IDEA Project No. 24549

KN229976-ARC FLASH STUDY

FF08

Fort Frontenac

Department of National Defence

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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 FF08 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 FF08 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. Fuse F_TRN-3 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-3 from 100A to 50A.

Revise style of fuse F_DS-Main from fast to time delay.

Revise fuse size of fuse F_DS-TX-1 from 30A to 20A.

Revise fuse size of fuse F_DS-LP-A from 70A to 50A.

Revise fuse size of fuse F_DS-P from 100A to 45A.

Revise style of fuse F_DS-BOILERS from time delay to fast.

Revise style of fuse F_DS-FF3 from time delay to fast.

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

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

Revise size of fuse F_TRN-3 from 100A to 50A to reduce the incident energy at DP-PRN-3 from Level B (16.208 cal/cm2) to Level A (6.715 cal/cm2).

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

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

No recommendations from this section.

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

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

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. Install connector on conduit to panel.

Panel P-Boilers:

1. Recommend replacing panel
2. Provide panel directory for new panel.
3. Panel is recommended to be replaced

600V Splitter:

1. Recommend replacing splitter.

Disconnect DS-LP-A:

1. Recommend replacing this set up with a splitter and two individual disconnects for the two separate panels.

General Building:

1. Lamacoid/label all equipment as per single line diagram
2. Print and Frame Single Line Diagram as required by CEC.

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

2. Short Circuit Study

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

2.1. Methodology

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

2.2. Information Provided

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

The Hydro Fault information was provided by Kingston Utilities.

2.3. Assumptions

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

2.4. Input Information

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

Cables:

ID	kV	Cond./ Phase	Cond./ Cable	Size AWG/mm²	Z					Length m	Conductor
					Z Ohms / Unit Length	R Ohms / Unit Length	X Ohms / Unit Length	L H / Unit Length	Y S / Unit Length		
CBL_DS-TX-1	0.6	1	1/C	8	0.7827	0.78	0.065	0.0001724	0	3	CU
CBL_FF08	0.6	1	3/C	3/0	0.29087	0.2744	0.0965	0.000256	0	100	CU
CBL_LP-A	0.6	1	1/C	3	0.25687	0.25	0.059	0.0001565	0	5	CU
CBL_P	0.6	1	1/C	3	0.25687	0.25	0.059	0.0001565	0	200	CU
CBL_P-BOILERS	0.6	1	1/C	3	0.25687	0.25	0.059	0.0001565	0	5	CU
CBL_P2-TRN4	5	1	1/C	1/0	0.13777	0.1281	0.0507	0.0001345	0	250	CU
CBL_P5	0.6	1	1/C	10	1.20165	1.2	0.063	0.0001671		20	CU
CBL_P6	0.6	1	1/C	12	2.00116	2	0.068	0.0001804		20	CU
CBL_SHS	0.6	1	1/C	10	1.20165	1.2	0.063	0.0001671		60	CU
CBL_SPLITTER-1	0.6	1	1/C	3/0	0.09458	0.079	0.052	0.0001379	0	5	CU
CBL_TRN4-TRN4a	5	1	1/C	1/0	0.13777	0.1281	0.0507	0.0001345	0	20	CU
CBL_TRN4a-TRN3	5	1	1/C	1/0	0.13777	0.1281	0.0507	0.0001345	0	225	CU
CBL_TX-1 PRI	0.6	1	1/C	8	0.7827	0.78	0.065	0.0001724	0	3	CU
CBL_TX-1 SEC	0.6	1	1/C	3	0.25687	0.25	0.059	0.0001565	0	50	CU
CBL_TX-FF3 PRI	0.6	1	1/C	12	2.00116	2	0.068	0.0001804	0	120	CU
CBL_TX-FF3 SEC	0.6	1	1/C	6	0.49416	0.49	0.064	0.0001698	0	3	CU

Buses/ Panels/ Switch Gear:

ID	Nominal kV	Type	Bracing Symm. kA	Bracing Asymm. kA	Bracing Peak kA
BUS-TRN3	4.16	Cable Bus		22	37.13
BUS_HV-SG	4.16	Switchgear		22	37.13
BUS_TRN-4	4.16	Cable Bus		22	37.13
BUS_TRN-4a	4.16	Cable Bus		22	37.13
DP-PRN-3	0.6	Panelboard	18	18	
P-BOILERS	0.6	Panelboard	14	14	
SPLITTER-1	0.6	Cable Bus	22	22	
SPLITTER-2	0.208	Cable Bus	22	22	
DS-LP-A-BUS	0.208	Cable Bus	100	100	
LP-A	0.24	Panelboard	10	10	
P	0.24	Panelboard	10	10	
SPLITTER-1	0.6	Cable Bus	22	22	

Circuit Breakers

ID	kV	Type	Bus	Rated Int. Adj. kA	Rated Int. kA
CB_FF08	0.6	Molded Case	DP-PRN-3	18	18
CB_SHS	0.6	Molded Case	P-BOILERS	14	14

Fuses:

ID	kV	Type	Bus	Rated Int. Adj. kA	Rated Int. kA
F_DS-BOILERS	0.6	Fuse	SPLITTER-1	100	100
F_DS-FF3	0.6	Fuse	SPLITTER-1	20	20
F_DS-P-5	0.208	Fuse	SPLITTER-2	200	200
F_DS-P-6	0.208	Fuse	SPLITTER-2	200	200
F_HV-SG	4.16	Fuse	BUS_HV-SG	26	26
F_P2	4.16	Fuse	BUS_HV-SG	26	26
F_TRN-3	4.16	Fuse	BUS-TRN3	3.5	3.5
F_DS-LP-A	0.208	Fuse	DS-LP-A-BUS	100	100
F_DS-P	0.208	Fuse	DS-LP-A-BUS	10	10
F_DS-TX-1	0.6	Fuse	Bus11	200	200

Switches:

ID	kV	Type	Bus	Rated Mom. Asymm. kA
DS-BOILERS	0.6	SPST Switch	SPLITTER-1	100
DS-FF3	0.6	SPST Switch	SPLITTER-1	20
DS-P-5	0.208	SPST Switch	SPLITTER-2	200
DS-P-6	0.208	SPST Switch	SPLITTER-2	200
SW1_TRN-3	4.16	SPST Switch	BUS-TRN3	22
SW1_TRN-4	4.16	SPST Switch	BUS_TRN-4	22
SW1_TRN4a	4.16	SPST Switch	BUS_TRN-4a	22
SW2_TRN-4	4.16	SPST Switch	BUS_TRN-4	22
SW2_TRN4a	4.16	SPST Switch	BUS_TRN-4a	22
SW_HV-SG	4.16	SPST Switch	BUS_HV-SG	26
SW_TRN-3	4.16	SPST Switch	BUS-TRN3	63
DS-LP-A	0.208	SPST Switch	DS-LP-A-BUS	100
DS-TX-1	0.6	SPST Switch	Bus11	200

2.5. Results

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

Project:	Arc Flash Study Fort Frontenac	ETAP		Page:	1
Location:	Fort Frontenac, Kingston	24.0.0C		Date:	01-10-2025
Contract:	KN229976			SN:	IDEAINC-01
Engineer:	Nicholas Frayn	Study Case:	SC	Revision:	Rev 1
Filename:	24549 - DCC Arc Flash - FF08			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-TRN3	4.160	BUS-TRN3	Cable Bus	10.684	2.1	1.051	11.233	18.577		22.000	37.130
	4.160	SW1_TRN-3	SPST Switch	10.684	2.1	1.051	11.233	18.577		22.000	
	4.160	SW_TRN-3	SPST Switch	10.684	2.1	1.051	11.233	18.577		63.000	
BUS_HV-SG	4.160	BUS_HV-SG	Switchgear	13.245	5.6	1.284	17.006	29.398		22.000	37.130
	4.160	SW_HV-SG	SPST Switch	13.245	5.6	1.284	17.006	29.398		26.000	
BUS_TRN-4	4.160	BUS_TRN-4	Cable Bus	11.915	3.0	1.115	13.289	22.734		22.000	37.130
	4.160	SW1_TRN-4	SPST Switch	11.915	3.0	1.115	13.289	22.734		22.000	
	4.160	SW2_TRN-4	SPST Switch	11.915	3.0	1.115	13.289	22.734		22.000	
BUS_TRN-4a	4.160	BUS_TRN-4a	Cable Bus	11.810	2.9	1.108	13.081	22.327		22.000	37.130
	4.160	SW1_TRN4a	SPST Switch	11.810	2.9	1.108	13.081	22.327		22.000	
	4.160	SW2_TRN4a	SPST Switch	11.810	2.9	1.108	13.081	22.327		22.000	
DP-PRN-3	0.600	DP-PRN-3	Panelboard	13.787	3.9	1.182	16.292	28.178	18.000	18.000	
P-BOILERS	0.600	P-BOILERS	Panelboard	10.821	1.8	1.027	11.117	17.851	14.000	14.000	
SPLITTER-1	0.600	SPLITTER-1	Cable Bus	11.120	1.9	1.035	11.508	18.689	22.000	22.000	
	0.600	DS-BOILERS	SPST Switch	11.120	1.9	1.035	11.508	18.689		100.000	
	0.600	DS-FF3	SPST Switch	11.120	1.9	1.035	11.508	18.689		20.000	
SPLITTER-2	0.208	SPLITTER-2	Cable Bus	0.793	0.9	1.001	0.794	1.161	22.000	22.000	
	0.208	DS-P-5	SPST Switch	0.793	0.9	1.001	0.794	1.161		200.000	
	0.208	DS-P-6	SPST Switch	0.793	0.9	1.001	0.794	1.161		200.000	

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

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

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

Project:	Arc Flash Study Fort Frontenac	ETAP		Page:	2
Location:	Fort Frontenac, Kingston	24.0.0C		Date:	01-10-2025
Contract:	KN229976			SN:	IDEAINC-01
Engineer:	Nicholas Frayn	Study Case:	SC	Revision:	Rev 1
Filename:	24549 - DCC Arc Flash - FF08			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-TRN3	4.160	F_TRN-3	Fuse		10.684	2.1	1.000	10.684	4.160	6.65	3.500	3.500	*
BUS_HV-SG	4.160	F_HV-SG	Fuse		13.245	5.6	1.000	13.245	4.760	6.65	26.000	26.000	
		F_P2	Fuse		13.245	5.6	1.000	13.245	4.760	6.65	26.000	26.000	
DP-PRN-3	0.600	CB_FF08	Molded Case		13.787	3.9	1.046	14.416	0.600	30.00	18.000	18.000	
P-BOILERS	0.600	CB_SHS	Molded Case		10.821	1.8	1.000	10.821	0.600	30.00	14.000	14.000	
SPLITTER-1	0.600	F_DS-BOILERS	Fuse		11.120	1.9	1.000	11.120	0.600	15.00	200.000	200.000	
		F_DS-FF3	Fuse		11.120	1.9	1.000	11.120	0.600	15.00	200.000	200.000	
SPLITTER-2	0.208	F_DS-P-5	Fuse		0.793	0.9	1.000	0.793	0.600	20.00	200.000	200.000	
		F_DS-P-6	Fuse		0.793	0.9	1.000	0.793	0.600	15.00	200.000	200.000	

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

* Indicates a device with interrupting duty exceeding the device capability

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

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

Project:	**ETAP**	Page:	1
Location:	24.0.0C	Date:	01-07-2025
Contract:		SN:	IDEAINC-01
Engineer:	Study Case: SC	Revision:	Base
Filename: 24549 - DCC Arc Flash - FF08		Config.:	Normal

Momentary Duty Summary Report

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

Bus		Device			Momentary Duty					Device Capability		
ID	kV	ID	Ckt #	Type	Symm. kA rms	X/R Ratio	M.F.	Asymm. kA rms	Asymm. kA Peak	Symm. kA rms	Asymm. kA rms	Asymm. kA Peak
SPLITTER-1	0.600	SPLITTER-1		Cable Bus	11.120	1.9	1.035	11.508	18.689	22.000	22.000	
Bus11	0.600	Bus11		Bus	9.236	1.6	1.021	9.431	14.971			
	0.600	DS-TX-1		SPST Switch	9.236	1.6	1.021	9.431	14.971		200.000	
Bus14	0.600	Bus14		Bus	8.843	1.4	1.013	8.957	13.931			
Bus7	0.240	Bus7		Bus	1.996	1.2	1.004	2.005	3.009			
DS-LP-A-BUS	0.208	DS-LP-A-BUS		Cable Bus	1.466	0.9	1.001	1.468	2.145	100.000	100.000	
	0.208	DS-LP-A		SPST Switch	1.466	0.9	1.001	1.468	2.145		100.000	
P	0.240	P		Panelboard	1.014	0.6	1.000	1.014	1.441	10.000	10.000	
LP-A	0.240	LP-A		Panelboard	1.666	0.9	1.001	1.667	2.432	10.000	10.000	

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

Protective device duty is calculated based on total fault current

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

* Indicates a device with momentary duty exceeding the device capability

Project:	**ETAP**	Page:	2
Location:	24.0.0C	Date:	01-07-2025
Contract:		SN:	IDEAINC-01
Engineer:	Study Case: SC	Revision:	Base
Filename: 24549 - DCC Arc Flash - FF08		Config.:	Normal

Interrupting Duty Summary Report

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

Bus		Device				Interrupting Duty				Device Capability			
ID	kV	ID	Ckt #	Type	CPT (Cy)	Symm. kA rms	X/R Ratio	M.F.	Adj. Sym. kA rms	kV	Test PF	Rated Int.	Adjusted Int.
Bus11	0.600	F_DS-TX-1		Fuse		9.236	1.6	1.000	9.236	0.600	15.00	200.000	200.000
DS-LP-A-BUS	0.208	F_DS-LP-A		Fuse		1.466	0.9	1.000	1.466	0.250	20.00	100.000	100.000
		F_DS-P		Fuse		1.466	0.9	1.000	1.466	0.250	20.00	10.000	10.000

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

HV CB interrupting capability is adjusted based on bus nominal voltage

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

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

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

* Indicates a device with interrupting duty exceeding the device capability

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

2.6. Observations and Recommendations

Fuses for transformer TRN-3 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 12kA or greater for current limiting fuses. Continuous rating to be 50A for TRN-3.

