4	**B-N**	121
C PHASE	1.4	**C-N**	120
NEUTRAL	3.5	**A-B**	210
		A-C	209
		B-C	210

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DRYCORE
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Location	Building FF05 HALLWAY BY 111
Component	PANEL P-2
IR File Name	FLIR2274
Picture File Name	FLIR2275
Date	FRIDAY November 1ST
Image time	9:32 AM



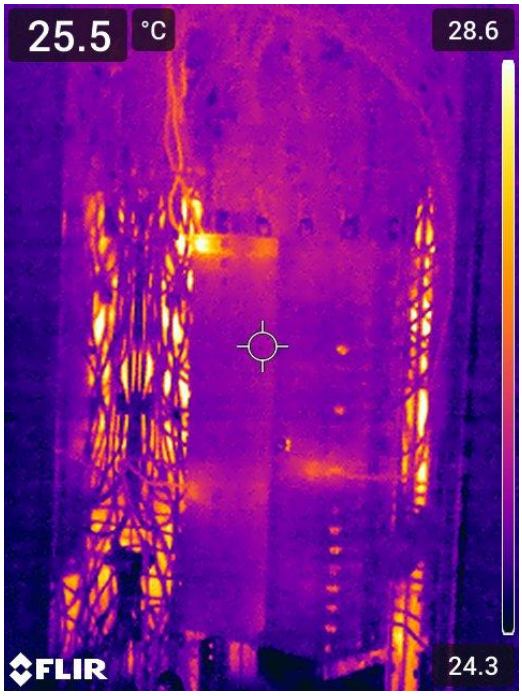


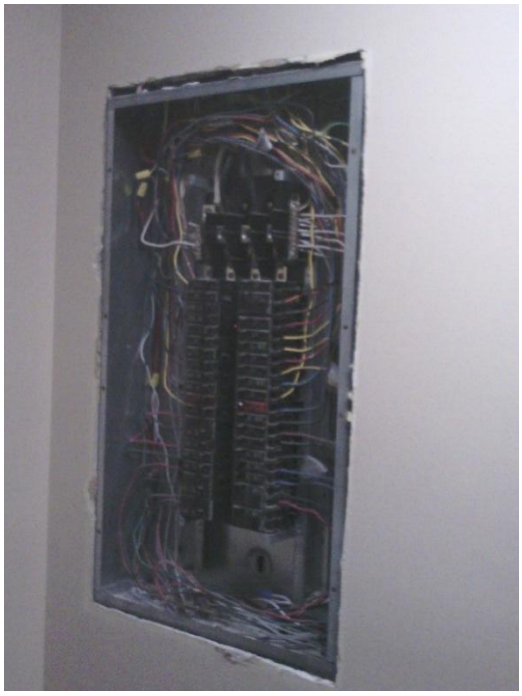
PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	5.3	**A-N**	120
B PHASE	4.9	**B-N**	120
C PHASE	3.3	**C-N**	120
NEUTRAL	2.7	**A-B**	210
		A-C	209
		B-C	209

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DRYCORE
ELECTRIC • ÉLECTRIQUE

Location	Building FF05 HALLWAY BY 111
Component	PANEL P-1
IR File Name	FLIR2276
Picture File Name	FLIR2277
Date	FRIDAY November 1ST
Image time	9:39 AM





PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	11.3	**A-N**	121
B PHASE	9.6	**B-N**	121
C PHASE	7.2	**C-N**	121
NEUTRAL	5	**A-B**	211
		A-C	210
		B-C	211

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Location	EXTERIOR BEHIND FF05
Component	TAP BOX DP-PRN1
IR File Name	FLIR2206
Picture File Name	FLIR2207
Date	THURDSAY October 31th
Image time	11:56 AM





Location	EXTERIOR BEHIND FF03
Component	TRANSFORMER TRN-1
IR File Name	FLIR2208
Picture File Name	FLIR2209
Date	THURDSAY October 31th
Image time	12:12 AM





