DESSAU

Agriculture and Agri-food Canada – Central Experimental farm

Arc flash study and shock hazard

Final report

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REVISION AND PUBLICATION REGISTER		
Revision N°	**Date**	**Modification And/Or Publication Details**
01	2014-05-08	Final report – Reviewed after comments
00	2013-05-10	Final report

1 INTRODUCTION

As part of a project, Agriculture and Agri-food Canada mandated Dessau in order to achieve an Arc flash and shock hazard analysis of the power distribution within 38 buildings, from a total of 88 buildings, of the Central Experimental Farm located at 960, Carling Avenue.

*An arc flash hazard analysis is a study to investigate a worker's potential exposure to arc flash energy, conducted for the purpose of injury prevention and the determination of safe work practices, arc flash protection boundary, and the appropriate levels of personal protective equipment.**

It is now required by the Canadian Electrical Code (Article 2-306) that electrical equipments shall be field marked to warn persons of potential electric shock and arc flash hazards. This tag is required to help determining the severity of potential exposure, planning safe work practices and selecting personal protective equipment (PPE) to protect workers while doing live work. *Furthermore, the Code demands to place the marking in order to be clearly visible to persons before doing work on equipments.*

This engineering study presents an arc flash analysis for the electrical power distribution of the Central Experimental Farm. The scope of work includes the main substation, 38 buildings, all the 600 V switching cabinets, panelboards, 600 V disconnect switches until 208 V equipment powered by a transformer of over 125 kVA. In the process of the arc flash study, short-circuit and coordination study are achieve on the existing protections and are presented in the following report. A device evaluation is done jointly with the short-circuit study and is also provided in this document.

* CSA Z462, Workplace Electrical Safety

2 METHODOLOGY

2.1 DATA

Three visits were made during March and May 2012, and during February 2013. These visits had for purpose to collect information on breakers model, relay settings, protective device caliber and power cables length and caliber.

The one line diagrams were provided by the client and used as reference to be informed on the equipment and their location. Also, local electrician was provided by the client in order to assist us and identify all equipments to be covered.

To obtain incident energy levels, the network is simulated with short-circuit data supplied by Hydro-Ottawa. The values are also evaluated for 85% of nominal short-circuits power given by the facility. All the values supplied by Hydro-Ottawa are presented in appendix to this report.

Table 1 Nominal short-circuit power

DESCRIPTION	VALUE	NOMINAL
Connexion point voltages	Voltage (kV)	13.2
Main substation – VT855	Short-circuit power (MVA)	279
	LLL X/R	3.84
Transformer – PT145	Short-circuit power (MVA)	71
	LLL X/R	2.89
Transformer – PT146	Short-circuit power (MVA)	71
	LLL X/R	2.89
Transformer – PT221	Short-circuit power (MVA)	78
	LLL X/R	2.91
Transformer – T1000 (X31453)	Short-circuit power (MVA)	78
	LLL X/R	2.91

2.2 MODELING AND CALCULATIONS

For open area cases near equipments where the voltage exceeds 15 kV, the incident energy and arc flash boundary are calculated using Lee method. All other calculations are made according to the equations of the IEEE 1584 and CSA Z462 standards. The study has been conducted using the software ETAP from OTI Company.

As specified in IEEE 1584 standard, a second fault-clearing time is calculated using 85% of the minimum arcing current in order to provide a margin for possible changes of arcing current level. The highest value in term of incident energy is chosen to be the worst case scenario.

As recommended in IEEE 1584, the total fault clearing time is limited to a maximum of 2 seconds (120 cycles) on all protective devices. It is considered that a worker, exposed to an active arc flash, is likely to move away from the arc flash boundary after a certain time. Situations where the total fault clearing time is greater than 2 seconds introduces high incident energy level, where in reality, the worker is not totally exposed to this level of danger. In cases where work is carried out in a confined space, a longer duration would need to be considered.

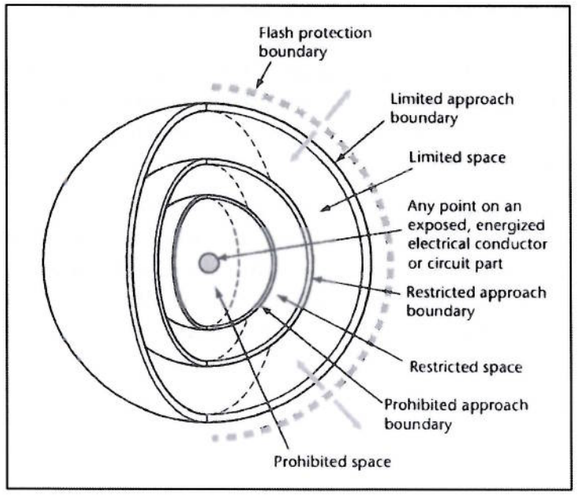
As required by CSA, the arc flash protection boundary must correspond to the distance at which the incident energy reaches 5 J/cm² (1.2 cal/cm^2). When fault-clearing time is 0.1 s or less, the arc flash protection boundary must be the distance at which the incident energy level reaches 6.24 J/cm² (1.5 cal/cm^2). For the purpose of this study, it was decided that the arc flash protection boundary would always represent the distance at which the incident energy reaches 5 J/cm² (1.2 cal/cm^2), which is a conservative approach.

3 INTRODUCTION TO ARC FLASH

3.1 TERMINOLOGY

This section is intended to establish the terminology used in this report, in accordance with CSA Z462. Understanding this terminology is necessary in order to implement the new electrical safety requirements.

Figure 1 Approach Distances



3.1.1 Incident energy

The amount of energy generated during an electrical arc event onto a surface, at a certain distance from its source. The sudden release of that energy is likely to cause multiple injuries to someone standing close by, including: severe burns, damages to internal organs, loss of hearing, loss of sight and even, death. Incident energy is measured in joules per squared centimeter (J/cm^2) or in calories per squared centimeter (cal/cm^2).

3.1.2 Limited approach boundary

An approach limit set at a certain distance from an exposed energized electrical conductor or circuit part in which a shock hazard exists.

3.1.3 Restricted approach boundary

An approach limit set at a certain distance from an exposed energized electrical conductor or circuit part in which there is an increased risk of shock due to electrical arc-over combined with inadvertent movement of personnel working in close proximity to the energized electrical conductor or circuit part.

3.1.4 Prohibited approach boundary

An approach limit set at a certain distance from an exposed energized electrical conductor or circuit part, considered as dangerous as making direct contact with the electrical conductor or circuit part.

3.1.5 Arc flash protection boundary

When an arc flash hazard exists, an approach limit is set at a distance from a prospective arc source in which a person could receive second-degree burns if an electrical arc flash were to occur.

3.2 ELECTRIC SHOCK

An electric shock occurs when a person comes into contact with energized parts. Current passes through the skin, muscles and vital organs, causing a shock. The severity of an electric shock depends on the current's intensity, its path through the body and the duration of the contact.

Table 1 Effects of Electric Currents on Humans

PHYSIOLOGICAL EFFECT	AC CURRENT 60 HZ
Tingling sensation	1 mA
Harmless shock	2 mA
Painful shock	9 mA
Sustained muscular contraction	20 mA
Ventricular fibrillation	100 mA
Severe burns and muscular contraction	300 mA

In general, dry skin is a poor conductor, with a resistance value of approximately 100,000 Ω. Broken or wet skin may have a much lower resistance value, set at around 1,000 Ω. Consequently, as voltage levels increase and body resistance values decrease, the effects of electrical shock escalate. Electric current may also cause an erratic heartbeat know as ventricular fibrillation. If fibrillation occurs even briefly and goes untreated, its effects are usually fatal.

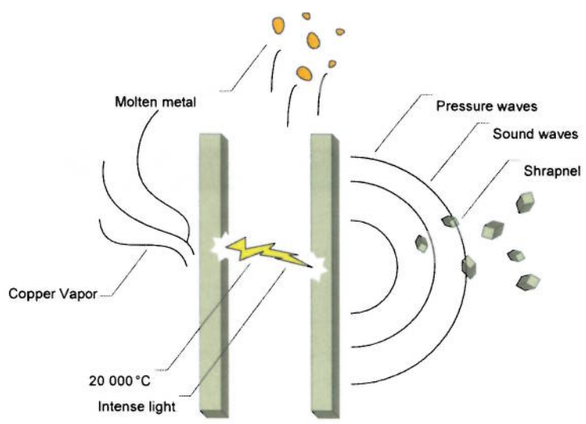
3.3 ELECTRIC ARC

An electric arc or an arcing fault is a flashover of electric current through air in electrical equipment, from one exposed live conductor to another or to the ground. It occurs when the voltage difference between two parts is greater than the insulation capacity between them. Undesired electrical arcs can be initiated in many ways: equipment failure, spark discharge caused by accidental touching or the dropping of tools, over-voltage across narrow gaps or failure of insulating materials improperly designed or utilized equipment, and improper work procedures. Arcs can also be caused by dust, corrosion or vapour condensation.