3. Protective Device Coordination Study

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

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

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

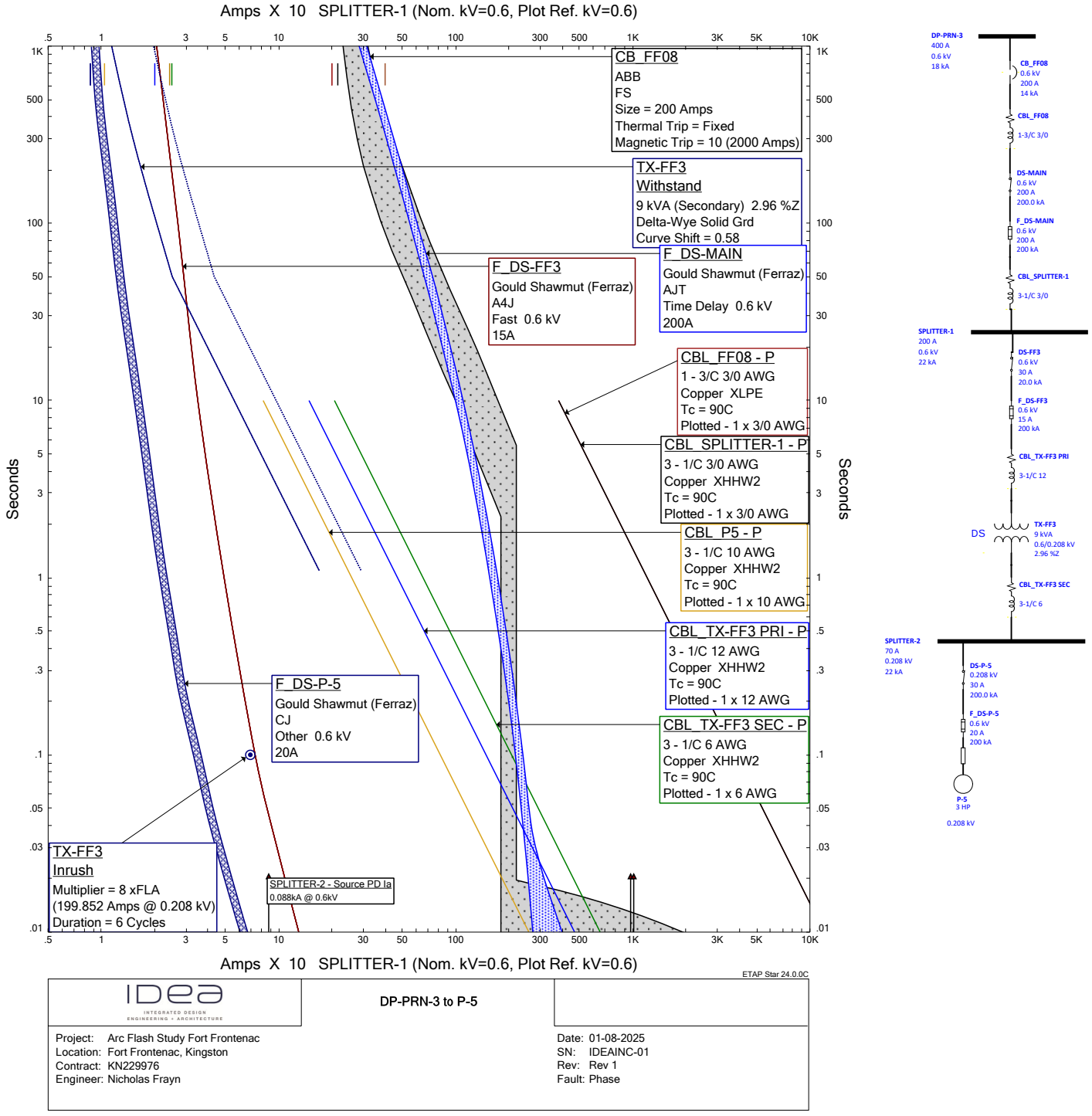
3.1. Methodology

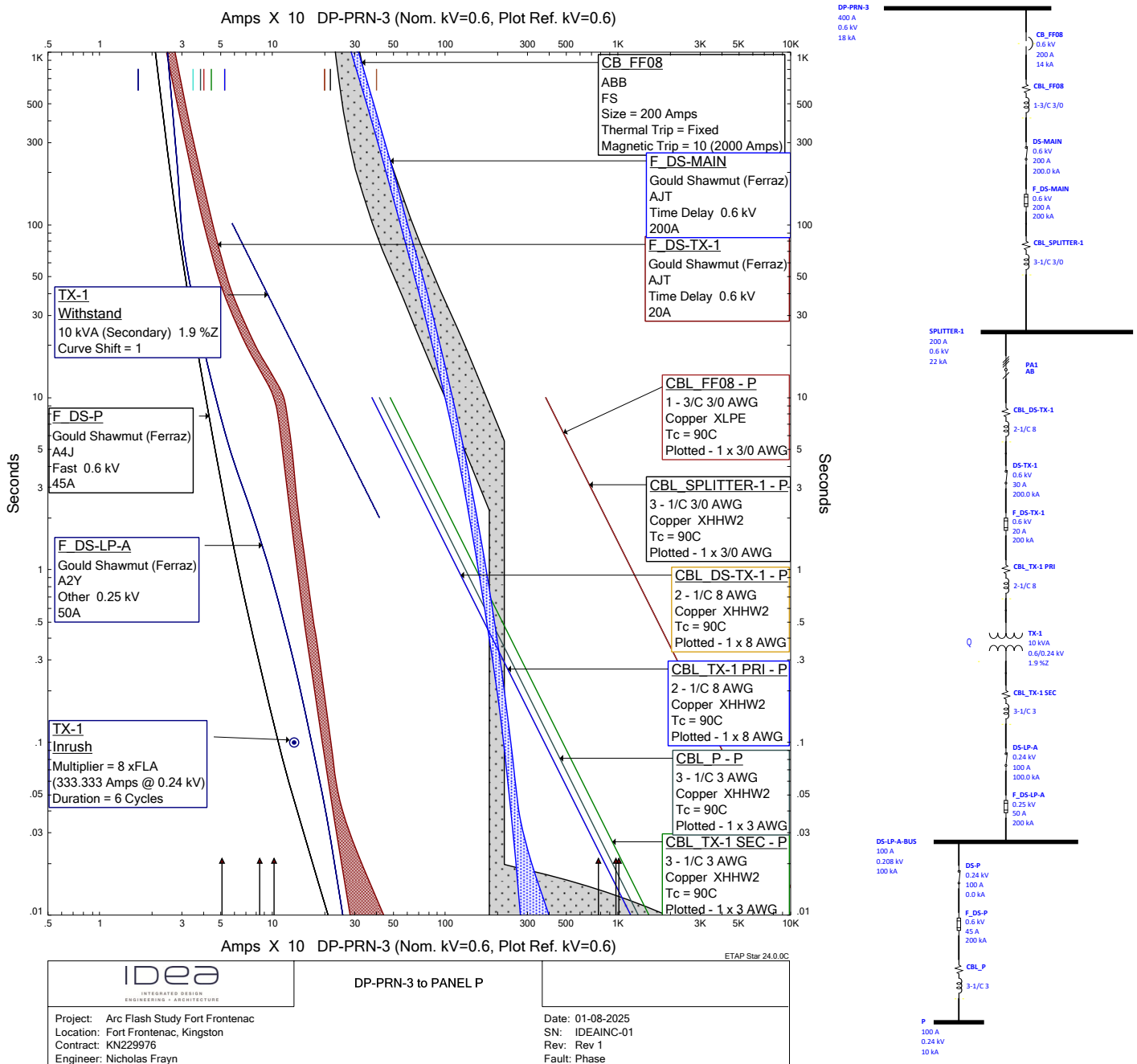
The Protective Device Coordination Study is performed utilizing the ETAP Power System Software. From the modeled distribution system, time-current characteristics curves for protective devices, cables, motors and transformers are plotted on logarithmic time plots (log-log axis). This view is used to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

ETAP models the exact device make/models and breaker trip settings to show exactly how the device will operate in the field. In addition to protective device time-current plots, transformer damage curves and inrush current are plotted to ensure the transformer is adequately protected but will also not cause nuisance trips due to their magnetizing current. Cable curves are also displayed to show that the feeder and equipment cables are adequately protected.

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

3.2. Time Current Plots


Amps X 10 SPLITTER-1 (Nom. kV=0.6, Plot Ref. kV=0.6)
Seconds
CB_FF08
ABB
FS
Size = 200 Amps
Thermal Trip = Fixed
Magnetic Trip = 10 (2000 Amps)
TX-FF3
Withstand
9 kVA (Secondary) 2.96 %Z
Delta-Wye Solid Grd
Curve Shift = 0.58
F_DS-MAIN
Gould Shawmut (Ferraz)
AJT
Time Delay 0.6 kV
200A
F_DS-FF3
Gould Shawmut (Ferraz)
A4J
Fast 0.6 kV
15A
CBL_FF08 - P
1 - 3/C 3/0 AWG
Copper XLPE
Tc = 90C
Plotted - 1 x 3/0 AWG
CBL_SPLITTER-1 - P
3 - 1/C 3/0 AWG
Copper XHHW2
Tc = 90C
Plotted - 1 x 3/0 AWG
CBL_P5 - P
3 - 1/C 10 AWG
Copper XHHW2
Tc = 90C
Plotted - 1 x 10 AWG
CBL_TX-FF3 PRI - P
3 - 1/C 12 AWG
Copper XHHW2
Tc = 90C
Plotted - 1 x 12 AWG
CBL_TX-FF3 SEC - P
3 - 1/C 6 AWG
Copper XHHW2
Tc = 90C
Plotted - 1 x 6 AWG
F_DS-P-5
Gould Shawmut (Ferraz)
CJ
Other 0.6 kV
20A
TX-FF3
Inrush
Multiplier = 8 xFLA
(199.852 Amps @ 0.208 kV)
Duration = 6 Cycles
SPLITTER-2 - Source PD Ia
0.088kA @ 0.6kV
DP-PRN-3
400 A
0.6 kV
18 kA
CB_FF08
0.6 kV
200 A
14 kA
CBL_FF08
1-3/C 3/0
DS-MAIN
0.6 kV
200 A
200.0 kA
F_DS-MAIN
0.6 kV
200 A
200 kA
CBL_SPLITTER-1
3-1/C 3/0
SPLITTER-1
200 A
0.6 kV
22 kA
DS-FF3
0.6 kV
30 A
20.0 kA
F_DS-FF3
0.6 kV
15 A
200 kA
CBL_TX-FF3 PRI
3-1/C 12
DS
TX-FF3
9 kVA
0.6/0.208 kV
2.96 %Z
CBL_TX-FF3 SEC
3-1/C 6
SPLITTER-2
70 A
0.208 kV
22 kA
DS-P-5
0.208 kV
30 A
200.0 kA
F_DS-P-5
0.6 kV
20 A
200 kA
P-5
3 HP
0.208 kV
Amps X 10 SPLITTER-1 (Nom. kV=0.6, Plot Ref. kV=0.6)
ETAP Star 24.0.0C
IDEA
INTEGRATED DESIGN ENGINEERING + ARCHITECTURE
DP-PRN-3 to P-5
Project: Arc Flash Study Fort Frontenac
Location: Fort Frontenac, Kingston
Contract: KN229976
Engineer: Nicholas Frayn
Date: 01-08-2025
SN: IDEAINC-01
Rev: Rev 1
Fault: Phase