Appendix D – Site Checklist

FF05

Line #	Tasks	Confirmation of Completion	Results/Notes
1	P-1		
2	Refer to panel information sheet & perform visual testing for P-1	☐	
3	Remove panel cover	☐	
4	Perfrom thermal scanning, record photo's for report	☐	
5	Refer to panel information sheet and perform panel testing	☐	
6	Confirm incoming wire size, number of cables per phase, & cable type (Cu/Al):	☐	#2 CU WIRE 1 WIRE PER PHASE
7	Confirm wire length, conduit type, & conduit size from P-1 to TRN-1	☐	275' THROUGH 1 1/2 RIGID
8	Confirm all breaker ratings	☐	
9	Confirm all breaker SCCR ratings	☐	10KA
10			
11	P-2		
12	Refer to panel information sheet & perform visual testing for P-2	☐	
13	Remove panel cover	☐	
14	Perfrom thermal scanning, record photo's for report	☐	
15	Refer to panel information sheet and perform panel testing	☐	
16	Confirm incoming wire size, number of cables per phase, & cable type (Cu/Al):	☐	#2 CU WIRE 1 WIRE PER PHASE
17	Confirm wire length, conduit type, & conduit size from P-2 to TRN-1	☐	230' THROUGH 1 1/2" RIGID
18	Confirm all breaker ratings	☐	
19	Confirm all breaker SCCR ratings	☐	10KA
20			
21	P-3		
22	Refer to panel information sheet & perform visual testing for P-3	☐	
23	Remove panel cover	☐	
24	Perfrom thermal scanning, record photo's for report	☐	
25	Refer to panel information sheet and perform panel testing	☐	
26	Confirm incoming wire size, number of cables per phase, & cable type (Cu/Al):	☐	#2 CU WIRE 1 WIRE PER PHASE
27	Confirm wire length, conduit type, & conduit size from P-3 to TRN-1	☐	175' THROUGH 1 1/2" RIGID
28	Confirm all breaker ratings	☐	
29	Confirm all breaker SCCR ratings	☐	10KA
30			
31	P-4		
32	Refer to panel information sheet & perform visual testing for P-4	☐	
33	Remove panel cover	☐	
34	Perfrom thermal scanning, record photo's for report	☐	
35	Refer to panel information sheet and perform panel testing	☐	
36	Confirm incoming wire size, number of cables per phase, & cable type (Cu/Al):	☐	#3 CU WIRE 1 WIRE PER PHASE
37	Confirm wire length, conduit type, & conduit size from P-4 to TRN-1	☐	100' THROUGH 1 1/2" RIGID
38	Confirm all breaker ratings	☐	
39	Confirm all breaker SCCR ratings	☐	10KA

40			
41	General		
42	Confirm if all panels are fed from exterior DP-PRN-1	☐	
43	Ensure all relays are located and captured	☐	
44	Measure current on all phases of any piece of equipment found to be anomalous during thermal scans	☐	

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

Exterior Inspection

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

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

Appendix 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.

FF05

Branch Panel – P-1:

Visual Testing

1. Make/Model/Age of Equipment	Square D/NOOD442L225CU/ E2
2. Voltage Rating	120/208V
3. Amperage Rating	225A
4. Number of Circuits	42cct
5. Phase (1/3)	3
6. MLO or MCB	MLO
7. MCB Rating (If Applicable)	
8. Short Circuit Current Rating (kA)	
9. Corrosion/Rust/Leaks Present?	NO
10. Panel Location (Floor #, Room #)	1ST FLOOR BESIDE 113
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?	1 M clearance, cover missing screws
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	121
2. Voltage Phase B to Neutral	121
3. Voltage Phase C to Neutral	121
4. Voltage Phase A to B	211
5. Voltage Phase A to C	210
6. Voltage Phase B to C	211
7. Current Phase A	11.3
8. Current Phase B	9.6
9. Current Phase C	7.2
10. Current on Neutral	5
11. Current on Ground	
12. Notes	