3.4 HAZARDS OF ARCING FAULTS

When an arcing fault occurs, it quickly creates a short circuit in which a strong electric current circulates. The heat generated by the arcing current can reach 20,000°C and causes a sudden increase in air temperature and vaporization of conductive metal, resulting in a significant and sudden increase in pressure. This results in an extremely violent shock wave.

Figure 2 Hazards of Arcing Faults



Some of the hazards related to arcing faults are: external and internal burns, lacerations, blindness, hearing loss, concussion, collapsed lungs and even death. The severity of the effects will depend on the amount of energy released, which is in accordance to system voltage, fault current magnitude and fault duration. Also, arcing faults that occur in enclosed spaces, such as an MCC or switchgear, increase the blast and energy transmitted as these are forced towards the open end of the enclosure and consequently towards the worker.

3.5 DE-ENERGIZED WORK

According to CSA Z462, an electrically safe work condition shall be achieved by performing the following procedures:

- Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags;
- After properly interrupting the load current, open the disconnecting device(s) for each source;
- Wherever possible, visually verify that all blades of the disconnecting devices are fully open or that draw-out-type circuit breakers are withdrawn to the fully disconnected position;
- Apply lockout devices in accordance with a documented and established protocol;
- Use an adequately rated voltage detector to test each phase conductor or circuit part and verify that they are de-energized. Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Before and after each test, determine whether the voltage detector is operating satisfactorily.
- Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it can be reasonably anticipated that the parts being de-energized could contact other exposed energized conductors or circuit parts, apply ground-connecting devices rated for the available fault duty.

3.6 PERSONAL PROTECTIVE EQUIPMENT (PPE)

No repairs or alterations shall be carried out on live equipment except when the complete disconnection of the equipment is not possible.

Suitable PPE is required when:

- The worker is standing within the arc flash protection boundary, and
- The electrical equipment is energized, and
- The worker is directly exposed to live parts.

Live work on electrical equipment with an incident energy level greater than 40 cal/ cm^2 is prohibited. PPE requirements are intended to protect workers from an arc flash and shock hazards. These requirements do not address protection against physical trauma other than exposure to the thermal effects of an arc flash.

4 ARC FLASH ANALYSIS

The 960 Carling Avenue electrical system is fed by a 13.2kV substation from three different feeders. Thirty-one buildings covered by this study are fed by the four protective devices in that main substation and the seven others are fed from individual padmount transformers (kiosks).

To consider the worse case event of a short-circuit current fluctuation from Hydro-Ottawa lines, the electrical network has been studied with two different scenarios. A first scenario have been studied with the maximum short-circuit while a second scenario have been studied with 85% of the maximum short-circuit current provided by Hydro-Ottawa for the four individual transformers and the substation.

While doing the surveys, access to building 94 was denied due to construction in progress. We are able to approximate the energy available at the main breaker. By cons, it is evident that due to the inaccessibility we can further develop this building. The estimation of the incident energy is approximately 2.64 cal/cm², which is categorized as level 1.

It was agreed at the beginning of the study that Building 78 (Central heating plant) was excluded from this study because of its reconstruction project in progress.

The study has been performed using data from supply of Hydro-Ottawa. The two scenarios presented in this report are simulated in normal power mode.

4.1 NORMAL CASE SUPPLY CHARACTERISTICS

The results of this case are based on these hypotheses:

- The electrical distribution system is fed by the distributor supply as described in appendix.
- All manual and automatic transfer switches are set to «normal supply».
- The wire gauges that couldn't be identified were evaluated in conformity with the tables 2 and 13 of the Canadian electrical code C22.1, latest version, based on the upstream protective devices.
- The settings of the protective device "SP1 Splitter" in SG-1 of building 21 were evaluated using a coordination study with the upstream breaker settings.
- The settings of the protective device "MDP2" in SG-1 of building 21 were evaluated using a coordination study with the downstream equipments. With the coordination, the short-circuit current is interrupted by the long time protection. The long time operates after many seconds, thus the interrupting time has been set to the maximum of 2 seconds.
- The interrupting time of the protective device "F5" in SG-1 of building 21 was evaluated to the maximum of 2 seconds to avoid the 1000kVA transformer's inrush current.

- The breaker's switches of "CB1","CB2","CB3","CB4","F5","F6","F9" and "F10" were evaluated using the information written on the panels due to the inability to open these panels.
- The information received from Hydro-Ottawa for the protective relays of "CB1","CB2","CB3" and "CB4" shows an instantaneous setting of 60. However, this setting has been adjusted to its maximum of 40 as mentioned in the manufacturer's technical specifications.
- The automatic transfer switch "ATS-2A" in building 88 is connected to the building main distribution.
- No information was received from the Central Experimental Farm concerning relay 1 in single line diagram. The arc flash was assumed for the worst case scenario with a 2 seconds interrupting time.
- The transformers PT146, PT221 and T1000, located near Prince of Wales drive, are owned by Hydro-Ottawa. These transformers are limited access and it's impossible to access their technical specifications. To compensate this fact, they were evaluated using the information from the upstream protection given by Hydro-Ottawa.

4.1.1 Equipments with high arcing levels

Multiple equipments in different buildings require special attention due to their high arcing levels (>8cal/cm²). In the following section, summarizations of the entire site have been made to identify hazardous devices. The summarization is divided into different buildings. The buildings not listed below don't need a special attention because their arcing levels are less than 8 cal/cm².

The complete list of results and the coordination curves are present in appendix.

4.1.1.1 Padmount switchgears

Table 2 Padmount switchgears with high arcing level > 8cal/cm²

EQUIPMENT NAME	TENSION (V)	TRI-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
PS-1	12.8	20.2	19.4	3.1	56.2	> 4
PS-2	12.8	19.8	19	2.7	42.69	> 4
PS-3	12.8	19.5	18.8	2.5	37.32	4
PS-4	12.8	19.3	18.5	2.3	31.52	4
PS-5	12.8	18.8	18	1.9	20.75	3
PS-6	12.8	18.7	18	1.8	18.78	3
PS-7	12.8	18.7	18	1.7	17.09	3
PS-8	12.8	18.7	18	1.8	18.83	3

EQUIPMENT NAME	TENSION (V)	TRI-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
PS-9	12.8	18.8	18.1	2	22.16	3
PS-10	12.8	19.3	18.5	2.4	32.78	4
PS-11	12.8	19.1	18.3	2.2	28.51	4

4.1.1.1.1 Analysis

All those high arcing levels of padmount switchgears are explained by the fact that they are fed by the main distribution. The high amount of short-circuit current available at this point combined with a long response time from relays "CB2" and "CB4" causes this high level of energy.

4.1.1.2 Building 20 – K.W. Neatby building

Table 3 Building 20 - Equipments with high arcing level > 8cal/cm²

EQUIPMENT NAME	VOLTAGE (V)	THREE-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
BLDG#20_MAIN BUS	12.8	21	20.1	3.9	87.71	> 4
BUS020-1_SWITCHGEAR #1	0.6	23.9	16.6	3	12.72	3
BUS020-127_MAIN_SWGEAR#1	0.6	24	19.5	5.1	146.78	> 4
BUS020-141_MAIN_SWGEAR#2	0.6	23.8	19.3	5	145.84	> 4
BUS020-142_MCC1	0.6	14.6	12.1	1.3	10.11	3
BUS020-2_SWITCHGEAR#2	0.6	23.8	16.5	3	12.65	3

4.1.1.2.1 Analysis

The following results show extreme levels at the main distribution panels of the building (BLDG#20_MAIN BUS, BUS020-127_MAIN_SWGEAR#1 and BUS020-141_MAIN_SWGEAR#2). This is due to the current on the secondary side of the transformer figured at its primary. This current is the same size as the transformer's inrush current. Thus, the protection has to avoid being within the inrush current. Even trying several different settings, including the most restrictive, the execution time of the relay is too slow to lower the energy levels. The coordination of the distribution switchgears (BUS020-1_SWITCHGEAR #1 and BUS020-2_SWITCHGEAR#2) and MCC1 (BUS020-142_MCC1) are already accurate. Any changes would compromise the coordination.

4.1.1.2.2 *Recommendations*

The settings of relays for "F9" and "F10" breakers are set over the destruction curve of their respective transformers. In order to protect the main transformers of 2 MVA of the building 20, the phase settings of the upstream protections should be lowered as presented below. Even with a change of the settings, the arcing level will not be better. However, the durability of the two transformers will be increased in case of high current events.