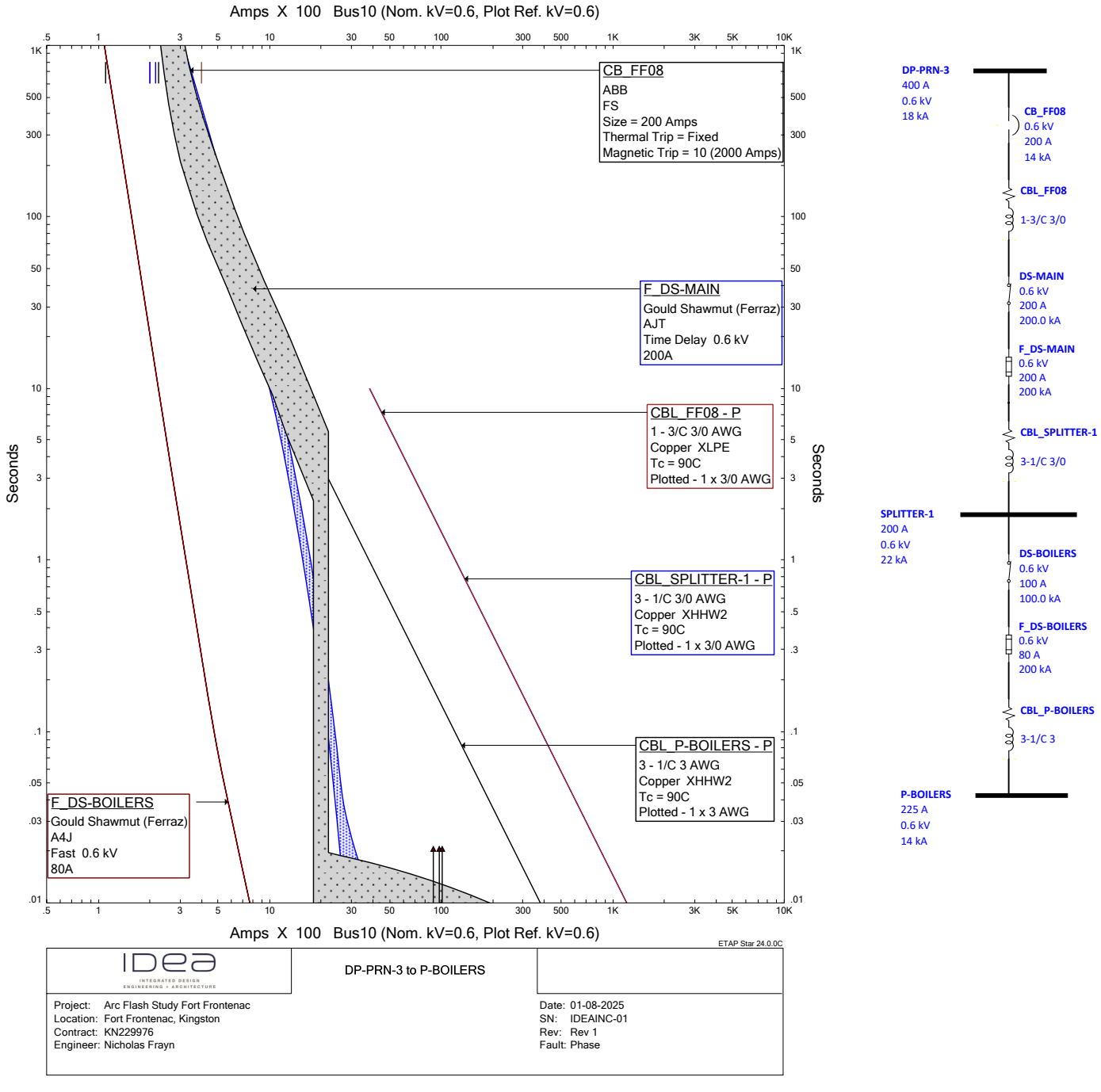
ETAP Star 24.0.0C

IDEA
INTEGRATED DESIGN ENGINEERING + ARCHITECTURE

DP-PRN-3 to PANEL P

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

Date: 01-08-2025
SN: IDEAINC-01
Rev: Rev 1
Fault: Phase



Amps X 100 Bus10 (Nom. kV=0.6, Plot Ref. kV=0.6)

ETAP Star 24.0.0C

IDEA INTEGRATED DESIGN ENGINEERING + ARCHITECTURE

DP-PRN-3 to P-BOILERS

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

Date: 01-08-2025
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:**	01-10-2025
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**
	Hydro Kingston	F_HV-SG	Base	S&C	SM-5	4.76	Standard	200E	225
	BUS_HV-SG	F_P2	Base	S&C	SM-5	4.76	Standard	150E	187
	BUS-TRN3	F_TRN-3	Base	Cooper	Bay-O-Net (240-46)	4.16	Other	C16	100
1	BUS-TRN3	F_TRN-3	Rev 1	Cooper	Bay-O-Net (240-46)	4.16	Other	C12	50
	Bus10	F_DS-MAIN	Base	Gould Shawmut (Ferraz)	CJ	0.6	Other	200A	200
1	Bus10	F_DS-MAIN	Rev 1	Gould Shawmut (Ferraz)	AJT	0.6	Time Delay	200A	200
	Bus11	F_DS-TX-1	Base	Gould Shawmut (Ferraz)	AJT	0.6	Time Delay	30A	30
1	Bus11	F_DS-TX-1	Rev 1	Gould Shawmut (Ferraz)	AJT	0.6	Time Delay	20A	20
*	DS-LP-A-BUS	F_DS-LP-A	Base	Bussmann	FRN-R (7/09)	0.25	Time Delay	70A	70
1	DS-LP-A-BUS	F_DS-LP-A	Rev 1	Gould Shawmut (Ferraz)	A2Y	0.25	Other	50A	50
	DS-LP-A-BUS	F_DS-P	Base	Gould Shawmut (Ferraz)	NRN	0.25	Standard	100A	100
1	DS-LP-A-BUS	F_DS-P	Rev 1	Gould Shawmut (Ferraz)	A4J	0.6	Fast	45A	45
*	SPLITTER-1	F_DS-BOILERS	Base	Bussmann	FRS-R	0.6	Time Delay	80A	80
1	SPLITTER-1	F_DS-BOILERS	Rev 1	Gould Shawmut (Ferraz)	A4J	0.6	Fast	80A	80
*	SPLITTER-1	F_DS-FF3	Base	Gould Shawmut (Ferraz)	TRS	0.6	Time Delay	15R	15
1	SPLITTER-1	F_DS-FF3	Rev 1	Gould Shawmut (Ferraz)	A4J	0.6	Fast	15A	15
	SPLITTER-2	F_DS-P-6	Base	Gould Shawmut (Ferraz)	AJT	0.6	Time Delay	20A	20
	SPLITTER-2	F_DS-P-5	Base	Gould Shawmut (Ferraz)	CJ	0.6	Other	20A	20

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-PRN-3	CB_FF08	Base	ABB	FS	200	Fixed	200.000	10	2000.000
	P-BOILERS	CB_SHS	Base	Westinghouse	FA	15	Fixed	15.000	Fixed	

Notes:

1 Rev 1 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.

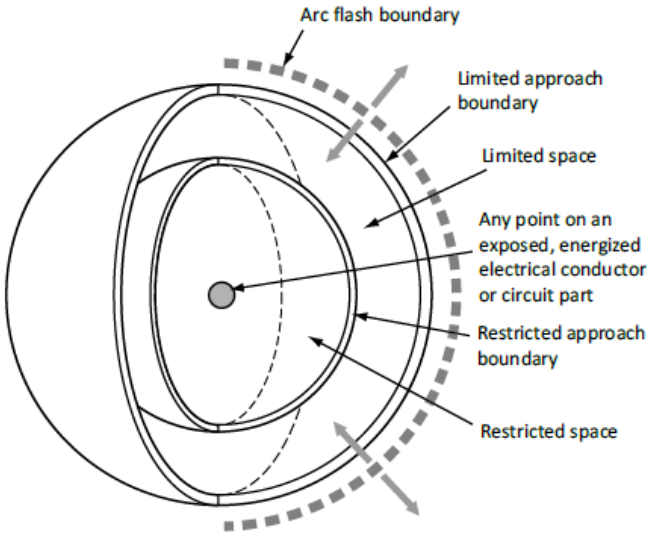
CSA Z462:24 should be reviewed in depth by each employer to create the Job Safety Plan to properly identify the information noted above.

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.

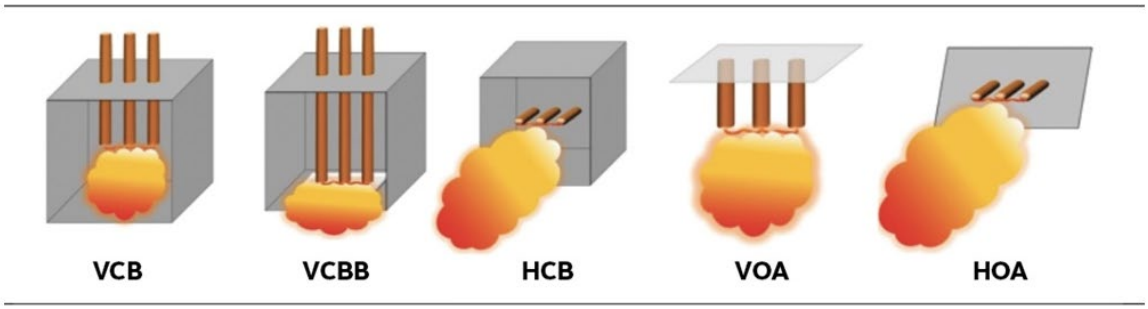
ETAP Power System Software is used to calculate the available arc flash incident energy. The software uses the IEEE 1584 calculation method to determine the available energy and Arc Flash boundary.

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-TRN3	4.160	Cable Bus	104	10.684	10.681	9.304	F_P2	1.64	0.00	1.64	1.4	0.4	36	Level A
BUS_HV-SG	4.160	Switchgear	104	13.245	13.242	11.487	F_HV-SG	1.53	0.00	1.53	1.4	0.3	36	Level A
BUS_TRN-4	4.160	Cable Bus	104	11.915	11.911	10.354	F_P2	1.52	0.00	1.52	1.4	0.4	36	Level A
BUS_TRN-4a	4.160	Cable Bus	104	11.810	11.807	10.265	F_P2	1.53	0.00	1.53	1.4	0.4	36	Level A
DP-PRN-3	0.600	Panelboard	25	13.787	1.985	1.461	F_TRN-3	9.94	0.00	9.94	3.1	3.9	18	Level A
P-BOILERS	0.600	Panelboard	25	10.821	10.821	8.986	F_DS-BOILERS	0.60	0.00	0.60	0.5	0.2	18	Level A
SPLITTER-1	0.600	Cable Bus	13	11.120	11.094	9.733	F_DS-MAIN	0.60	0.00	0.60	0.5	0.2	18	Level A
SPLITTER-2	0.208	Cable Bus	13	0.793	0.247	0.088	F_DS-FF3	3.23	0.00	3.23	0.1	0.0	18	Level A

Bus Arc Flash Hazard Analysis Summary

Faulted Bus				Fault Current			Trip Device							
ID	Nom. kV	Equipment Type	Gap (mm)	Bolted Fault (kA) Bus	Bolted Fault (kA) PD	PD Arc Fault (kA)	Source Trip Device ID	Trip (cycle)	Open (cycle)	FCT (cycle)	Arc Flash Boundary (ft)	Incident Energy (cal/cm²)	Working Distance (in)	Energy Level
DS-LP-A-BUS	0.208	Cable Bus	13	1.229	1.229	0.243	F_DS-LP-A	101.72	0.00	101.72	1.1	0.7	18	Level A
LP-A	0.240	Panelboard	25	1.382	1.382	0.277	F_DS-LP-A	66.91	0.00	66.91	1.0	0.7	18	Level A
P	0.240	Panelboard	25	0.668	0.668	0.147	F_DS-P	120.00	0.00	120.00	1.0	0.6	18	Level A

Arc Flash Analysis Results:

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

Please note that the size of fuse TRN-3 was reduced to 50A in the Arc Flash study for FF03, and this reduces the Arc Flash Incident Energy at DP-PRN-3 from Level B to Level A.

4.7. Arc Flash Labels

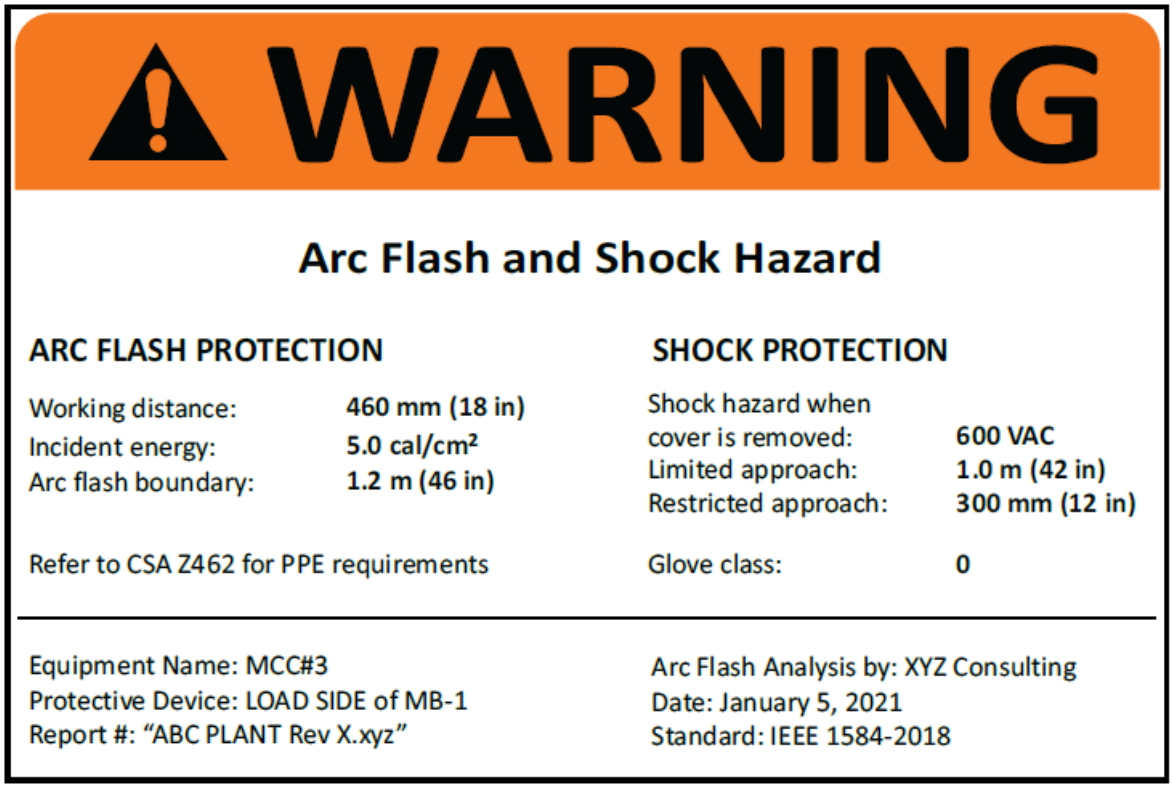
With the incident energy, arc flash boundary, and PPE requirements determined, the information is to be affixed to the equipment in the form of an Arc Flash Label. The Arc Flash labels contain the following information:

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

The label must also:

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

An example of an arc flash label is below:



5. Infrared Thermographic Scanning Report

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

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

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

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

6. Phase Balancing Analysis and Equipment Testing

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

installed. The results complete with notable observations and solutions are listed below. The complete list of equipment within FF08 including all current and voltage readings can be found in Appendix E.