Branch Panel – P-2:

Visual Testing

1. Make/Model/Age of Equipment	Square D/QBL-424/ T2
2. Voltage Rating	120/208V
3. Amperage Rating	100A
4. Number of Circuits	24cct
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?	NO
10. Panel Location (Floor #, Room #)	1ST FLOOR BY ROOM 111
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 - NO PANEL IDENTIFICATION
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	Cleaning, no phasing tape. 1 breaker sounds like arcing, could not locate exact breaker

Panel Testing

1. Voltage Phase A to Neutral	120
2. Voltage Phase B to Neutral	120
3. Voltage Phase C to Neutral	120
4. Voltage Phase A to B	210
5. Voltage Phase A to C	209
6. Voltage Phase B to C	209
7. Current Phase A	5.3
8. Current Phase B	4.9
9. Current Phase C	3.3
10. Current on Neutral	2.7
11. Current on Ground	
12. Notes	

Branch Panel – P-3:

Visual Testing

1.	Make/Model/Age of Equipment	Square D/QBL-424/ T2
2.	Voltage Rating	120/208V
3.	Amperage Rating	100A
4.	Number of Circuits	24cct
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?	NO
10.	Panel Location (Floor #, Room #)	1ST FLOOR BY ROOM 107 HALLWAY
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	Outside of panel not identified
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	No phasing tape on feeder conductors

Panel Testing

1.	Voltage Phase A to Neutral	121
2.	Voltage Phase B to Neutral	121
3.	Voltage Phase C to Neutral	120
4.	Voltage Phase A to B	210
5.	Voltage Phase A to C	209
6.	Voltage Phase B to C	210
7.	Current Phase A	4
8.	Current Phase B	3.4
9.	Current Phase C	1.4
10.	Current on Neutral	3.5
11.	Current on Ground	
12.	Notes	

Branch Panel – P-4:

Visual Testing

1. Make/Model/Age of Equipment	Square D/QBL-424/
2. Voltage Rating	120/208V
3. Amperage Rating	100A
4. Number of Circuits	24cct
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?	NO
10. Panel Location (Floor #, Room #)	1ST FLOOR BY RM 101 HALLWAY
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	No label on outside of panel
16. Verify Panel Directories	PRESENT
17. Condition of Cable Connections	GOOD
18. CEC Violations Present?	Missing knockouts
19. Insulation Bushing at Entrance	YES
20. Appropriate Anchoring Present?	YES
21. Evidence of Arcing?	NONE
22. Notes	No phasing tape on feeder cables

Panel Testing

1. Voltage Phase A to Neutral	120
2. Voltage Phase B to Neutral	121
3. Voltage Phase C to Neutral	121
4. Voltage Phase A to B	210
5. Voltage Phase A to C	209
6. Voltage Phase B to C	210
7. Current Phase A	2.8
8. Current Phase B	1.2
9. Current Phase C	2.1
10. Current on Neutral	2.6
11. Current on Ground	
12. Notes	

Transformer – TRN-1:

Visual Testing

1. Make/Model/Age of Equipment	CES MARKHAM 1992
2. Voltage Rating	HV 4160/2400 LV120/208V
3. Amperage Rating	
4. Number of Circuits	
5. Phase (1/3)	3
6. MLO or MCB	
7. MCB Rating (If Applicable)	
8. Short Circuit Current Rating (kA)	
9. Corrosion/Rust/Leaks Present?	COVER RUSTY
10. Panel Location (Floor #, Room #)	BEHIND FF05
11. Physical Damage Present?	NO
12. Evidence of Moisture or Intrusions?	INSIDE CABINET GROUND LOST DUE TO RUST ON COVER
13. General Condition of Components	GOOD
14. Bus Bar Condition	GOOD
15. Verify Panel Labeling	NA
16. Verify Panel Directories	NA
17. Condition of Cable Connections	GOOD
18. CEC Violations Present?	NO
19. Insulation Bushing at Entrance	NA
20. Appropriate Anchoring Present?	YES
21. Evidence of Arcing?	NO
22. Notes	NO PENETROX ON TERMINATIONS