Table 4 Settings of relay "F9"

IDENTIFICATION	SETTING	PARAMETER	ACTUAL	RECOMMENDATIONS
Relay F9 ALSTOM MCGG	Phase Overcurrent	Curve Type	STD INVERSE	STD INVERSE
		Pickup range	0.05 – 2.4 xCT Sec	0.05 – 2.4 xCT Sec
		Pickup	1.25 xCT	1.25 xCT
		Time dial	0.2	0.05
	Phase Instantaneous	Pickup range	1 – 31 x51 Pickup	1 – 31 x51 Pickup
		Pickup	8	8

Table 5 Settings of relay "F10"

IDENTIFICATION	SETTING	PARAMETER	ACTUAL	RECOMMENDATIONS
Relay F10 ALSTOM MCGG	Phase Overcurrent	Curve Type	STD INVERSE	STD INVERSE
		Pickup range	0.05 – 2.4 xCT Sec	0.05 – 2.4 xCT Sec
		Pickup	1.25 xCT	1.25 xCT
		Time dial	0.2	0.05
	Phase Instantaneous	Pickup range	1 – 31 x51 Pickup	1 – 31 x51 Pickup
		Pickup	8	8

The new coordination curves are presented in appendix.

After applying recommendations, the arcing levels are not lowered. The incident energy is a little reduced when lowering the settings. However, an extreme level is still present at the main panel of the building 20.

Table 6 Building 20 - Equipments with a change of incident energy

EQUIPMENT NAME	VOLTAGE (V)	THREE-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY

EQUIPMENT NAME	VOLTAGE (V)	THREE-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
BUS020-127_MAIN_SWGEAR#1	0.6	24	19.5	4.9	136.94	> 4
BUS020-141_MAIN_SWGEAR#2	0.6	23.8	19.3	4.9	140.14	> 4

4.1.1.3 Building 21 – Header house

Table 7 Building 21 - Equipments with high arcing level > 8cal/cm²

EQUIPMENT NAME	VOLTAGE (V)	THREE-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
SG-1_PRIM_XFO	12.8	20.3	19.5	10.7	13.19	3
SG-1_SEC_XFO	0.6	18.3	13	8.3	55.95	> 4
BUS021-12_SPLITTER-SP1	0.6	16.4	10	6.8	42.3	> 4
BUS021-14_MDP-2	0.6	17.9	12.7	8.2	54.79	> 4
BUS021-7_DPD	0.208	6.3	3.3	1.9	21.79	3
BUS021-8	0.208	6.3	3.3	1.9	21.79	3
BUS021-9	0.208	6.4	3.4	2	21.93	3

4.1.1.3.1 Analysis

The extreme level (>4) of energy at the secondary side of the main 1000 kVA transformer (SG-1_SEC_XFO) is due to the interrupting time of the protective device "F5" in SG-1 of building 21 which was set to the maximum of 2 seconds to avoid the 1000kVA transformer's inrush current. It is impossible to lower this energy level with the protection elements currently in place. For the two other extreme levels (>4), the coordination curves demonstrates that the settings are already aggressive. To avoid unintentional triggering of an upstream circuit breaker, these levels cannot be reduced.

Since the mandate does not include the power distribution of buildings 6 and 132, this means that the equipments are unknown. It is appropriate to refrain of proposing any modification on relays "CB1" and "CB3" to not interfere coordination. Due to that, the arcing level of "SG-1_PRIM_XFO" can't be lowered.

The three other busses with high arcing levels (BUS021-7_DPD, BUS021-8 and BUS021-9) are due to the current of the secondary side of the transformer figured at their primary. Those currents are the same size as the inrush currents. Thus, the protections have to avoid being under the inrush current. There are no possibilities to improve the level of energy because the only way to change the settings will occurs coordination problems.

4.1.1.4 Building 22 – Laboratory service building

Table 8 Building 22 - Equipments with high arcing level > 8cal/cm²

EQUIPMENT NAME	VOLTAGE (V)	THREE-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
BLDG#22	12.8	20.3	19.4	2	22.92	3

4.1.1.4.1 Analysis

Since the building 22 (BLDG#22) is fed from main substation by breakers "CB1" and "CB3", like mentioned previously, it is impossible to propose any modifications.

4.1.1.5 Building 49 – William Saunders building

Table 9 Building 49 - Equipments with high arcing level > 8cal/cm²

EQUIPMENT NAME	VOLTAGE (V)	THREE-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
BUS049-1_MAIN	0.208	6.5	3.4	2	22.23	3

4.1.1.5.1 Analysis

The high arcing level at the main panel of the building 49 is due to the current of the secondary side of the transformer figured at its primary. This current is the same size as the inrush current. Thus, the protection has to avoid being under the inrush current.

4.1.1.6 Building 50 – Main greenhouse range

Table 10 Building 50 - Equipments with high arcing level > 8cal/cm²

EQUIPMENT NAME	VOLTAGE (V)	THREE-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
BUS050-1_MAIN	0.6	7.6	5.2	2.5	19.26	3
BUS050-7_PANEL - PC	0.208	7.9	3.7	2.7	22.66	3
BUS050-8_PANEL - PB	0.208	7.8	3.7	2.7	22.39	3
BUS050-9_PANEL - PA	0.208	11.3	4.7	3.2	29.67	4

4.1.1.6.1 Analysis

The coordination of the building 50 main breaker with the fuse above its transformer is already accurate. Any changes would compromise the coordination. For this reason, the arcing level of the main panel cannot be decreased.

The high arcing levels of the three panels are due to the current on the secondary side of the transformer figured at its primary. This current is the same size as the inrush current. Thus, the protection has to avoid being under the inrush current.

4.1.1.6.2 Recommendations

With the coordination, it is possible to see that the upstream protective device of the panel "BUS050-9_PANEL – PA" is set on the inrush current. However, the settings are already set to the maximum. It is recommended to change the breaker in order to provide a good coordination and better safety.

4.1.1.7 Building 59 – Nutrition building

Table 11 Building 59 - Equipments with high arcing level > 8cal/cm²

EQUIPMENT NAME	VOLTAGE (V)	THREE-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
BUS059-1_MAIN SWITCH	0.208	6.9	3.5	2	23.28	3
BUS059-3_PANEL DP1	0.208	2.5	1.7	1.6	9.47	3

4.1.1.7.1 Analysis

The coordination of building 59 main fuse (F059-1) with the fuse above its transformer (Fuse16) and the downstream protections (CB059-1 and CB059-2) is already accurate. Any changes would compromise the coordination. For this reason, the arcing level of the main panel "BUS059-3_PANEL DP1" cannot be decreased. Any changes of the fuse above the transformer PT145 is not possible due to the short-circuit current figured at its primary as mentioned previously.

4.1.1.8 Building 60 – Heritage House

Table 12 Building 60 - Equipments with high arcing level > 8cal/cm²

EQUIPMENT NAME	VOLTAGE (V)	THREE-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
BUS060-1_TRANSFER SWITCH	0.208	1.9	1.4	1.2	8.37	3

4.1.1.8.1 Analysis

The result shown in the table for the building 60 represents the arcing level with the magnetic setting set to the maximum as mentioned in the hypotheses. With a lower setting, the coordination may not be accurate and the arcing level stays high. Thus, no changes are recommended for this building.

4.1.1.9 Building 72 – Service building

Table 13 Building 72 - Equipments with high arcing level > 8cal/cm²

EQUIPMENT NAME	VOLTAGE (V)	THREE-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
BUS072-1_MAIN DISCONNECT	0.208	8.5	3.9	2.8	23.85	3

4.1.1.9.1 Analysis

The high arcing levels of the main panel at building 72 is due to the current on the secondary side of the transformer figured at its primary. This current is the same size as the inrush current. Thus, the protection has to avoid being under the inrush current. No recommendation can be done in order to keep a good selectivity.

4.1.1.10 Building 74 – Arboretum building

Table 14 Building 74 - Equipments with high arcing level > 8cal/cm²

EQUIPMENT NAME	VOLTAGE (V)	THREE-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
BUS074-1_MAIN DISCONNECT	0.208	7.1	3.6	2	23.8	3
BUS074-3_PANEL CDP-1	0.208	5.9	3	2.4	18.14	3

4.1.1.10.1 Analysis

Since the building 74 is also connected to PT146 as building 72, the level at the main switch "BUS074-1_MAIN DISCONNECT "cannot be lowered for the same reasons. Then, in order to keep the good coordination already set, it is not recommended to change the fuse protecting the panel "BUS074-3_PANEL CDP-1".

4.1.1.11 Building 75 – Cereal building

Table 15 Building 75 - Equipments with high arcing level > 8cal/cm²

EQUIPMENT NAME	VOLTAGE (V)	THREE-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
BUS075-1_MAIN	0.208	9.4	3.5	2.7	21.57	3

4.1.1.11.1 Analysis

The high arcing levels of the main panel at building 75 is due to the current on the secondary side of the transformer figured at its primary. This current is the same size as the inrush current. Thus, the protection has to avoid being under the inrush current. With the settings of the main protection in building 75, it is impossible to change the upstream fuse of the transformer T9 in order to keep a good coordination.