Observations:

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 FF08 including all physical observations can be found in Appendix D&E.

Observations:

Panel P:

1. Bond wire (#6) comes out of panel through 1-1/4” knockout with no connector.

Recommendation:

1. **Install connector on conduit to panel.**

Panel P-Boilers:

1. Moisture and corrosion present and panel is covered in dark black powder.
2. No panel labeling or directory present.
3. 1/2” knockout missing from top of panel.

Recommendation:

1. **Recommend replacing panel.**
2. **Provide panel directory for new panel.**
3. **Panel is recommended to be replaced**

600V Splitter:

1. Excessive rusting to entire splitter

Recommendation:

1. **Recommend replacing splitter.**

Disconnect DS-LP-A:

1. Disconnect has two sets of feeders leaving, one feeding panel LP-A, and one feeding DS-P and panel P.

Recommendation:

1. **Recommend replacing this set up with a splitter and two individual disconnects for the two separate panels.**

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



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LEVEL OF SECURITY | NIVEAU DE SÉCURITÉ
UNCLASS | NON CLASSIFIÉ

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IDEA
INTEGRATED DESIGN
ENGINEERING + ARCHITECTURE

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

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

SCALE | ÉCHELLE
1:150

LOCATION | EMPLACEMENT
388 ONTARIO STREET
KINGSTON
ONTARIO

PROJECT | PROJET
ARC FLASH STUDY
FORT FRONTENAC
KN299976

TRADE | MÉTIER	DATE
ELECTRICAL	2025-03-14

SUBJECT | SUJET
ELECTRICAL
SITE PLAN

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

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

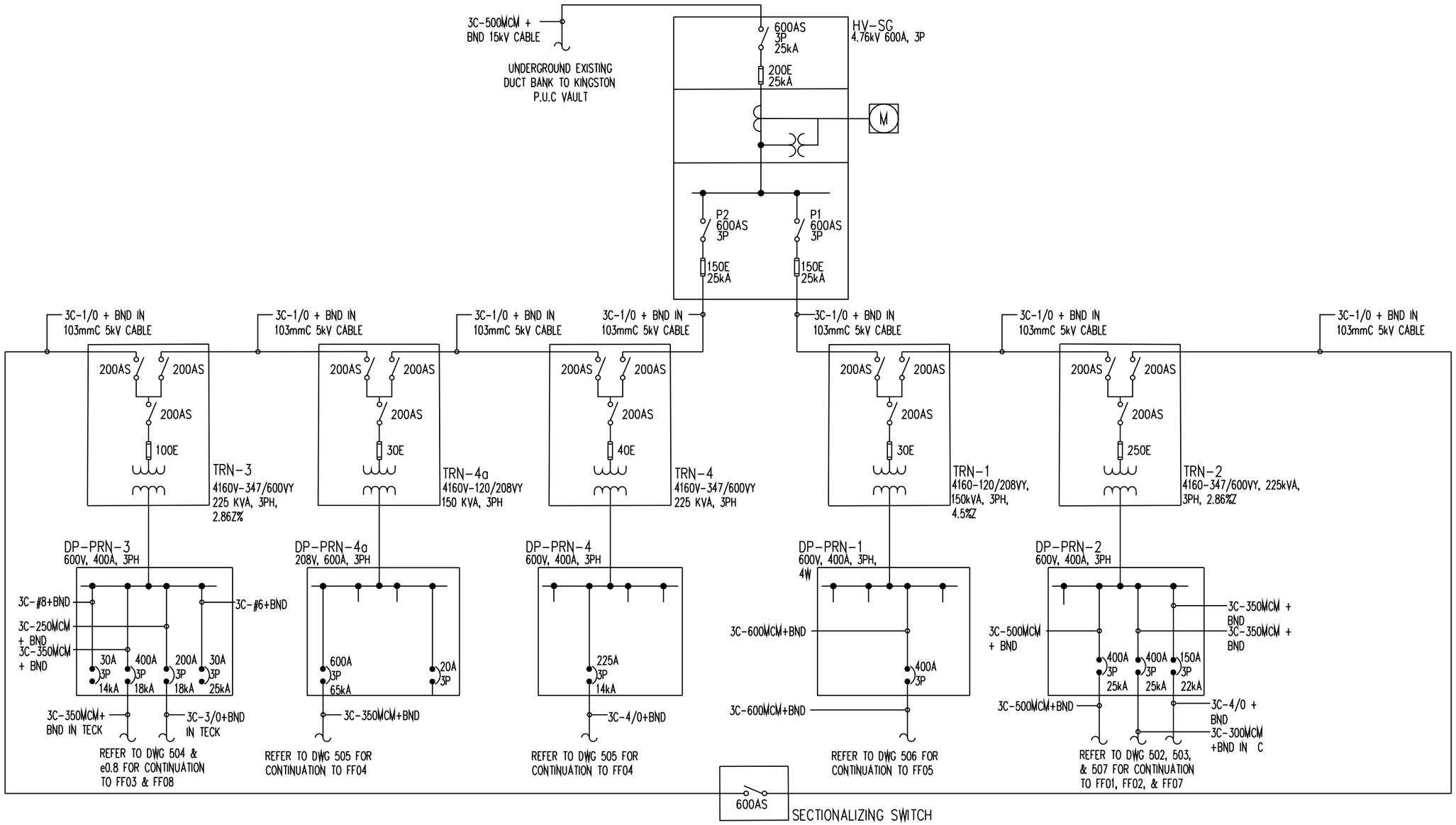
DWG. NO. | NO. DESSIN
K-B35-9306/91-500

Canada

BORDER LAST UPDATED 2012-04-01

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

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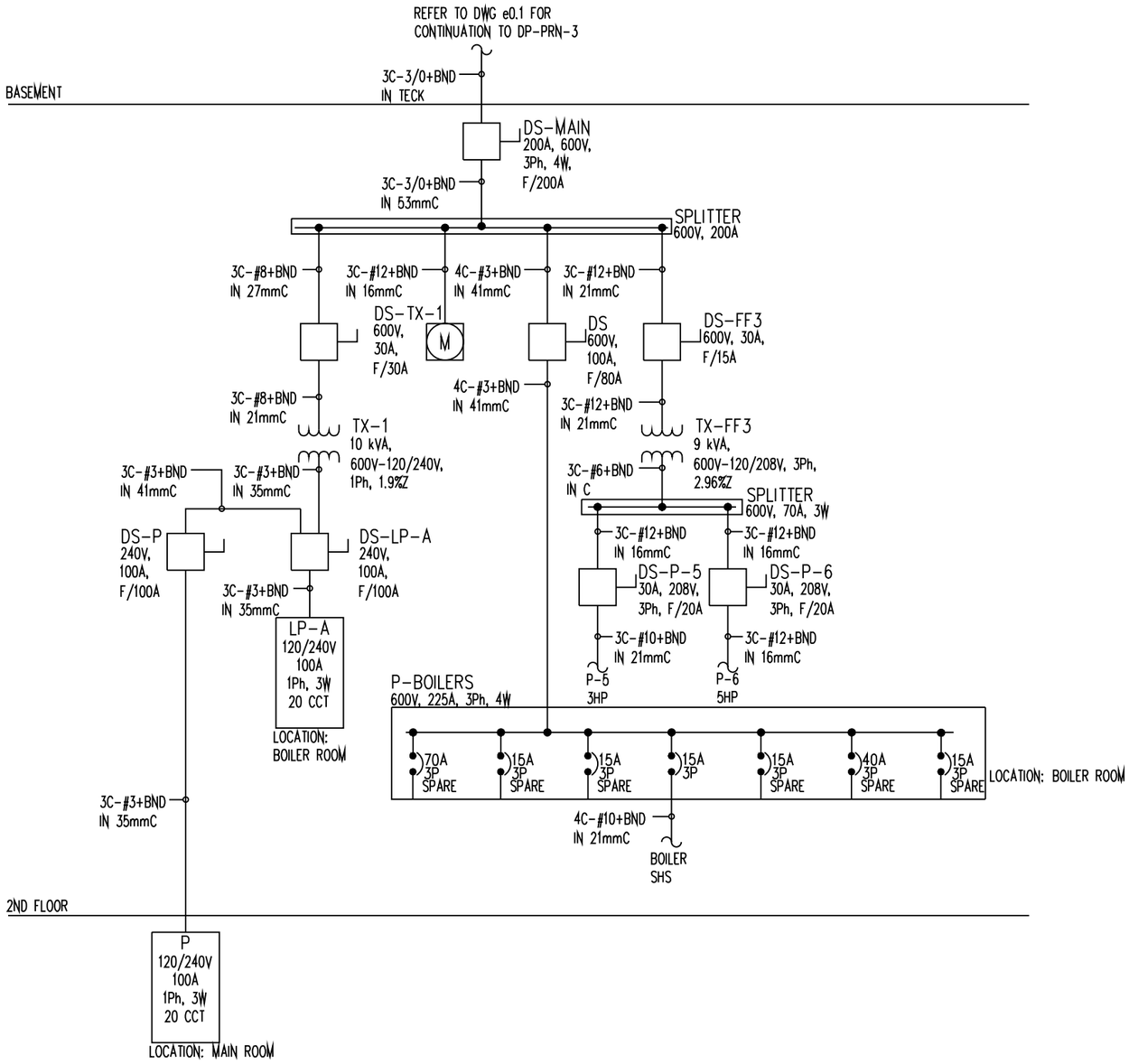


BORDER LAST UPDATED 2011-11-11

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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	



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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: FF08
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	9/10
DWG NO.: NO. DESSIN:	K-B35-9306/91-508	

BORDER LAST UPDATED 2011-11-11

Appendix B – Thermal Scan Images

DRYCORE
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[redacted]

INFRARED SCAN AND EQUIPMENT PICTURES

[redacted]

FORT FRONTENAC

388 ONTARIO ST.

KINGSTON, ONTARIO

K7K 2X9

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DRYCORE
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Job Summary

Project Name: Fort Frontenac IR Scan October 2024

Drycore Job Number: 24-348

Service Location: Fort Frontenac 388 Ontario St. Kingston Ontario

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

Customer Contact: Nick Frayn

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

Field Representative: Andrew Beuman

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

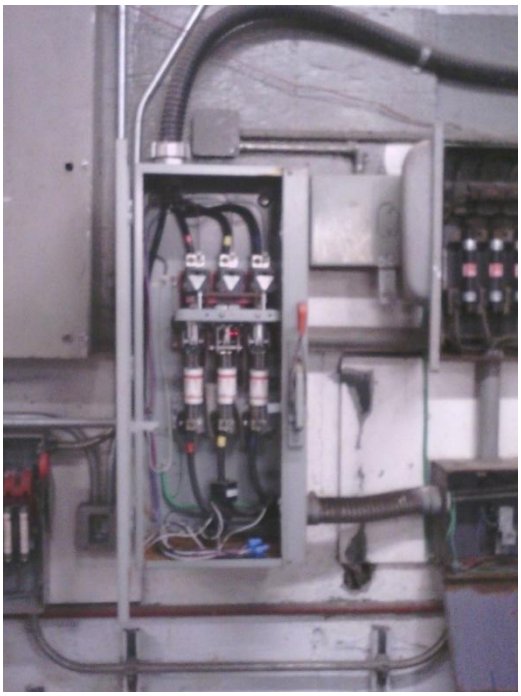
DRYCORE
ELECTRIC • ÉLECTRIQUE

Floor/ Room Number	Equipment Type	Equipment Identification	IR File Number	Picture File Number
BUILDING FF08				
Boiler Room	DISC	DS-Main	2238	2239
	DISC	DS-TX-1	2240	2241
	SPLITTER	600v Splitter	2242	2243
	Transformer	TX-1	2244	2245
	DISC	DS	2246	2247
	DISC	DS-FF3	2248	2249
	BOX	Metering	2250	2251
	PANEL	P-Boilers	2252	2253
	Transformer	TX-FF3	2254	2255
	SPLITTER	DS-P5 & DS-P-6	2256	2257
	STARTER	DS-P-5	2258	2259
	STARTER	DS-P-6	2260	2261
Boiler Rm Closet	DISC	DS-LP-A	2262	2263
	DISC	DS-P	2264	2265
	PANEL	LP-A	2266	2267
1st Floor	PANEL	Panel – P	2268	2269