Transformer Testing (Primary)

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

Transformer Testing (Secondary)

1. Voltage Phase A to Neutral	121
2. Voltage Phase B to Neutral	122
3. Voltage Phase C to Neutral	121
4. Voltage Phase A to B	212
5. Voltage Phase A to C	211
6. Voltage Phase B to C	211
7. Current Phase A	21.5
8. Current Phase B	11.6
9. Current Phase C	11.5
10. Current on Neutral	6.9
11. Current on Ground	4
12. Notes	

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

info@integrateddesign.ca
www.integrateddesign.ca

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

Distribution Panel – DP-PRN-1:

BUILDING 5

Visual Testing

1. Make/Model/Age of Equipment	NO LABEL	BREAKER
2. Voltage Rating	NO LABEL	ABB MJ04333
3. Amperage Rating	NO LABEL	400A
4. Number of Circuits	4 BREAKERS	TYPE JS
5. Phase (1/3)	3 PHASE 4 WIRE	60KA@220VAC
6. MLO or MCB	MLO	42KA@240VAC
7. MCB Rating (If Applicable)		600MCM LINE AND LOAD
8. Short Circuit Current Rating (kA)		BREAKER
9. Corrosion/Rust/Leaks Present?	CORROSION RUSTY	CORROSION
10. Panel Location (Floor #, Room #)	BEHIND FF05	OXIDIZED
11. Physical Damage Present?	NO	
12. Evidence of Moisture or Intrusions?	YES	
13. General Condition of Components	PITTED OXIDIZED	
14. Bus Bar Condition	OK	
15. Verify Panel Labeling	NA	
16. Verify Panel Directories	YES	
17. Condition of Cable Connections	OXIDIZED	
18. CEC Violations Present?	NO cover over spare breaker position	
19. Insulation Bushing at Entrance	no	
20. Appropriate Anchoring Present?	YES	
21. Evidence of Arcing?	NONE	
22. Notes	Requires new rubber seal, MCB show signs of moisture damage	

Panel Testing

1. Voltage Phase A to Neutral	121
2. Voltage Phase B to Neutral	121.9
3. Voltage Phase C to Neutral	121.4
4. Voltage Phase A to B	211.5
5. Voltage Phase A to C	210.5
6. Voltage Phase B to C	210.6
7. Current Phase A	21.5
8. Current Phase B	11.6
9. Current Phase C	11.4
10. Current on Neutral	6.8
11. Current on Ground	4.2
12. Notes	NO PENETROX ON CABLE TERMINATIONS

Main High Voltage Switch Gear at TRN1 Location:

Visual Testing

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

SW1
FUSED AT 150 E
SW2
FUSED AT 150 E

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

Primary Conductor Testing

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

Appendix F – Kingston Utilities Information

Short Circuit Study Report

Service Address: 317 St, Kingston, Ontario

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

Date: September 12, 2024

Max. Short-circuit Info.

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

Min. Short-circuit Info.

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

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

Appendix 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	**0.3**				
Arc Flash Boundary	**1.4**	**ft**	Limited approach	**5.0**	**ft**
			Restricted approach	**2.2**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**1**	

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

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF05

Arc Flash and Shock Hazard Present

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

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

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF05

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	**15.9**		Limited approach	**3.5**	**ft**
Arc Flash Boundary	**7.6**	**ft**	Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

Equipment: **DP-FF05** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF05

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	**16.0**		Limited approach	**3.5**	**ft**
Arc Flash Boundary	**7.6**	**ft**	Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

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

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF05

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**18**	**in**	Shock Hazard when covers removed	**208**	**VAC**
Incident Energy in cal/cm²	**4.4**				
Arc Flash Boundary	**3.4**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

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

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF05

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	**3.8**				
Arc Flash Boundary	**3.1**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

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

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF05

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-3** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF05

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-4** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF05