4.1.1.12 Building 76 – Cereal barn

Table 16 Building 76 - Equipments with high arcing level > 8cal/cm²

EQUIPMENT NAME	VOLTAGE (V)	THREE-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
BUS076-1_MAIN SWITCH	0.6	5.4	4	1.3	10.05	3

4.1.1.12.1 Analysis

The high arcing level at the main switch of the building 76 is due to the combination of a long run of cable between the building 91 (fed from this building) and the long response time of the protection device. The long run of cable decreases the amount of short-circuit current at the entry of the building resulting of an action in the long time setting by the upstream protection. With the downstream fuses in the building 76, it is impossible to change those settings.

4.1.1.13 Building 82 – Storage building

Table 17 Building 82 - Equipments with high arcing level > 8cal/cm²

EQUIPMENT NAME	VOLTAGE (V)	THREE-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
BUS082-1_MAIN	0.208	5.3	2.9	1.8	18.92	3

4.1.1.13.1 Analysis

The high arcing level of the main panel at building 82 is due to the current on the secondary side of the transformer figured at its primary. This current is the same size as the inrush current. Thus, the protection has to avoid being under the inrush current. In order to keep a good coordination, it is recommended to keep the fuse already installed.

4.1.1.14 Building 85 – Information booth

Table 18 Building 85 - Equipments with high arcing level > 8cal/cm²

EQUIPMENT NAME	VOLTAGE (V)	THREE-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
BUS085-1_MAIN	0.208	6.4	3.2	2.5	19.34	3

4.1.1.14.1 Analysis

Since building 85 is also connected to the transformer "T9" as building 75, the level of energy cannot be lowered in order to keep a good coordination.

4.1.1.15 Building 99 – Service building

Table 19 Building 99 - Equipments with high arcing level > 8cal/cm²

EQUIPMENT NAME	VOLTAGE (V)	THREE-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
BUS099-20_300KVA-SEC-XFO	0.208	8.7	4.2	2.2	28.12	4

4.1.1.15.1 Analysis

The high arcing level of the panel after the 300 kVA transformer (BUS099-20_300KVA-SEC-XFO) is due to the current on the secondary side of the transformer figured at its primary. This current is the same size as the inrush current. Thus, the protection has to avoid being under the inrush current. The fuse installed to protect the transformer is already selected for optimal protection.

4.1.1.16 Building 110 – Service building

Table 20 Building 110 - Equipments with high arcing level > 8cal/cm²

EQUIPMENT NAME	VOLTAGE (V)	THREE-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
BUS110_MAIN	0.6	8	5.8	1.8	18.42	3

4.1.1.16.1 Analysis

The high arcing level of the panel after the transformer "T6" (BUS110_MAIN) is due to the current on the secondary side of the transformer figured at its primary as mentioned previously. The coordination curves shows it isn't possible to reduce the fuse to decrease de level of energy at the main panel of the building 110.

4.1.1.17 Building 134 – Storage building

Table 21 Building 134 - Equipments with high arcing level > 8cal/cm²

EQUIPMENT NAME	VOLTAGE (V)	THREE-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
BUS134-1_MAIN	0.208	2.2	1.5	1.5	8.52	3

4.1.1.17.1 Analysis

The building 134 is fed by a molded case circuit breaker in the panel CDP-1 located in the building 72. The molded case breaker doesn't have any settings or any magnetic setting.

4.1.1.17.2 Recommendations

In order to have a lower amount of energy at the main panel of this building, it is recommended to change the breaker for an adjustable breaker. This change may help reducing the arcing level.

4.1.1.18 Building 136 – Bio-control laboratory

Table 22 Building 136 - Equipments with high arcing level > 8cal/cm²

EQUIPMENT NAME	VOLTAGE (V)	THREE-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
BUS136-2_PANEL 452-08	0.208	4	2.3	2	13.55	3

4.1.1.18.1 Analysis

The high arcing level of the panel after the 150 kVA transformer in the building 136 (BUS136-2_PANEL 452-08) is due to the current on the secondary side of the transformer figured at its primary as mentioned previously. Even if the fuse is reduced, the interrupting time is over 2 seconds. In this case, the amount of energy is the same even if the fuse is changed. For this reason, it is not necessary to replace the fuse.

4.1.1.19 Building 140 – Plant growth building

Table 23 Building 140 - Equipments with high arcing level > 8cal/cm²

EQUIPMENT NAME	VOLTAGE (V)	THREE-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
BUS140-1_MAIN	0.208	13	5.7	2.6	38.64	4

4.1.1.19.1 Analysis

The high arcing level of the panel after the transformer "T2" (BUS140-1_MAIN) is due to the current on the secondary side of the transformer figured at its primary as mentioned previously. The coordination curves shows it isn't possible to reduce the fuse to decrease the level of energy at the main panel of the building 140.

4.1.1.20 Kiosk E-K94-K94-P

Table 24 Kiosk E-K94-K94-P - Equipments with high arcing level > 8cal/cm²

EQUIPMENT NAME	VOLTAGE (V)	THREE-PHASE FAULT (KA)	ARC FAULT (KA)	SECURITY BOUNDARY (M)	INCIDENT ENERGY (CAL./CM²)	RISK CATEGORY
BUSK94-1_E-K94-K94-P	0.6	8.1	5.3	2.9	11.87	3

4.1.1.20.1 Analysis

The high arcing level of the kiosk after the transformer "T4" (BUSK94-1_E-K94-K94-P) is also due to the current on the secondary side of the transformer figured at its primary as mentioned previously. The coordination curves shows it isn't possible to reduce the fuse to decrease the level of energy at this kiosk.

5 SHORT-CIRCUIT ANALYSIS

The approach for coordination study is to find the settings of the protections in order to get the perfect balance between the security and minimization of the impact of a defect on the others distribution branches. In case of a default on a branch, the corresponding circuit breaker isolates its own distribution without affecting the other breakers to maintain power over the other places in the most acceptable delay. This way, the network remains reliable with an acceptable safety level.

Every time a significant change to an electrical distribution system (for example, expansion, reconfiguration, additional load or upgrade) the challenge is to keep the reliability of the distribution.

The scope of work is to determine the magnitude of current flowing throughout the power system at various time intervals during a fault. This will help to evaluate the size and settings of a system's protective devices, such as relays, fuses and circuit breakers, and the circuits they protect. The goal is to provide power transformers, switchgear, substations, motor control centers, panelboards and other electrical equipment with the required protection.

After several attempts and trials with the models of the protections presently in place at the experimental farm, it is possible to identify some defects. Sometimes, it is impossible to find a favorable solution due to the small range of optional settings that provide certain protections. As presented in the results section in Appendix 2, it is the case with the relays of the main distribution.

A summarization is presented in the appendix to identify cases of fuses or breakers having a too small breaking capacity compare to the interruptible current. In fact, the selected model of the main fuse in Building 22 is currently estimated, it is recommended to validate the model and see if this model has a breaking capacity beyond the interruptible current of 20 802 kA. When the current exceeds the interruptible capacity of the protective device it may seriously get damage or even disintegrate. The same phenomenon has been noted in several places of the experimental farm, as fuses or breakers in many panels.

Referring to appendix 2, it is possible to notice some failing equipment. These ones are identified by text in red followed by a star which indicates that the device doesn't support the fault current. Using these underrated equipments will eventually get damaged since the protective device is not built for this amount of short circuit current. To maintain the durability of the equipment, it is recommended to change the existing failing device to an equivalent which will be able to withstand the short-circuit current presented at column called "Symm. kA rms" in report presented at Appendix 2.

Also, the complete equipment table presented in appendix is followed by a summary table only showing failing devices.

6 COMMENTS AND RECOMMENTATIONS

6.1 GENERALITIES

Based on obtained results, it is possible to highlight elements that could improve the security of workers at the 960 Carling Avenue. This can be achieved either by applying some modifications at some protective devices settings or by the repair of mechanical deficiencies.

The first major recommendation is to improve the global identification of the electrical equipments to be sure that the workers are well informed about the implication of their intervention. Also, it can permit to keep a good following on the documentation as single lines diagrams.

All electrical equipments which as an interruptible capacity less than actual short-circuit level shall be replaced by suitable equipments. Refer to appendix.

It is recommended to validate the installation of the "ATS-2A" in order to be conformed to the standards.

The existing settings for all of the protective relays including the trip units on the low voltage circuit breakers were collected on site prior to carry this power system study. In order to provide adequate equipment protection and proper time operation for workers protection, it is recommended to modify the minimal changes of settings discussed in the previous sections.

Also, building 19 upstream protection devices seem to overlap with downstream equipments. To maintain a good selectivity at the main switch of the building and to keep the same arc flash levels throughout the building, it is recommended to change the short time pick up setting to four (4) times pickup current instead of the current setting (1.5x current) on circuit breaker identified as CB020-9. See appendix to get the coordination curve with new settings.

The upstream breaker of building 47 has a lower pickup then the downstream breakers. With the existing device, even if a change of settings is done on the upstream protection it will not be able to coordinate the other downstream breakers on the feeding panel. It is recommended to let the settings as they are on site to maintain the arc flash levels or change the relay on the protective device to offer a better range of settings.

Access to building 19 was denied during surveys due to construction. Therefore, no recommendations can be done since no downstream protection devices are known.