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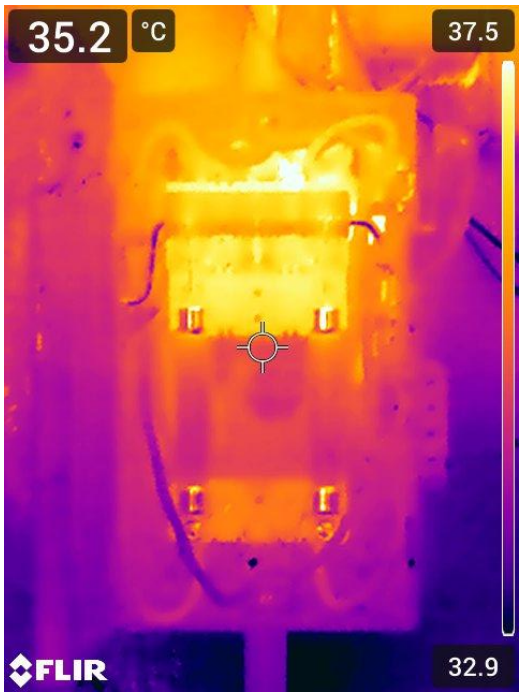
Location	Building FF08 BOILER ROOM
Component	MAIN DISCONNECT
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Picture File Name	FLIR2239
Date	FRIDAY November 1st
Image time	8:39 AM

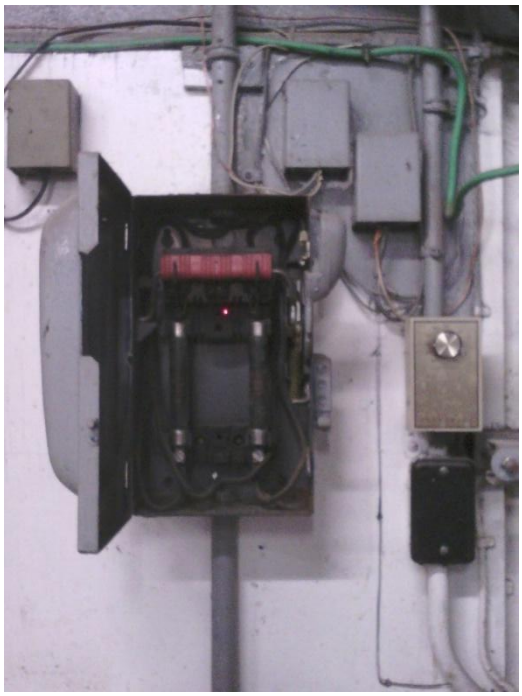




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Location	Building FF08 BOILER ROOM
Component	DS-TX-1 DISCONNECT
IR File Name	FLIR2240
Picture File Name	FLIR2241
Date	FRIDAY November 1st
Image time	8:40 AM





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Location	Building FF08 BOILER ROOM
Component	600V SPLITTER
IR File Name	FLIR2242
Picture File Name	FLIR2243
Date	FRIDAY November 1st
Image time	8:40 AM

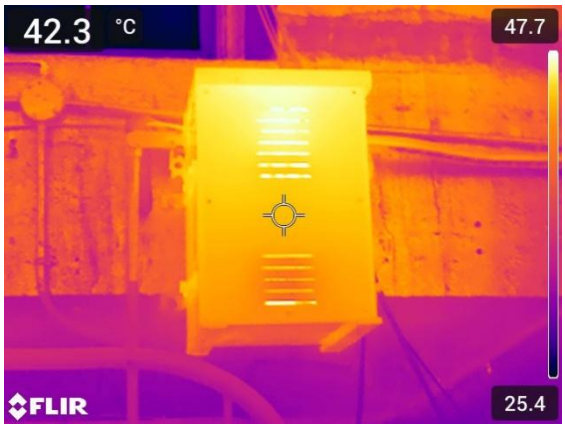




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Location	Building FF08 BOILER ROOM
Component	TRANSFORMER TX-1
IR File Name	FLIR2244
Picture File Name	FLIR2245
Date	FRIDAY November 1st
Image time	8:41 AM





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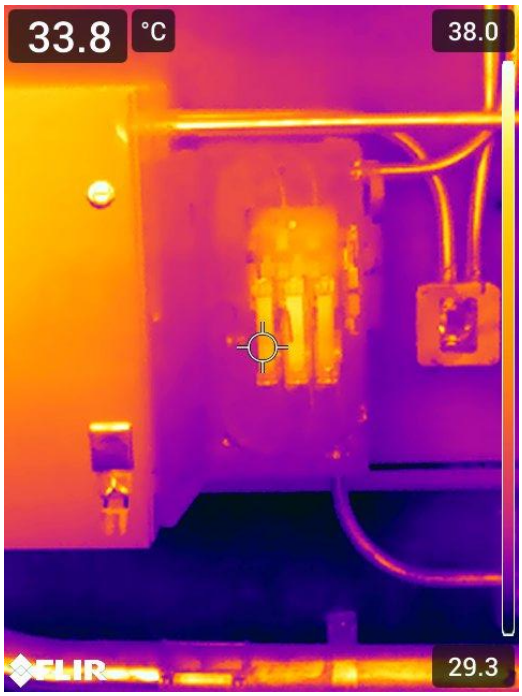
Location	Building FF08 BOILER ROOM
Component	DS DISCONNECT
IR File Name	FLIR2246
Picture File Name	FLIR2247
Date	FRIDAY November 1st
Image time	8:41 AM





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Location	Building FF08 BOILER ROOM
Component	DS-FF3 DISCONNECT
IR File Name	FLIR2248
Picture File Name	FLIR2249
Date	FRIDAY November 1st
Image time	8:42 AM

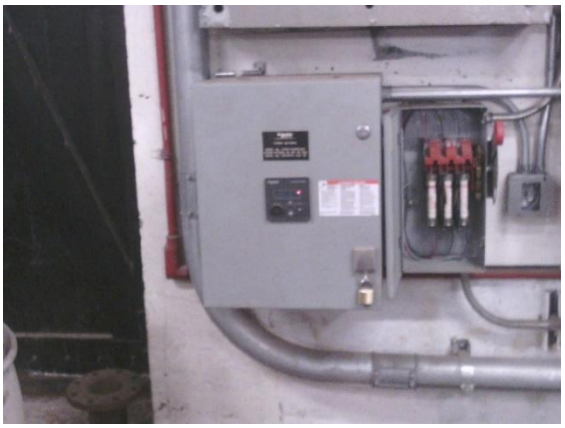




DRYCORE
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Location	Building FF08 BOILER ROOM
Component	METERING BOX
IR File Name	FLIR2250
Picture File Name	FLIR2251
Date	FRIDAY November 1st
Image time	8:42 AM

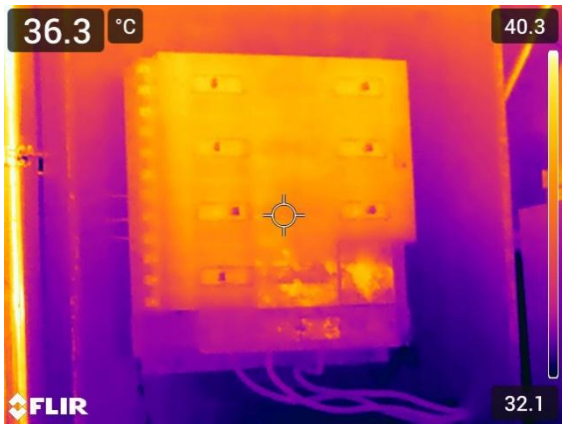




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Location	Building FF08 BOILER ROOM
Component	P-BOILER PANEL
IR File Name	FLIR2252
Picture File Name	FLIR2253
Date	FRIDAY November 1st
Image time	8:47 AM



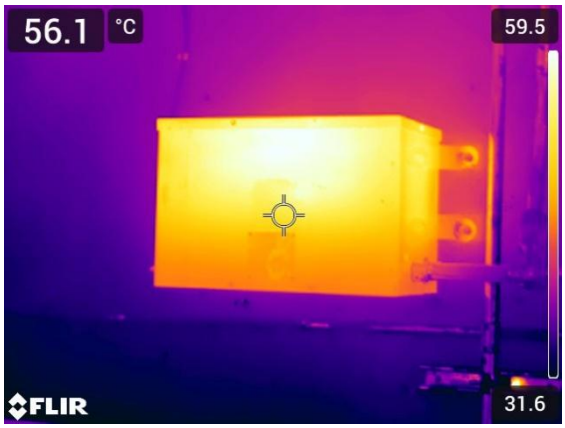


PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	1.5	**A-N**	342
B PHASE	1.4	**B-N**	343
C PHASE	1.6	**C-N**	343
NEUTRAL	N/A	**A-B**	594
		A-C	593
		B-C	596

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Location	Building FF08 BOILER ROOM
Component	TRANSFORMER TX-FF3
IR File Name	FLIR2254
Picture File Name	FLIR2255
Date	FRIDAY November 1st
Image time	8:49 AM

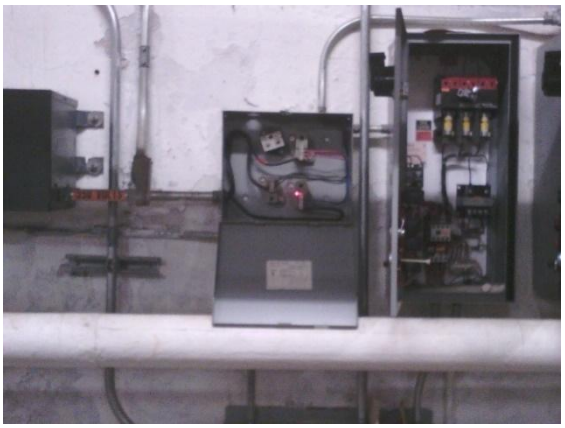




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Location	Building FF08 BOILER ROOM
Component	SPLITTER DS-P-5 & DS-P-6
IR File Name	FLIR2256
Picture File Name	FLIR2257
Date	FRIDAY November 1st
Image time	8:49 AM



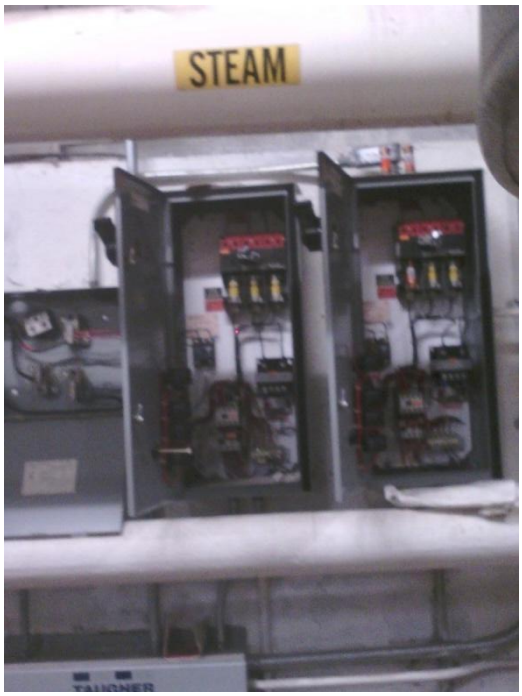


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Location	Building FF08 BOILER ROOM
Component	DS-P-5 STARTER
IR File Name	FLIR2258
Picture File Name	FLIR2259
Date	FRIDAY November 1st
Image time	8:49 AM

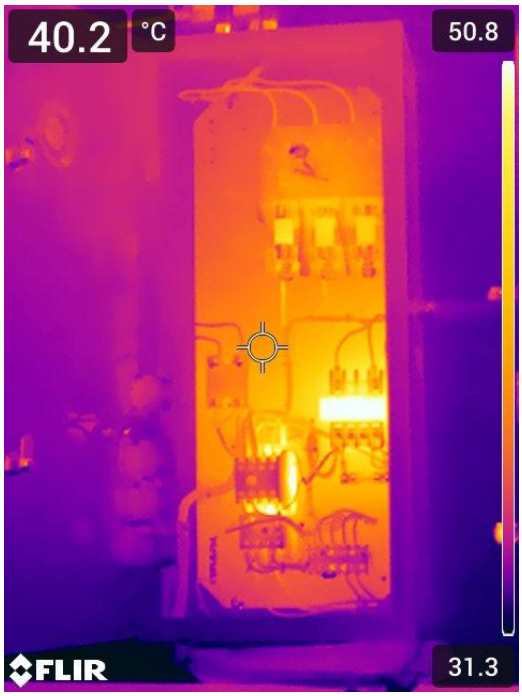




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Location	Building FF08 BOILER ROOM
Component	DS-P-6 STARTER
IR File Name	FLIR2260
Picture File Name	FLIR2261
Date	FRIDAY November 1st
Image time	8:49 AM