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

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

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

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF05

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

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

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

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF05

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	**15.9**		couvercles enlevés	**208**	**VAC**
Périmètre d’éclats d’arcs	**7.6**	**ft**	Périmètre d’accès limite	**3.5**	**ft**
			Périmètre d’accès restreint	**1.0**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**00**	

Équipement: **DP-FF05** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF05

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	**16.0**		couvercles enlevés	**208**	**VAC**
Périmètre d’éclats d’arcs	**7.6**	**ft**	Périmètre d’accès limite	**3.5**	**ft**
			Périmètre d’accès restreint	**1.0**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**00**	

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

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF05

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

PROTECTION D’ÉCLATS D’ARCS			PROTECTION DE CHOC ÉLECTRIQUE		
Distance de travail	**18**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**4.4**		couvercles enlevés	**208**	**VAC**
Périmètre d’éclats d’arcs	**3.4**	**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	**00**	

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

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF05

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	**3.8**		couvercles enlevés	**208**	**VAC**
Périmètre d’éclats d’arcs	**3.1**	**ft**	Périmètre d’accès limite	**3.5**	**ft**
			Périmètre d’accès restreint	**1.0**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**00**	

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

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF05

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-3** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF05

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-4** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF05

Appendix H – Cost Estimate

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

Phase **Class D Budget Cost Estimate - Building FF05** File Ref: 24549

SECTIONAL COST SUMMARY

Group Item	Element	Element Subtotal	Subtotal	-20.00%	20.00%
1	**TRN-1**		**$ 3,000**	**$ 2,400.0**	**$ 3,600.0**
1.1	Revise size of fuses in TRN-1 (Bay-o-net and CLF) from 30A to 50A	$ 3,000		$ 2,400.0	$ 3,600.0
2	**DP-PRN-1**		**$ 260**	**$ 208.0**	**$ 312.0**
2.1	Revise instantaneos trip of breaker CB-FF05 from high to low	$ 260		$ 208.0	$ 312.0
3	**Panel DP-FF05**		**$ 260**	**$ 208.0**	**$ 312.0**
3.1	Revise instantaneos trip of main breaker from 10X to 5.1X	$ 260		$ 208.0	$ 312.0
4	**Panel P-1**		**$ 590**	**$ 472.0**	**$ 708.0**
4.1	Panel P-1 has a defective breaker or loose connection. Sounds of arcing could be heard. Investigate connection and provide new breaker as required	$ 440		$ 352.0	$ 528.0
4.2	Relocate owner's equipment in front of panel	$ -		$ -	$ -
4.3	Install new panel screws	$ 150		$ 120.0	$ 180.0
5	**Panel P-2**		**$ 590**	**$ 472.0**	**$ 708.0**
5.1	Perform panel clean	$ 150		$ 120.0	$ 180.0
5.2	One breaker was creating arcing sound. Investigate breakers and replace.	$ 440		$ 352.0	$ 528.0
6	**Panel P-3**		**$ 300**	**$ 240.0**	**$ 360.0**
6.1	Tape or heat shrink feeder cables for proper phase identification	$ 300		$ 240.0	$ 360.0
7	**Panel P-4**		**$ 450**	**$ 360.0**	**$ 540.0**
7.1	Tape or heat shrink feeder cables for proper phase identification	$ 300		$ 240.0	$ 360.0
7.2	Provide knockout covers	$ 150		$ 120.0	$ 180.0
8	**General Building**		**$ 550**	**$ 440.0**	**$ 660.0**
8.1	Print and frame Single Line Diagram as required by CEC.	$ 150		$ 120.0	$ 180.0
8.2	Provide lamacoid labels for all distribution equipment	$ 400		$ 320.0	$ 480.0
	TOTAL BUDGET ESTIMATE		**$ 6,000** (+/- 20%)	$4,800	$7,200

Note: The above estimates are exclusive of the following:

Professional Design Fees

Hydro utility company charges and levies

US / Canada Tarrifs