Then, some security issues could be revised so as to minimize worker exposure to live equipment during circuit breakers levers manipulation on some electrical panel. These elements are presented in the following section.

6.2 SECURITY FIXES

The following recommendations presents simple fixes to enhance security around the electrical distribution equipments of the 960 Carling Avenue. Refer to the pictures in appendix.

6.2.1 Building 142, Greenhouse

The Greenhouse has a switch with copper tubes instead of fuses. It is highly recommended to replace these tubes by the correct fuses to avoid any damage in case of an electrical problem.

6.2.2 Building 50, panel PA

The panel PA located in building 50 allows a visual exposure to live pieces when the door is open which contravenes at the article 2.202 of the Canadian electrical code. It would be recommended to adequately fix a plate between the two circuit breakers to cover the opening.

6.2.3 Building 50, panel PP

The panel PP located in building 50 allows a visual exposure to live pieces when the door is open which contravenes at the article 2.202 of the Canadian electrical code. It would be recommended to adequately fix a plate between the two circuit breakers to cover the opening.

6.2.4 Building 21, panel E, R

The panel E.R located in building 21 allows a visual exposure to live pieces when the door is open which contravenes at the article 2.202 of the Canadian electrical code. It would be recommended to fix plates on the two holes to cover the openings.

6.2.5 Building 50, panel T-05

The panel T-05 located in building 50 present two holes allowing a visual exposure to live cables. It would be recommended to fix a plate to cover the opening.

6.2.6 Building 143, Air comp. disconnect switch

The air compressor disconnect switch located in building 143 holds drive belts which could be dangerous if they were accidently hooked. They could change the state of the disconnect switch. It is recommended to put these belts in a designated area.

Annexe 1 Arc flash results

DESSAU

Central Experimental Farm - 960 Carling Avenue, Ottawa,Ontario

Arc flash study

Equipment name	Voltage (kV)	Working distance (cm)	Upstream protection	Fault current (kA)	Arcing current (kA)	Incident energy (cal/cm²)	Energy levels	Arc flash boundary (m)
BLDG#20_MAIN BUS	12.8	45.7	CB2	21	20.1	87.71	> 4	3.9
BLDG#22	12.8	45.7	CB1	20.3	19.4	22.92	3	2
BUS012-1_PANEL SPP1	0.6	45.7	CBMSS-5	3.7	3.3	0.12	0	0.1
BUS012-2	0.6	45.7	CBMSS-5	3.7	3.2	0.12	0	0.1
BUS012-3_CIRC PUMP	0.6	45.7	CBMSS-5	3.4	3	0.11	0	0.1
BUS012-4_AC	0.6	45.7	CBMSS-5	3.5	3.1	0.11	0	0.1
BUS012-5_TRANSFORMER	0.6	45.7	CBMSS-5	3.6	3.2	0.11	0	0.1
BUS018-1	0.6	45.7	CB020-15	8.7	7.4	0.44	0	0.3
BUS018-2	0.6	45.7	CB020-15	8.6	6.8	0.37	0	0.2
BUS018-3_SPLITTER SP1	0.6	45.7	CB018-4	7.4	6.3	0.31	0	0.2
BUS018-4_AHU#1	0.6	45.7	CB018-4	6.7	5.7	0.28	0	0.2
BUS018-5_H-1	0.6	45.7	CB018-4	6.9	5.9	0.29	0	0.2
BUS018-6_CU-1	0.6	45.7	CB018-4	6.9	5.9	0.29	0	0.2
BUS018-7_VENT	0.6	45.7	F012-5	5.1	4.4	0.06	0	0.1
BUS019-2_SPLITTER	0.6	45.7	CB020-10	3.6	3.2	0.17	0	0.2
BUS019-3_PANEL A	0.6	45.7	CB020-10	3.4	3	0.16	0	0.2
BUS019-4_RADIATOR FAN	0.6	45.7	CB020-10	3.4	3	0.16	0	0.2
BUS019-5_HEATER RAD. F	0.6	45.7	CB020-10	3.4	3	0.16	0	0.2
BUS019-6	0.6	45.7	CB020-10	3.4	3	0.16	0	0.2
BUS019-7_FUEL PUMPS	0.6	45.7	CB020-10	3.4	3	0.16	0	0.2
BUS019-8_MAIN SWITCH	0.6	45.7	CB020-10	3.6	3.2	0.17	0	0.2
BUS020-1_SWITCHGEAR #	0.6	61	F-109	23.9	16.6	12.72	3	3
BUS020-10_75 KVA TRANS	0.6	45.7	CB020-21	13.5	11.2	1.01	0	0.4
BUS020-100_PANEL 5C	0.6	45.7	CB020-111	15.5	11.8	0.99	0	0.4
BUS020-102_P-1 DISCONN	0.6	45.7	CB020-113	10.7	9	0.48	0	0.3
BUS020-103_P-2 DISCONN	0.6	45.7	CB020-114	10.7	9	0.48	0	0.3
BUS020-104_P-3 DICONNE	0.6	45.7	CB020-115	11.6	9.7	0.52	0	0.3
BUS020-105_P-4 DISCONN	0.6	45.7	CB020-116	11.6	9.7	0.52	0	0.3
BUS020-106_P-5 DISCONN	0.6	45.7	CB020-117	10.7	9	0.48	0	0.3
BUS020-107_P-6 DISCONN	0.6	45.7	CB020-118	10.7	9	0.48	0	0.3
BUS020-108_EF-1 DISCON	0.6	45.7	CB020-119	3	2.7	0.13	0	0.1
BUS020-109_COOL TOWEI	0.6	45.7	CB020-120	12.6	10.5	0.57	0	0.3
BUS020-11_75 KVA TRANS	0.6	45.7	CB020-21	13.5	11.2	1.01	0	0.4
BUS020-110_COOL TOWEI	0.6	45.7	CB020-121	6.1	5.3	0.27	0	0.2
BUS020-111_COOL TOWEI	0.6	45.7	CB020-122	12.6	10.5	0.57	0	0.3
BUS020-112_COOLING TO'	0.6	45.7	CB020-123	6.1	5.3	0.27	0	0.2
BUS020-114_AHU-4 DISCO	0.6	45.7	CB020-128	16.1	13.3	0.73	0	0.4
BUS020-115_AHU-1 DISCO	0.6	45.7	CB020-129	11.7	9.8	0.52	0	0.3
BUS020-116_AHU-5 DISCO	0.6	45.7	CB020-130	12.5	10.4	0.56	0	0.3
BUS020-117_AHU-2 DISCO	0.6	45.7	CB020-131	13.4	11.2	0.60	0	0.3
BUS020-118_AHU-3 DISCO	0.6	45.7	CB020-132	17.1	14.1	0.77	0	0.4
BUS020-119_P-8 DISCONN	0.6	45.7	CB020-133	8.3	7	0.37	0	0.3
BUS020-12_150 KVA TRAN	0.6	45.7	CB020-21	13.5	11.2	1.01	0	0.4
BUS020-120_P-7 DISCONN	0.6	45.7	CB020-134	8.3	7	0.37	0	0.3
BUS020-121_P-9 DISCONN	0.6	45.7	CB020-135	10.8	9.1	0.48	0	0.3
BUS020-122_AIR COMPRE	0.6	45.7	CB020-136	1.4	1.2	0.08	0	0.1