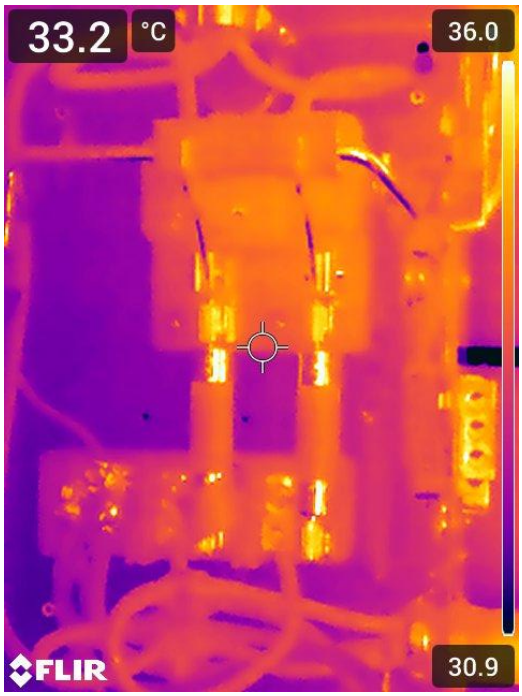


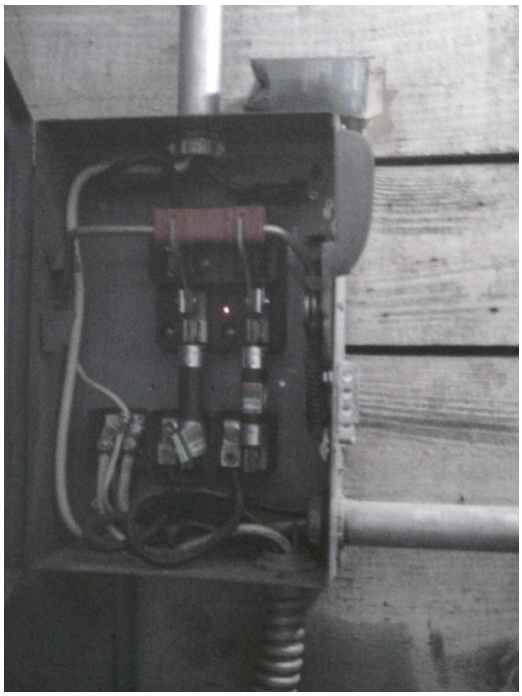


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Location	Building FF08 BOILER RM CLOSET
Component	DS-LP-A DISCONNECT
IR File Name	FLIR2262
Picture File Name	FLIR2263
Date	FRIDAY November 1st
Image time	8:51 AM

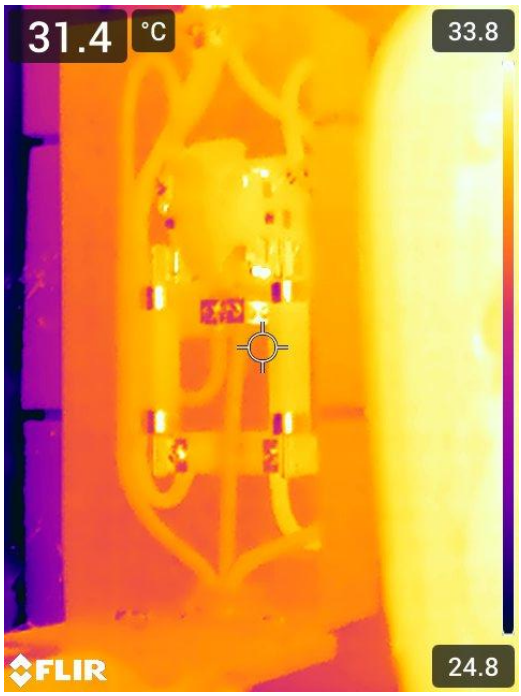




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DRYCORE
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Location	Building FF08 BOILER RM CLOSET
Component	DS-PDISCONNECT
IR File Name	FLIR2264
Picture File Name	FLIR2265
Date	FRIDAY November 1st
Image time	8:51 AM

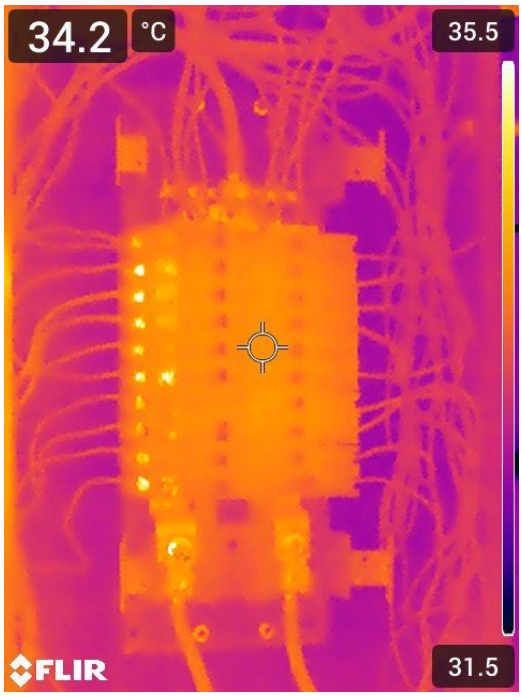


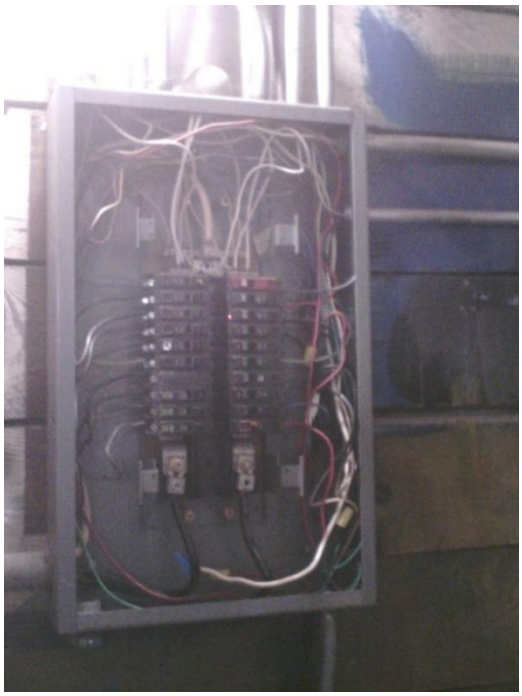


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DRYCORE
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Location	Building FF08 BOILER RM CLOSET
Component	LP-A PANEL
IR File Name	FLIR2266
Picture File Name	FLIR2267
Date	FRIDAY November 1st
Image time	8:52 AM



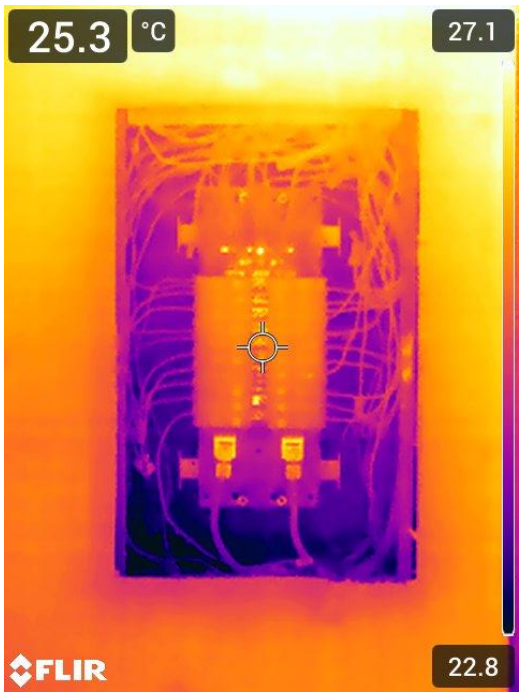


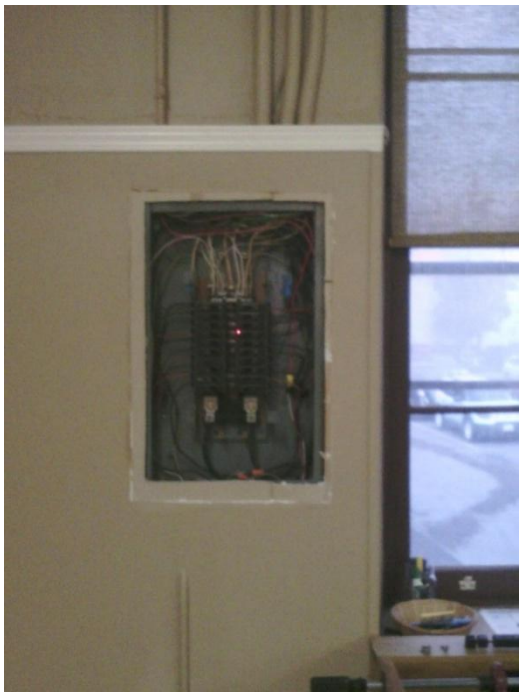
PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	2.4	**A-N**	118
B PHASE	1.7	**B-N**	118
C PHASE	N/A	**C-N**	N/A
NEUTRAL	.6	**A-B**	236
		A-C	N/A
		B-C	N/A

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DRYCORE
ELECTRIC • ÉLECTRIQUE

Location	Building FF08 1ST FLOOR
Component	PANEL-P
IR File Name	FLIR2268
Picture File Name	FLIR2269
Date	FRIDAY November 1st
Image time	9:03 AM



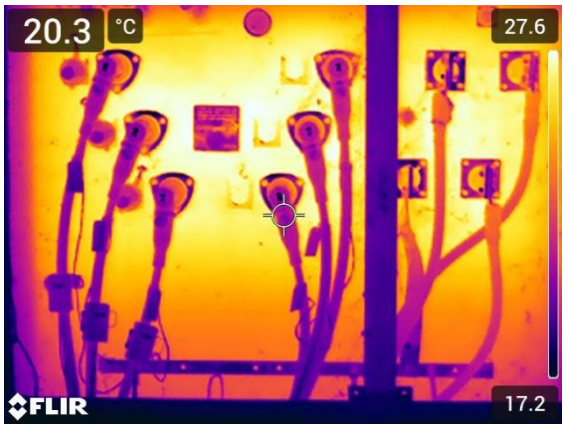


PHASE	LOAD IN AMPS	PHASE	VOLTS
A PHASE	1.7	**A-N**	117
B PHASE	2.7	**B-N**	117
C PHASE	N/A	**C-N**	N/A
NEUTRAL	1.7	**A-B**	236
		A-C	N/A
		B-C	N/A

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DRYCORE
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Location	EXTERIOR BEHIND FF03
Component	TRANSFORMER TRN-3
IR File Name	FLIR2200
Picture File Name	FLIR2201
Date	THURDSAY October 31th
Image time	9:29 AM





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DRYCORE
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Location	EXTERIOR BEHIND FF03
Component	TAP BOX DP-PRN3
IR File Name	FLIR2198
Picture File Name	FLIR2199
Date	THURDSAY October 31th
Image time	9:29 AM





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Appendix C – Site Checklist

FF08

Line #	Tasks	Confirmation of Completion	Results/Notes
1	DS-MAIN		
2	Confirm amperage rating	☐	200A
3	Confirm voltage rating	☐	600V 100HP
4	Remove cover plate	☐	
5	Perform thermal scanning, record photo's for report	☐	
6	Confirm if fused or unfused	☐	200A FUSES
7	Confirm fuse ratings (if applicable)	☐	
8	Confirm fuse type, series, & manufacturer	☐	LR14742 HRCI-5
9	Confirm SCCR rating	☐	200KA
10	Confirm wire size, number of cables per phase, & cable type (Cu/Al) from DS-MAIN to SPLITTER	☐	3/0 CU WIRE 1 WIRE PER PHASE
11	Confirm wire length, conduit type, & conduit size from DS-MAIN to SPLITTER	☐	5' OF WIRE THROUGH 2" METALIC FLEX
12			
13	SPLITTER		
14	Confirm amperage rating	☐	NO LABEL
15	Confirm voltage rating	☐	NO LABEL
16	Remove cover panel	☐	
17	Perform thermal scanning, record photo's for report	☐	
18			
19	*Confirm the following wire sizes, number of cables per phase, & cable type (Cu/Al):*		
20	SPLITTER to DS-TX-1	☐	#8 CU WIRE 1 WIRE PER PHASE
21	SPLITTER to Meter	☐	#12 CU WIRE 1 WIRE PER PHASE
22	SPLITTER to DS	☐	#3 CU WIRE 1 WIRE PER PHASE
23	SPLITTER to DS-FF3	☐	#12 CU WIRE 1 WIRE PER PHASE
24			
25	*Confirm the following lengths of wire, conduit type, & conduit size:*		
26	SPLITTER to DS-TX-1	☐	3' THROUGH 1" RIGID
27	SPLITTER to Meter	☐	2' THROUGH 1/2" EMT
28	SPLITTER to DS	☐	2' THROUGH 1 1/2" RIGID
29	SPLITTER to DS-FF3	☐	8' THROUGH 3/4" EMT
30			
31	DS-TX-1		
32	Confirm amperage rating	☐	30A
33	Confirm voltage rating	☐	600V
34	Remove cover plate	☐	
35	Perform thermal scanning, record photo's for report	☐	
36	Confirm if fused or unfused	☐	FUSED
37	Confirm fuse ratings (if applicable)	☐	30A
38	Confirm fuse type, series, & manufacturer	☐	PIERCE FUSE
39	Confirm SCCR rating	☐	NOT READABLE
40			
41	TX-1		
42	Perform thermal scanning, record photo's for report	☐	
43	Confirm wire size, number of cables per phase, & cable type (Cu/Al) from DS-TX-1 to TX-1	☐	#8 CU WIRE 1 WIRE PER PHASE
44	Confirm wire size, number of cables per phase, & cable type (Cu/Al) from TX-1 to DS-LP-A	☐	#3 CU WIRE 1 WIRE PER PHASE
45	Confirm wire length, conduit type, & conduit size from DS-TX-1 to TX-1	☐	3' THROUGH 3/4" RIGID
46	Confirm wire length, conduit type, & conduit size from TX-1 to DS-LP-A	☐	50' THROUGH 1 1/4" RIGID
47	Confirm kVA rating	☐	10KVA
48	Confirm winding configurations	☐	DELTA/ WYE
49	Confirm impedance rating & X/R ratio	☐	1.9% 600-240V