DESSAU

Central Experimental Farm - 960 Carling Avenue, Ottawa,Ontario

Arc flash study

Equipment name	Voltage (kV)	Working distance (cm)	Upstream protection	Fault current (kA)	Arcing current (kA)	Incident energy (cal/cm²)	Energy levels	Arc flash boundary (m)
BUS020-123_P9	0.6	45.7	CB020-137	1.1	1	0.04	0	0.1
BUS020-124_EF-4 DISCON	0.6	45.7	CB020-138	11.4	9.5	0.51	0	0.3
BUS020-126_P1A	0.6	45.7	CB020-16	19.6	14.6	0.85	0	0.4
BUS020-127_MAIN_SWGE/	0.6	45.7	F10	24	19.5	146.78	> 4	5.1
BUS020-128	0.6	45.7	CB020-124	13.9	11.5	0.82	0	0.4
BUS020-129	0.6	45.7	CB020-125	13.9	11.5	0.82	0	0.4
BUS020-13_PANEL - C	0.208	45.7	F020-1	6.4	2.9	0.96	0	0.4
BUS020-130	0.6	45.7	CB020-126	7.2	6.2	0.32	0	0.2
BUS020-131	0.6	45.7	CB020-156	8.2	7	0.36	0	0.2
BUS020-132	0.6	45.7	CB020-155	7.2	6.2	0.31	0	0.2
BUS020-133	0.6	45.7	CB020-158	6.1	5.3	0.27	0	0.2
BUS020-134	0.6	45.7	CB020-157	7.2	6.2	0.31	0	0.2
BUS020-137_550V MAIN	0.6	45.7	CB020-87	7.1	6.1	0.31	0	0.2
BUS020-138_SPLIT B RM B	0.6	45.7	F020-15	6.7	5.7	0.08	0	0.1
BUS020-139_ROOF COND	0.6	45.7	F020-15	6.5	5.6	0.08	0	0.1
BUS020-14_SPLITTER B14	0.6	45.7	CB020-22	12.9	10.8	0.97	0	0.4
BUS020-140_MCC#2	0.6	45.7	CB020-3	19.5	14.5	6.96	2	1.3
BUS020-141_MAIN_SWGE/	0.6	45.7	F9	23.8	19.3	145.84	> 4	5
BUS020-142_MCC1	0.6	45.7	CB020-1	14.6	12.1	10.11	3	1.3
BUS020-143_ROOF COND	0.6	45.7	F020-15	6.5	5.6	0.08	0	0.1
BUS020-144_TRANS PANE	0.6	45.7	F020-15	6.6	5.7	0.08	0	0.1
BUS020-145_05-200-11	0.6	45.7	CB020-88	7.1	6.1	0.31	0	0.2
BUS020-146_TRANS PANE	0.6	45.7	CB020-88	6.7	5.7	0.30	0	0.2
BUS020-147_AC LIBRARY	0.6	45.7	CB020-88	6.7	5.7	0.30	0	0.2
BUS020-148_AC LIBRARY	0.6	45.7	CB020-88	6.7	5.7	0.30	0	0.2
BUS020-149_SPLIT B RM B	0.6	45.7	CB020-88	6.7	5.7	0.30	0	0.2
BUS020-15_WATER PUMP	0.6	45.7	CB020-22	12.7	10.6	0.95	0	0.4
BUS020-150_PANEL N	0.208	45.7	F020-16	6.6	2.9	0.37	0	0.3
BUS020-152_30-270-52	0.6	45.7	CB020-88	6.7	5.7	0.30	0	0.2
BUS020-153_DT1A	0.6	45.7	CB020-90	7.1	6.1	0.31	0	0.2
BUS020-16_WATER PUMP	0.6	45.7	CB020-22	10.8	9.1	0.80	0	0.4
BUS020-17_COND PUMP #	0.6	45.7	CB020-22	10.8	9.1	0.80	0	0.4
BUS020-18_COND PUMP #	0.6	45.7	CB020-22	11.5	9.7	0.86	0	0.4
BUS020-181_HUMID SYS 3	0.6	45.7	CB020-203	3.1	2.7	0.15	0	0.2
BUS020-183_HUMID SYS 2	0.6	45.7	CB020-205	3.9	3.4	0.18	0	0.2
BUS020-184_HUMID SYS 1	0.6	45.7	CB020-206	4.3	3.7	0.20	0	0.2
BUS020-185_CAFETERIA F	0.6	45.7	CB020-207	1.3	1.2	0.08	0	0.1
BUS020-186_HUMID SYS 4	0.6	45.7	CB020-208	2.9	2.5	0.14	0	0.2
BUS020-19_UNKNOWN	0.6	45.7	CB020-22	11.5	9.7	0.86	0	0.4
BUS020-191_HUMID SYS 5	0.6	45.7	CB020-213	2.4	2.2	0.12	0	0.1
BUS020-192_HOOD SYSTE	0.6	45.7	CB020-214	2.5	2.2	0.12	0	0.1
BUS020-193_AHV HOODS	0.6	45.7	CB020-215	2.9	2.6	0.14	0	0.2
BUS020-194_PANEL 5C	0.6	45.7	CB020-111	15	11.4	0.96	0	0.4
BUS020-195_COOLING MO	0.6	45.7	CB020-111	14.4	11.9	1.08	0	0.4
BUS020-196_05-200-84	0.6	45.7	CB020-111	12.6	10.5	0.94	0	0.4
BUS020-199_PANEL 5C	0.6	45.7	CB020-9	2.2	2	0.46	0	0.3

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Equipment name	Voltage (kV)	Working distance (cm)	Upstream protection	Fault current (kA)	Arcing current (kA)	Incident energy (cal/cm²)	Energy levels	Arc flash boundary (m)
BUS020-2_SWITCHGEAR#2	0.6	61	F-107	23.8	16.5	12.65	3	3
BUS020-20_EPO CONTACT	0.6	45.7	CB020-23	15.1	12.5	0.88	0	0.4
BUS020-200_COOL MOTOI	0.6	45.7	CB020-9	2.1	1.9	0.48	0	0.3
BUS020-201_COOL MOTOI	0.6	45.7	CB020-9	2.2	2	0.49	0	0.3
BUS020-204_EF-096,EF-18	0.6	45.7	CB020-218	1.2	0.9	0.08	0	0.1
BUS020-205_PASSENGER	0.6	45.7	CB020-219	9.8	8.2	0.40	0	0.3
BUS020-21_PANEL PP2A	0.6	45.7	CB020-23	14.5	11	0.73	0	0.3
BUS020-210_PENTHOUSE	0.6	45.7	CB020-224	4.3	3.7	0.20	0	0.2
BUS020-214_COOLING TO	0.6	45.7	CB020-228	0.9	0.7	0.58	0	0.3
BUS020-215_GE-189	0.6	45.7	CB020-229	2.2	2	0.11	0	0.1
BUS020-216_AC-15	0.6	45.7	CB020-230	2.2	2	0.11	0	0.1
BUS020-217_GE-116,GE-18	0.6	45.7	CB020-231	2.2	2	0.11	0	0.1
BUS020-218_B817	0.6	45.7	CB020-232	2.1	1.9	0.11	0	0.1
BUS020-219_FAN 310	0.6	45.7	CB020-233	2.3	2.1	0.11	0	0.1
BUS020-220_AUTOCLAVE	0.6	45.7	CB020-234	4.3	3.7	0.20	0	0.2
BUS020-222_FREIGHT ELE	0.6	45.7	CB020-236	13.3	11.1	0.54	0	0.3
BUS020-223_PAS ELEVAT	0.6	45.7	CB020-237	9.6	8.1	0.39	0	0.3
BUS020-225_ASCO_NORM	0.6	61	CB020-9	23	16	2.80	1	1.1
BUS020-44_PANEL P3	0.6	45.7	CB020-24	14	10.7	0.90	0	0.4
BUS020-46_PANEL 5B	0.6	45.7	CB020-110	15.5	11.8	0.99	0	0.4
BUS020-5_PANEL CDP-E1	0.6	61	CB020-9	22.2	15.5	2.70	1	1.1
BUS020-6_PANEL PP1	0.6	61	CB020-11	21.1	14.8	2.34	1	1
BUS020-65_PANEL P2	0.6	45.7	CB020-25	15.4	12.8	1.16	0	0.4
BUS020-66_PANEL P4	0.6	45.7	CB020-26	15.2	11.6	0.97	0	0.4
BUS020-68_A C 18	0.6	45.7	CB020-73	10.6	8.9	0.59	0	0.3
BUS020-69_TRANS LL9	0.6	45.7	CB020-74	13.5	11.2	0.75	0	0.4
BUS020-7_PANEL PP2	0.6	45.7	CB020-9	21.8	16.1	4.45	2	1
BUS020-71_TRANSFORME	0.6	45.7	CB020-76	4.3	3.7	0.22	0	0.2
BUS020-72_TRANSFORME	0.6	45.7	CB020-77	10.6	8.9	0.59	0	0.3
BUS020-73_TRANSFORME	0.6	45.7	CB020-78	4.3	3.7	0.22	0	0.2
BUS020-74_PANEL P6	0.6	45.7	CB020-27	18.6	13.9	1.19	0	0.5
BUS020-75	0.6	45.7	CB020-79	4.6	4	0.22	0	0.2
BUS020-78	0.6	45.7	CB020-82	9	7.7	0.45	0	0.3
BUS020-8_SPLITTER	0.6	45.7	CB020-21	13.6	11.3	1.02	0	0.4
BUS020-80	0.6	45.7	CB020-84	12.6	10.5	0.64	0	0.3
BUS020-82_CAFETERIA PA	0.6	45.7	CB020-27	18.3	15	1.39	1	0.5
BUS020-83_PANEL CDP1	0.6	61	CB020-9	14.5	10.6	1.79	1	0.8
BUS020-84_SPLIT B RM B7	0.6	45.7	CB020-89	7.1	6.1	0.31	0	0.2
BUS020-85_SPLIT A RM B7	0.6	45.7	CB020-91	7.1	6.1	0.31	0	0.2
BUS020-86_BOILER ROOM	0.6	45.7	CB020-92	3.4	3	0.16	0	0.2
BUS020-87_GLASS BLOWE	0.6	45.7	CB020-93	1.5	1.1	0.10	0	0.1
BUS020-88_FREIGHT ELEV	0.6	45.7	CB020-96	2.2	2	0.12	0	0.1
BUS020-89_SPLIT RM B66	0.6	45.7	CB020-97	3.4	3	0.16	0	0.2
BUS020-9_FEED 30KVA TR	0.6	45.7	CB020-21	13.5	11.2	1.01	0	0.4
BUS020-90_B54 HALL DISC	0.6	45.7	CB020-98	7.1	6.1	0.31	0	0.2
BUS020-91_150 KVA TRAN	0.6	45.7	CB020-99	7.1	6.1	0.31	0	0.2

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BUS020-93	0.6	45.7	CB020-101	7.8	6.7	0.35	0	0.2
BUS020-95_PANEL P7	0.6	45.7	CB020-102	7.1	5.7	0.28	0	0.2
BUS020-96_FIRE BOOST P	0.6	45.7	CB020-104	3.4	3	0.16	0	0.2
BUS020-97_COMPR RM B6	0.6	45.7	CB020-105	1.5	1.1	0.10	0	0.1
BUS020-98_PANEL P5A	0.6	45.7	CB020-12	19.2	14.3	2.94	1	0.8
BUS020-99_PASSENGER	0.6	45.7	CB020-94	2.2	2	0.12	0	0.1
BUS021-10_P-2 DISCONNE	0.6	45.7	CB26	2.5	2.3	0.10	0	0.1
BUS021-11_P-1 DISCONNE	0.6	45.7	CB25	2.5	2.3	0.10	0	0.1
BUS021-12_SPLITTER-SP1	0.6	61	CBSG021-1	16.4	10	42.30	> 4	6.8
BUS021-14_MDP-2	0.6	61	CBSG021-2	17.9	12.7	54.79	> 4	8.2
BUS021-15_PP11	0.6	45.7	CB021-20	16.1	13.3	1.22	1	0.5
BUS021-16_PP11	0.6	45.7	CB021-41	16.1	13.3	1.03	0	0.4
BUS021-3_GHLP-B	0.6	45.7	CB021-2	12.2	10.2	0.28	0	0.2
BUS021-4_GHLP-A	0.6	45.7	CB021-3	9	7.6	0.23	0	0.2
BUS021-5_GHLP-C	0.6	45.7	CB021-4	13	10.9	0.21	0	0.2
BUS021-50_P-3	0.6	45.7	CB28	2.3	2	0.07	0	0.1
BUS021-51_P-4	0.6	45.7	CB27	2.3	2	0.07	0	0.1
BUS021-6_MCC-C1	0.6	45.7	CB021-11	7.6	6.1	0.20	0	0.2
BUS021-7_DPD	0.208	45.7	CB021-9	6.3	3.3	21.79	3	1.9
BUS021-8	0.208	45.7	CB021-10	6.3	3.3	21.79	3	1.9
BUS021-9	0.208	45.7	CB021-12	6.4	3.4	21.93	3	2
BUS022-0_MAIN	12.8	45.7	F6	20.3	19.4	4.85	2	0.9
BUS022-10_FROM PANEL	0.6	45.7	CB022-7	4	3.5	0.18	0	0.2
BUS022-100_MAKEUP AIRI	0.6	45.7	F022-85	2.8	2.5	0.08	0	0.1
BUS022-101_AIR UNIT MU/	0.6	45.7	F022-87	2.2	2	0.06	0	0.1
BUS022-102_AIR UNIT 2ND	0.6	45.7	F022-84	2.2	2	0.06	0	0.1
BUS022-103_UNKNOWN	0.6	45.7	F022-90	2.8	2.5	0.03	0	0.1
BUS022-104_FUME HOOD	0.6	45.7	F022-89	3.9	3.4	0.05	0	0.1
BUS022-106_CIRC PUMP F	0.6	45.7	F022-88	2.8	2.5	0.03	0	0.1
BUS022-107_FUME FAN #1	0.6	45.7	F022-92	2.2	2	0.03	0	0.1
BUS022-108_FOR GLYCOL	0.6	45.7	F022-93	2.2	2	0.06	0	0.1
BUS022-109_COOLING MT	0.6	45.7	F022-94	2.2	2	0.03	0	0.1
BUS022-11_SOLVENT STO	0.6	45.7	CB022-8	4	3.5	0.18	0	0.2
BUS022-113_MUA GLYCOL	0.6	45.7	F022-98	3.9	3.4	0.11	0	0.1
BUS022-114_LOC FAN #16:	0.6	45.7	F022-99	3.9	3.4	0.11	0	0.1
BUS022-115_FUME FAN #1	0.6	45.7	F022-100	2.8	2.5	0.08	0	0.1
BUS022-116_MUAU GLYCC	0.6	45.7	F022-101	2.8	2.5	0.08	0	0.1
BUS022-117_WEST STAIR	0.6	45.7	F022-102	2.8	2.5	0.03	0	0.1
BUS022-118_WEST STAIR	0.6	45.7	F022-103	3.9	3.4	0.11	0	0.1
BUS022-119_TE3	0.6	45.7	CB022-36	1.3	1.2	0.05	0	0.1
BUS022-12_HOT TANK RM	0.6	45.7	CB022-10	4	3.5	0.18	0	0.2
BUS022-120_TE2	0.6	45.7	CB022-37	1.3	1.2	0.05	0	0.1
BUS022-121_TEG	0.6	45.7	CB022-38	1.3	1.2	0.05	0	0.1
BUS022-122_TEB	0.6	45.7	CB022-39	2.4	2.1	0.09	0	0.1
BUS022-123_5HP POMP	0.6	45.7	CB022-40	1.1	0.8	0.05	0	0.1
BUS022-124_20HP COMP	0.6	45.7	CB022-41	1.5	1.2	0.07	0	0.1

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BUS022-125_SPLIT RM B3'	0.6	45.7	CB022-42	4.3	3.8	0.13	0	0.1
BUS022-126_GEN ENCLOS	0.6	45.7	CB022-43	1.2	1.1	0.05	0	0.1
BUS022-127_COMPR RM 1	0.6	45.7	CB022-44	1.5	1.2	0.07	0	0.1
BUS022-128_VSD FUME H(	0.6	45.7	CB022-45	4.5	3.9	0.13	0	0.2
BUS022-129_HEAT PUMP #	0.6	45.7	CB022-46	1.3	1.2	0.05	0	0.1
BUS022-13_ELEVATOR	0.6	45.7	CB022-12	6.9	5.9	0.29	0	0.2
BUS022-130_HEAT PUMP #	0.6	45.7	CB022-47	1.3	1.2	0.05	0	0.1
BUS022-131_PANEL F	0.6	45.7	CB022-48	2.2	1.9	0.08	0	0.1
BUS022-132_CHILLER SYS	0.6	45.7	CB022-49	4.3	3.8	0.13	0	0.1
BUS022-133_FUME ROOM	0.6	45.7	CB022-50	1.2	1.1	0.05	0	0.1
BUS022-134_PUMPS 3A 3E	0.6	45.7	CB022-51	1.1	0.8	0.05	0	0.1
BUS022-135_FUME ROOM	0.6	45.7	CB022-52	1.3	1.2	0.05	0	0.1
BUS022-136_FUME ROOM	0.6	45.7	CB022-53	1.3	1.2	0.05	0	0.1
BUS022-137_COOLING TO'	0.6	45.7	CB022-54	1.3	1.2	0.05	0	0.1
BUS022-139_EEB	0.6	45.7	CB022-19	5.9	4.8	0.24	0	0.2
BUS022-14_MCC1	0.6	45.7	CB022-17	10.9	8.5	0.89	0	0.4
BUS022-140	0.6	45.7	F6	11.3	8.8	2.87	1	0.8
BUS022-141_ATS	0.6	45.7	CB022-19	7.5	6.4	0.32	0	0.2
BUS022-15_BOILER ROOM	0.6	45.7	CB022-22	9.7	8.2	0.38	0	0.3
BUS022-16_MCC 2	0.6	45.7	CB022-23	10.2	8	0.35	0	0.2
BUS022-17_FUME FAN #19	0.6	45.7	F022-6	4	3.5	0.05	0	0.1
BUS022-18_15B	0.6	45.7	F022-7	4	3.5	0.12	0	0.1
BUS022-19_FAN SOUTH W	0.6	45.7	F022-8	4	3.5	0.12	0	0.1
BUS022-2_D2	0.6	45.7	F022-2	10.9	8.5	2.33	1	0.7
BUS022-20_FAN SOUTH W	0.6	45.7	F022-9	4	3.5	0.12	0	0.1
BUS022-200_EEB-2	0.6	45.7	CB022-19	5.9	4.9	0.24	0	0.2
BUS022-21_CHILLER #1	0.6	45.7	F022-10	10.1	8.5	0.30	0	0.2
BUS022-22_CHILLER #2	0.6	45.7	F022-11	10.1	8.5	0.30	0	0.2
BUS022-23_WATER PUMP	0.6	45.7	F022-12	10.3	8.7	0.31	0	0.2
BUS022-24_WATER PUMP	0.6	45.7	F022-13	5.5	4.8	0.16	0	0.2
BUS022-25_PUMP#2 BASE	0.6	45.7	F022-14	4	3.5	0.05	0	0.1
BUS022-26_PUMP #1 3RD I	0.6	45.7	F022-15	4	3.5	0.05	0	0.1
BUS022-27_GLYCOL PRIMI	0.6	45.7	F022-16	5.7	4.9	0.17	0	0.2
BUS022-28_GLYCOL STAN	0.6	45.7	F022-17	5.7	4.9	0.17	0	0.2
BUS022-31_RETURN AIR F	0.6	45.7	F022-20	4	3.5	0.12	0	0.1
BUS022-32_AIR FAN 2ND F	0.6	45.7	F022-21	7.1	6	0.09	0	0.1
BUS022-33_AIR UNIT 2ND I	0.6	45.7	F022-22	9.5	8	0.28	0	0.2
BUS022-34_AIRUNIT SOUT	0.6	45.7	F022-23	7.6	6.5	0.23	0	0.2
BUS022-35_SYS FAN #161	0.6	45.7	F022-24	2.9	2.6	0.08	0	0.1
BUS022-36_AIR UNIT MUA-	0.6	45.7	F022-25	8.8	7.5	0.11	0	0.1
BUS022-37_CIRC PUMP P5	0.6	45.7	F022-26	4	3.5	0.12	0	0.1
BUS022-39_UNKNOWN	0.6	45.7	F022-28	4	3.5	0.05	0	0.1
BUS022-40_FUME FAN #16	0.6	45.7	F022-29	2.2	2	0.06	0	0.1
BUS022-41_FUME FAN #15	0.6	45.7	F022-30	4	3.5	0.12	0	0.1
BUS022-44_157	0.6	45.7	F022-33	2.9	2.6	0.03	0	0.1
BUS022-45_FUME FAN #15	0.6	45.7	F022-34	2.9	2.6	0.08	0	0.1