50			
51	DS-LP-A		
52	Confirm amperage rating	☐	100A
53	Confirm voltage rating	☐	240V
54	Remove cover plate	☐	
55	Perform thermal scanning, record photo's for report	☐	
56	Confirm if fused or unfused	☐	FUSED
57	Confirm fuse ratings (if applicable)	☐	100A
58	Confirm fuse type, series, & manufacturer	☐	FUSETRON FRN100 DUEL ELEMENT
59	Confirm SCCR rating	☐	100KA
60	Confirm wire size, number of cables per phase, & cable type (Cu/Al) from DS-LP-A to DS-P	☐	#3 CU WIRE 1 WIRE PER PHASE
61	Confirm wire length, conduit type, & conduit size from DS-LP-A to DS-p	☐	3' THROUGH 1 1/2" METALIC FLEX
62			
63	LP-A		
64	Refer to panel information sheet & perform visual testing for LP-A	☐	
65	Remove panel coverplate	☐	
66	Perform thermal scanning, record photo's for report	☐	
67	Refer to panel information sheet and perform panel testing	☐	
68	Confirm all breaker ratings	☐	
69	Confirm all breaker SCCR ratings	☐	10KA
70	Confirm incoming wire size, number of cables per phase, & cable type (Cu/Al):	☐	#3 CU WIRE 1 WIRE PER PHASE
71	Confirm wire length, conduit type, & conduit size from DS-LP-A to LP-A	☐	40' THROUGH 1 1/4" RIGID
72			
73	DS-P		
74	Confirm amperage rating	☐	100A
75	Confirm voltage rating	☐	240V
76	Remove cover plate	☐	
77	Perform thermal scanning, record photo's for report	☐	
78	Confirm if fused or unfused	☐	FUSED
79	Confirm fuse ratings (if applicable)	☐	100A
80	Confirm fuse type, series, & manufacturer	☐	NRN100 GOULD ONE TIME NON REUSABLE
81	Confirm SCCR rating	☐	UNKNOWN
82			
83	P		
84	Refer to panel information sheet & perform visual testing for P	☐	
85	Remove panel coverplate	☐	
86	Perform thermal scanning, record photo's for report	☐	
87	Refer to panel information sheet and perform panel testing	☐	
88	Confirm all breaker ratings	☐	
89	Confirm all breaker SCCR ratings	☐	10KA
90	Confirm incoming wire size, number of cables per phase, & cable type (Cu/Al):	☐	#3 CU WIRE 1 WIRE PER PHASE
91	Confirm wire length, conduit type, & conduit size from DS-P to P	☐	200' THROUGH 1 1/4" RIGID
92			
93	DS		
94	Confirm amperage rating	☐	100A
95	Confirm voltage rating	☐	575V
96	Remove cover plate	☐	
97	Perform thermal scanning, record photo's for report	☐	
98	Confirm if fused or unfused	☐	FUSED
99	Confirm fuse ratings (if applicable)	☐	80A
100	Confirm fuse type, series, & manufacturer	☐	FUSETRON FRS80A DUAL ELEMENT CLASS 9
101	Confirm SCCR rating	☐	100KA
102	Confirm wire size, number of cables per phase, & cable type (Cu/Al) from DS to P-BOILERS	☐	#3 CU WIRE 1 WIRE PER PHASE

103	Confirm wire length, conduit type, & conduit size from DS to P-BOILERS	☐	5' THROUGH 1 1/2" RIGID
104			
105	P-BOILERS		
106	Refer to panel information sheet & perform visual testing for P-BOILERS	☐	
107	Remove panel coverplate	☐	
108	Perform thermal scanning, record photo's for report	☐	
109	Refer to panel information sheet and perfrom panel testing	☐	
110	Trace and verify all down stream equipment	☐	
111			
112	*Confirm breaker ratings, SCCR ratings, Trip plug settings for the following:*		
113	Breaker 1 SPARE	☐	70A
114	Breaker 2 SPARE	☐	15A
115	Breaker 3 SPARE	☐	15A
116	Breaker 4 SPARE	☐	15A
117	Breaker 5 BOILER SHS	☐	15A
118	Breaker 6 SPARE	☐	15A
119	SPARE		40
120	*Confirm the following wire sizes, number of cables per phase, & cable type (Cu/Al):*		
121	P-BOILERS to Boiler SHS	☐	#10 CU WIRE 1 WIRE PER PHASE
122	P-BOILERS to Boiler NA	☐	
123	P-BOILERS to Boiler NA	☐	
124	P-BOILERS to Boiler NA	☐	
125	P-BOILERS to Boiler NA	☐	
126	P-BOILERS to Boiler NA	☐	
127			
128	*Confirm the following lengths of wire, conduit type, & conduit size:*		
129	P-BOILERS to Boiler SHS	☐	APPROX 60' THROUGH 3/4" EMT
130	P-BOILERS to Boiler NA	☐	
131	P-BOILERS to Boiler NA	☐	
132	P-BOILERS to Boiler NA	☐	
133	P-BOILERS to Boiler NA	☐	
134	P-BOILERS to Boiler NA	☐	
135			
136	DS-FF3		
137	Confirm amperage rating	☐	30A
138	Confirm voltage rating	☐	600V
139	Remove cover plate	☐	
140	Perform thermal scanning, record photo's for report	☐	
141	Confirm if fused or unfused	☐	FUSED
142	Confirm fuse ratings (if applicable)	☐	15A
143	Confirm fuse type, series, & manufacturer	☐	GOULD TRI-ONIC SHAWMUTT TIMEDELAY
144	Confirm SCCR rating	☐	TR5-15 HRCI-R O TYPE D 20KA
145	Confirm wire size, number of cables per phase, & cable type (Cu/Al) from DS-FF3 to TX-FF3	☐	#12 CU WIRE 1 WIRE PER PHASE
146	Confirm wire length, conduit type, & conduit size from DS-FF3 to TX-FF3	☐	120' THROUGH 3/4" EMT
147			
148	TX-FF3		
149	Perform thermal scanning, record photo's for report	☐	
150	Confirm wire size, number of cables per phase, & cable type (Cu/Al) from TX-FF3 to SPLITTER	☐	#6 CU WIRE 1 WIRE PER PHASE
151	Confirm wire length from TX-FF3 to SPLITTER	☐	3'
152	Confirm kVA rating	☐	9KVA
153	Confirm winding configurations	☐	DELTA/ WYE
154	Confirm impedance rating & X/R ratio	☐	2.96% 600/208V
155			
156	SPLITTER		

157	Confirm amperage rating	☐	70A
158	Confirm voltage rating	☐	600V
159	Remove cover panel	☐	
160	Perform thermal scanning, record photo's for report	☐	
161			
162	*Confirm the following wire sizes, number of cables per phase, & cable type (Cu/Al):*		
163	SPLITTER to DS-P-5	☐	#12 CU WIRE 1 WIRE PER PHASE
164	SPLITTER to DS-P-6	☐	#12 CU WIRE 1 WIRE PER PHASE
165			
166	*Confirm the following lengths of wire, conduit type, & conduit size:*		
167	SPLITTER to DS-P-5	☐	3' THROUGH 1/2" EMT
168	SPLITTER to DS-P-6	☐	5' THROUGH 1/2" EMT
169			
170	DS-P-5		
171	Confirm amperage rating	☐	30A
172	Confirm voltage rating	☐	208V
173	Remove cover plate	☐	
174	Perform thermal scanning, record photo's for report	☐	
175	Confirm if fused or unfused	☐	FUSED
176	Confirm fuse ratings (if applicable)	☐	FUSETEK SUPER J
177	Confirm fuse type, series, & manufacturer	☐	HRC1 J SJ20A
178	Confirm SCCR rating	☐	NOT MARKED
179	Confirm wire size, number of cables per phase, & cable type (Cu/Al) to P-5	☐	#10 CU WIRE 1 WIRE PER PHASE
180	Confirm wire length, conduit type, & conduit size to P-5	☐	20' THROUGH 3/4" EMT
181			
182	DS-P-6		
183	Confirm amperage rating	☐	30A
184	Confirm voltage rating	☐	208V
185	Remove cover plate	☐	
186	Perform thermal scanning, record photo's for report	☐	
187	Confirm if fused or unfused	☐	FUSED-
188	Confirm fuse ratings (if applicable)	☐	2X FUSETEK SUPER J HRC1-J SJ20A
189	Confirm fuse type, series, & manufacturer	☐	1X FERRAZ SHAWMUT SMART SPOT AJT20 TD CLASS J
190	Confirm SCCR rating	☐	
191	Confirm wire size, number of cables per phase, & cable type (Cu/Al) to P-6	☐	#12 CU WIRE 1 WIRE PER PHASE
192	Confirm wire length, conduit type, & conduit size to P-6	☐	20' THROUGH 1/2" EMT
193			
194	Equipment/General		
195	Confirm HP rating for P-5	☐	3HP
196	Confirm HP rating for P-6	☐	5HP
197	Ensure all relays are located and captured	☐	
198	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	☐	

92	Confirm primary voltage rating	☐	4160/2400V
93	Confirm secondary voltage rating	☐	347/600V
94	Confirm kVA rating	☐	225 KVA
95	Confirm winding configurations	☐	DELTA/ WYE
96	Confirm impedance rating & X/R ratio	☐	2.86%
97	Open TRN 03 enclosure and perform thermal scanning, record photo's for report	☐	
98	Confirm over current protection device	☐	BAYONET Fuses: UK advised not to touch
99	Confirm if FF03 & 08 is supplied by main tap at TRN 03 or if its fed from distribution panel PRN-3	☐	DP-PRN-3
100	Remove cover panel from PRN-3 and perform thermal scanning, record photo's for report	☐	
101	Confirm breaker ratings within PRN-3	☐	PANEL INFORMATION SHEETS
102	Confirm breaker SCCR ratings within PRN-3	☐	
103			
104	DP-PRN-3		
105	Refer to panel information sheet & perform visual testing for DP-PRN-3	☐	INFORMATION ON INFORMATION SHEETS
106	Remove panel coverplate	☐	
107	Perform thermal scanning, record photo's for report	☐	
108	Refer to panel information sheet and perform panel testing	☐	
109	Confirm all breaker ratings	☐	
110	Confirm all breaker SCCR ratings	☐	
111			
112	TRN 04		
113	Refer to panel information sheet & perform visual testing for TRN 01	☐	LABEL WAS NOT VISIBLE AS WEATHERED
114	Refer to panel information sheet and perform transformer primary and secondary testing	☐	
115	Confirm primary voltage rating	☐	
116	Confirm secondary voltage rating	☐	347/600V
117	Confirm kVA rating	☐	
118	Confirm winding configurations	☐	DELTA/ WYE
119	Confirm impedance rating & X/R ratio	☐	
120	Open TRN 04 enclosure and perform thermal scanning, record photo's for report	☐	
121	Confirm over current protection device	☐	Bayonet Fuses: advised by UK not to touch
122	Confirm if FF04 is supplied by main tap at TRN 03 or if its fed from distribution panel PRN-4	☐	DP-PRN-4
123	Remove cover panel from PRN-4 and perform thermal scanning, record photo's for report	☐	
124	Confirm breaker ratings within PRN-4	☐	
125	Confirm breaker SCCR ratings within PRN-4	☐	
126			
127	DP-PRN-4		
128	Refer to panel information sheet & perform visual testing for DP-PRN-4	☐	
129	Remove panel coverplate	☐	
130	Perform thermal scanning, record photo's for report	☐	
131	Refer to panel information sheet and perform panel testing	☐	
132	Confirm all breaker ratings	☐	
133	Confirm all breaker SCCR ratings	☐	
134			
135	TRN 04a		
136	Refer to panel information sheet & perform visual testing for TRN 01	☐	
137	Refer to panel information sheet and perform transformer primary and secondary testing	☐	
138	Confirm primary voltage rating	☐	4160/2400V
139	Confirm secondary voltage rating	☐	120/208V

Appendix D – Site Panel Information

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

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

PANEL INSPECTION NOTES:

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

FF08

Branch Panel – LP-A:

Visual Testing

1.	Make/Model/Age of Equipment	Square D/QBL-320/
2.	Voltage Rating	120/240V
3.	Amperage Rating	100A
4.	Number of Circuits	20cct
5.	Phase (1/3)	1
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 #)	Boiler Room
11.	Physical Damage Present?	NO
12.	Evidence of Moisture or Intrusions?	NO
13.	General Condition of Components	GOOD
14.	Bus Bar Condition	GOOD
15.	Verify Panel Labeling	GOOD
16.	Verify Panel Directories	PRESENT
17.	Condition of Cable Connections	GOOD
18.	CEC Violations Present?	NONE
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	118
2.	Voltage Phase B to Neutral	118
3.	Voltage Phase C to Neutral	
4.	Voltage Phase A to B	236
5.	Voltage Phase A to C	
6.	Voltage Phase B to C	
7.	Current Phase A	2.4
8.	Current Phase B	1.7
9.	Current Phase C	
10.	Current on Neutral	.6
11.	Current on Ground	
12.	Notes	

Branch Panel – P:

Visual Testing

1.	Make/Model/Age of Equipment	Square D/QBL-320/
2.	Voltage Rating	120/240V
3.	Amperage Rating	100A
4.	Number of Circuits	20cct
5.	Phase (1/3)	1
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 #)	2ND FLOOR MAIN ROOM
11.	Physical Damage Present?	NO
12.	Evidence of Moisture or Intrusions?	NO
13.	General Condition of Components	GOOD
14.	Bus Bar Condition	GOOD
15.	Verify Panel Labeling	GOOD
16.	Verify Panel Directories	PRESENT
17.	Condition of Cable Connections	GOOD
18.	CEC Violations Present?	Bond wire #6 comes out of panel through 1 1/4" knock out no connector
19.	Insulation Bushing at Entrance	YES
20.	Appropriate Anchoring Present?	YES
21.	Evidence of Arcing?	NONE
22.	Notes	Cleaning required, 1 M working space, panel lock broken

Panel Testing

1.	Voltage Phase A to Neutral	117
2.	Voltage Phase B to Neutral	117
3.	Voltage Phase C to Neutral	
4.	Voltage Phase A to B	236
5.	Voltage Phase A to C	
6.	Voltage Phase B to C	
7.	Current Phase A	1.7
8.	Current Phase B	2.7
9.	Current Phase C	
10.	Current on Neutral	1.7
11.	Current on Ground	
12.	Notes	

Branch Panel – P-BOILERS:

Visual Testing

1.	Make/Model/Age of Equipment	Westinghouse/ cannot read panel model
2.	Voltage Rating	600V
3.	Amperage Rating	225A
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?	MINOR CORROSION
10.	Panel Location (Floor #, Room #)	Boiler Room
11.	Physical Damage Present?	NO
12.	Evidence of Moisture or Intrusions?	NO
13.	General Condition of Components	VERY DIRTY
14.	Bus Bar Condition	COVERED IN DARK BLACK POWDER
15.	Verify Panel Labeling	NONE
16.	Verify Panel Directories	NONE
17.	Condition of Cable Connections	GOOD
18.	CEC Violations Present?	1/2" KNOCK OUT MISSING TOP OF PANEL
19.	Insulation Bushing at Entrance	YES
20.	Appropriate Anchoring Present?	YES
21.	Evidence of Arcing?	NONE
22.	Notes	Recommended to replace panel or shut down and conduct deep clean

Panel Testing

1.	Voltage Phase A to Neutral	342
2.	Voltage Phase B to Neutral	343
3.	Voltage Phase C to Neutral	343
4.	Voltage Phase A to B	594
5.	Voltage Phase A to C	593
6.	Voltage Phase B to C	596
7.	Current Phase A	1.5
8.	Current Phase B	1.4
9.	Current Phase C	1.6
10.	Current on Neutral	
11.	Current on Ground	
12.	Notes	

Transformer – TRN-3:

Visual Testing

1. Make/Model/Age of Equipment	CES MARKHAM	
2. Voltage Rating	4160/2400V	347/600V
3. Amperage Rating		
4. Number of Circuits	NA	
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	
10. Panel Location (Floor #, Room #)		
11. Physical Damage Present?	NO	
12. Evidence of Moisture or Intrusions?	MINOR MOISTURE	
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	NO	
20. Appropriate Anchoring Present?	YES	
21. Evidence of Arcing?	NONE	
22. Notes	Most rust is surface and on the outside of the enclosure	

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 346
2. Voltage Phase B to Neutral 350
3. Voltage Phase C to Neutral 343
4. Voltage Phase A to B 598
5. Voltage Phase A to C 594
6. Voltage Phase B to C 595
7. Current Phase A 67.2
8. Current Phase B 66.1
9. Current Phase C 49.2
10. Current on Neutral
11. Current on Ground .1
12. Notes

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

Distribution Panel – DP-PRN-3:

Visual Testing

1.	Make/Model/Age of Equipment	unknown
2.	Voltage Rating	requires field evaluation
3.	Amperage Rating	
4.	Number of Circuits	room for 4 circuit breakers
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 #)	OUTDOORS BY FF03
11.	Physical Damage Present?	NO
12.	Evidence of Moisture or Intrusions?	YES
13.	General Condition of Components	ACCEPTABLE
14.	Bus Bar Condition	GROUND BAR CORRODED
15.	Verify Panel Labeling	NONE
16.	Verify Panel Directories	3 OUT OF 4
17.	Condition of Cable Connections	GROUNDS NEED ATTENTION
18.	CEC Violations Present?	NEEDS NEW DOOR GASKET
19.	Insulation Bushing at Entrance	NO
20.	Appropriate Anchoring Present?	YES
21.	Evidence of Arcing?	NONE
22.	Notes	

WIRE 250MCM CU

CB1
LIFT
3 PHASE
30A CB
SEIMENS
HFD 600V
25KA
LINE #6 CU
LOAD #8 CU

CB2
UNLABELED
3 PHASE
POWER CB
30A
HD06
14KA
LINE #8 CU
LOAD #8 CU

CB3
FEEDS BUILDING 8
ALAN BRADLEY
AS
200A
20KA/15KA
LINE 250 MCM CU
LOAD 3/0 CU TECK

CB4
BUILDING 3
ALAN BRADLY
18KA/15KA
400A
LINE 350MCM CU
LOAD SINGLE
CONDUCTOR 300MCM CU
TECK

Panel Testing

1.	Voltage Phase A to Neutral	345.8
2.	Voltage Phase B to Neutral	349.9
3.	Voltage Phase C to Neutral	343
4.	Voltage Phase A to B	597
5.	Voltage Phase A to C	594
6.	Voltage Phase B to C	595
7.	Current Phase A	67.2
8.	Current Phase B	66.1
9.	Current Phase C	49.2
10.	Current on Neutral	
11.	Current on Ground	
12.	Notes	Breaker 2 is too big for enclosure inner door does not close well

Appendix E – Kingston Utilities Information

Short Circuit Study Report

Service Address: 317 St, Kingston, Ontario

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

Date: September 12, 2024

Max. Short-circuit Info.

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

Min. Short-circuit Info.

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

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

Appendix F – Arc Flash Labels

Arc Flash and Shock Hazard Present

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

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

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF08

Arc Flash and Shock Hazard Present

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

Equipment: **BUS_TRN-4** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF08

Arc Flash and Shock Hazard Present

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

Equipment: **BUS_TRN-4a** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF08

Arc Flash and Shock Hazard Present

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

Equipment: **BUS-TRN3** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF08

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	**8.1**				
Arc Flash Boundary	**5.0**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**0**	

Equipment: **DP-PRN-3** 03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF08

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	**0.2**				
Arc Flash Boundary	**0.5**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**0**	

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

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF08

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	**0.2**				
Arc Flash Boundary	**0.5**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**0**	

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

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF08

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	**1.1**				
Arc Flash Boundary	**1.4**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

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

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF08

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	**1.8**		Limited approach	**3.5**	**ft**
Arc Flash Boundary	**2.0**	**ft**	Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

Equipment: **DS-LP-A-BUS**

03-09-2025 Std. IEEE 1584

Arc Flash Analysis by: IDEA Inc.

File: 24549 - DCC Arc Flash - FF08

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**18**	**in**	Shock Hazard when covers removed	**240**	**VAC**
Incident Energy in cal/cm²	**1.4**				
Arc Flash Boundary	**1.6**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

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

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF08

Arc Flash and Shock Hazard Present

ARC FLASH PROTECTION			SHOCK PROTECTION		
Working Distance	**18**	**in**	Shock Hazard when covers removed	**240**	**VAC**
Incident Energy in cal/cm²	**1.3**				
Arc Flash Boundary	**1.6**	**ft**	Limited approach	**3.5**	**ft**
			Restricted approach	**1.0**	**ft**
Refer to CSA Z462 for PPE requirements			Gloves class	**00**	

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

Arc Flash Analysis by: IDEA Inc. File: 24549 - DCC Arc Flash - FF08

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

PROTECTION D’ÉCLATS			PROTECTION DE CHOC		
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 - FF08

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

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

Équipement: **BUS_TRN-4** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF08

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

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

Équipement: **BUS_TRN-4a** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF08

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

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

Équipement: **BUS-TRN3** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF08

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

PROTECTION D’ÉCLATS			PROTECTION DE CHOC		
Distance de travail	**18**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**8.1**		couvercles enlevés	**600**	**VAC**
Périmètre d’éclats d’arcs	**5.0**	**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	**0**	

Équipement: **DP-PRN-3** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF08

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

PROTECTION D’ÉCLATS			PROTECTION DE CHOC		
Distance de travail	**18**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**0.2**		couvercles enlevés	**600**	**VAC**
Périmètre d’éclats d’arcs	**0.5**	**ft**	Périmètre d’accès limite	**3.5**	**ft**
			Périmètre d’accès restreint	**1.0**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**0**	

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

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF08

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

PROTECTION D’ÉCLATS			PROTECTION DE CHOC		
Distance de travail	**18**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**0.2**		couvercles enlevés	**600**	**VAC**
Périmètre d’éclats d’arcs	**0.5**	**ft**	Périmètre d’accès limite	**3.5**	**ft**
			Périmètre d’accès restreint	**1.0**	**ft**
Se référer à Z462 pour ÉPI approprié requis			Classe de gants	**0**	

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

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF08

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

PROTECTION D’ÉCLATS			PROTECTION DE CHOC		
Distance de travail	**18**	**in**	Choc électrique quand		
Énergie incidente cal/cm²	**1.1**		couvercles enlevés	**208**	**VAC**
Périmètre d’éclats d’arcs	**1.4**	**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: **SPLITTER-2** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF08

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	**1.8**		couvercles enlevés	**208**	**VAC**
Périmètre d’éclats d’arcs	**2.0**	**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: **DS-LP-A-BUS** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF08

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	**1.4**		couvercles enlevés	**240**	**VAC**
Périmètre d’éclats d’arcs	**1.6**	**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: **LP-A** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF08

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	**1.3**		couvercles enlevés	**240**	**VAC**
Périmètre d’éclats d’arcs	**1.6**	**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** 03-09-2025 Std. IEEE 1584

Étude d’éclats d’arcs par: IDEA Inc. File: 24549 - DCC Arc Flash - FF08

Appendix G – Cost Estimate

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

Phase **Class D Budget Cost Estimate - Building FF08** File Ref: 24549

SECTIONAL COST SUMMARY

Group Item	Element	Element Subtotal	Subtotal	-20.00%	20.00%
1	**TRN-3**		**$ 3,000**	**$ 2,400.0**	**$ 3,600.0**
1.1	Revise size of fuses in TRN-3 (Bay-o-net and CLF) from 100A to 50A	$ 3,000		$ 2,400.0	$ 3,600.0
2	**DP-PRN-3**		**$ 50,870**	**$ 40,696.0**	**$ 61,044.0**
2.1	Tag panel to be monitored with IR scan every one to two years as increased corrosion can cause failed connections	$ -		$ -	$ -
2.2	Provide new grounding lug	$ 570		$ 456.0	$ 684.0
2.3	Provide new door gasket	$ 300		$ 240.0	$ 360.0
2.4	Replace panel	$ 50,000		$ 40,000.0	$ 60,000.0
3	**DS-MAIN**		**$ 430**	**$ 344.0**	**$ 516.0**
3.1	Revise fuse style from fast blow to time delay	$ 430		$ 344.0	$ 516.0
4	**Panel P**		**$ 300**	**$ 240.0**	**$ 360.0**
4.1	Bond wire (#6) comes out of panel through 1-1/4" knockouit with no connector. Install connector on conduit to panel.	$ 300		$ 240.0	$ 360.0
5	**Panel P-Boilers**		**$ 6,300**	**$ 5,040.0**	**$ 7,560.0**
5.1	Replace panel	$ 6,300		$ 5,040.0	$ 7,560.0
6	**600V Splitter**		**$ 1,300**	**$ 1,040.0**	**$ 1,560.0**
6.1	Replace splitter	$ 1,300		$ 1,040.0	$ 1,560.0
7	**DS-LP-A**		**$ 2,000**	**$ 1,600.0**	**$ 2,400.0**
7.1	Disconnect has two sets of feeders leaving, one feeding panel LP-A, and one feeding DS-P and panel P. Replace this set up with a splitter and two individual disconnects for the two separate panels.	$ 2,000		$ 1,600.0	$ 2,400.0
8	**DS-TX-1**		**$ 300**	**$ 240.0**	**$ 360.0**
8.1	Revise fuse size from 30A to 20A	$ 300		$ 240.0	$ 360.0
9	**DS-P**		**$ 350**	**$ 280.0**	**$ 420.0**
9.1	Revise fuse size from 100A to 45A	$ 350		$ 280.0	$ 420.0
10	**DS-Boilers**		**$ 350**	**$ 280.0**	**$ 420.0**
10.1	Revise style of fuses from time delay to fast blow	$ 350		$ 280.0	$ 420.0
11	**DS-FF3**		**$ 350**	**$ 280.0**	**$ 420.0**
11.1	Revise style of fuse from time delay to fast blow	$ 350		$ 280.0	$ 420.0
12	**General Building**		**$ 1,000**	**$ 800.0**	**$ 1,200.0**
12.1	Print and frame Single Line Diagram as required by CEC.	$ 150		$ 120.0	$ 180.0
12.2	Provide nomenclature and labeling for entire distribution system	$ 850		$ 680.0	$ 1,020.0
	TOTAL BUDGET ESTIMATE		**$ 66,550** (+/- 20%)	$53,240	$79,860

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