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BUS022-46_156	0.6	45.7	F022-35	2.9	2.6	0.08	0	0.1
BUS022-47_MUA GLYCOL I	0.6	45.7	F022-36	2.9	2.6	0.03	0	0.1
BUS022-48_EXHST FAN #1	0.6	45.7	F022-37	2.9	2.6	0.08	0	0.1
BUS022-50_TRANSFORME	0.6	45.7	CB022-21	1.2	0.9	0.08	0	0.1
BUS022-51_MUAU GLYCOI	0.6	45.7	F022-40	4	3.5	0.12	0	0.1
BUS022-53_MCC1A	0.6	45.7	CB022-24	4.1	3.5	0.17	0	0.1
BUS022-54_L.E.S. FAN #17	0.6	45.7	F022-43	1.9	1.7	0.02	0	0.1
BUS022-55_CANOPY FAN :	0.6	45.7	F022-44	1.9	1.7	0.02	0	0.1
BUS022-56_L.E.S. FAN #17	0.6	45.7	F022-45	1.9	1.7	0.02	0	0.1
BUS022-57_FUME FAN #17	0.6	45.7	F022-46	1.9	1.7	0.02	0	0.1
BUS022-58_FUME FAN #17	0.6	45.7	F022-47	1.6	1.4	0.02	0	0.1
BUS022-59_30-270-47-H	0.6	45.7	F022-48	1.6	1.4	0.02	0	0.1
BUS022-60_EXHAUST RM :	0.6	45.7	F022-49	1.9	1.7	0.02	0	0.1
BUS022-61_EXHAUST RM :	0.6	45.7	F022-50	1.9	1.7	0.02	0	0.1
BUS022-62_30-270-67-H	0.6	45.7	F022-51	1.6	1.4	0.02	0	0.1
BUS022-63_30-270-68-H	0.6	45.7	F022-52	1.9	1.7	0.02	0	0.1
BUS022-64_30-270-65-H	0.6	45.7	F022-53	1.9	1.7	0.02	0	0.1
BUS022-65_30-270-66-H	0.6	45.7	F022-54	2.3	2.1	0.03	0	0.1
BUS022-66_30-270-37-H	0.6	45.7	F022-55	2.3	2.1	0.03	0	0.1
BUS022-67_30-270-64-H	0.6	45.7	F022-56	1.9	1.7	0.02	0	0.1
BUS022-68_30-270-39-H	0.6	45.7	F022-57	1.6	1.4	0.02	0	0.1
BUS022-69_30-270-69-H	0.6	45.7	F022-58	2.3	2.1	0.03	0	0.1
BUS022-70_30-270-35-H	0.6	45.7	F022-59	1.9	1.7	0.02	0	0.1
BUS022-71_TRANSFORME	0.6	45.7	F022-60	2.5	2.3	0.03	0	0.1
BUS022-72_30-270-20-H	0.6	45.7	F022-61	1.6	1.4	0.02	0	0.1
BUS022-73_30-270-22-H	0.6	45.7	F022-62	1.6	1.4	0.02	0	0.1
BUS022-74_30-270-70-H	0.6	45.7	F022-63	1.6	1.4	0.02	0	0.1
BUS022-75_FUME FAN #17	0.6	45.7	F022-64	1.9	1.7	0.02	0	0.1
BUS022-76_EF-105	0.6	45.7	F022-65	1.6	1.4	0.02	0	0.1
BUS022-77_EF-111	0.6	45.7	F022-66	1.9	1.7	0.02	0	0.1
BUS022-78_EF-112	0.6	45.7	F022-67	1.9	1.7	0.02	0	0.1
BUS022-79_PANEL PB	0.6	45.7	CB022-16	6.2	5.1	0.24	0	0.2
BUS022-8_HOT WATER TA	0.6	45.7	CB022-5	4	3.5	0.18	0	0.2
BUS022-80_AIR COND RM	0.6	45.7	CB022-25	4.3	3.8	0.19	0	0.2
BUS022-81_MUA-1	0.6	45.7	CB022-7	3.9	3.4	0.18	0	0.2
BUS022-82_CIRC PUMP P-	0.6	45.7	CB022-7	3.9	3.4	0.18	0	0.2
BUS022-83_FUME FAN #19	0.6	45.7	F022-68	2.8	2.5	0.08	0	0.1
BUS022-84_15B	0.6	45.7	F022-69	2.8	2.5	0.08	0	0.1
BUS022-85_FAN SOUTH W	0.6	45.7	F022-70	3.9	3.4	0.11	0	0.1
BUS022-86_FAN SOUTH W	0.6	45.7	F022-71	3.9	3.4	0.11	0	0.1
BUS022-87_CHILLER #1	0.6	45.7	F022-72	2.8	2.5	0.08	0	0.1
BUS022-88_CHILLER #2	0.6	45.7	F022-73	2.2	2	0.06	0	0.1
BUS022-9_B10 MAT. 90	0.6	45.7	CB022-6	2.7	2.4	0.14	0	0.2
BUS022-90_WATER PUMP	0.6	45.7	F022-75	2.2	2	0.06	0	0.1
BUS022-91_PUMP#2 BASE	0.6	45.7	F022-76	2.8	2.5	0.08	0	0.1
BUS022-92_PUMP #1 3RD I	0.6	45.7	F022-77	2.8	2.5	0.08	0	0.1

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Equipment name	Voltage (kV)	Working distance (cm)	Upstream protection	Fault current (kA)	Arcing current (kA)	Incident energy (cal/cm²)	Energy levels	Arc flash boundary (m)
BUS022-93_GLYCOL PUMF	0.6	45.7	F022-78	3.9	3.4	0.11	0	0.1
BUS022-94_GLYCOL PUMF	0.6	45.7	F022-79	3.9	3.4	0.05	0	0.1
BUS022-95_COOLING TOW	0.6	45.7	F022-80	3.9	3.4	0.11	0	0.1
BUS022-96_COOLING TOW	0.6	45.7	F022-81	3.9	3.4	0.11	0	0.1
BUS022-97_RETURN AIR F	0.6	45.7	F022-82	2.8	2.5	0.08	0	0.1
BUS022-98_SUPPLY FAN 2	0.6	45.7	F022-83	3.9	3.4	0.05	0	0.1
BUS022-99_LOC FAN #161	0.6	45.7	F022-86	2.2	2	0.03	0	0.1
BUS023-1_600V MAIN SWI	0.6	45.7	CB020-15	5.4	4.7	0.29	0	0.2
BUS023-2_SPLITTER	0.6	45.7	F023-1	5.4	4.7	0.16	0	0.2
BUS023-4_600V SW. NO.2	0.6	45.7	F023-1	5.2	4.5	0.15	0	0.2
BUS037-2_BUILDING-34	0.6	45.7	CB040-1	3.5	3	0.89	0	0.4
BUS037-3_TRANSF_75VKA	0.6	45.7	CB040-1	3.4	3	0.89	0	0.4
BUS037-4_MAIN	0.6	45.7	CB040-1	3.5	3.1	0.90	0	0.4
=Données!A291	0.6	45.7	CB040-4	3	2.3	0.16	0	0.2
BUS047-2_TRANSFORMEF	0.6	45.7	F047-1	3	2.7	0.07	0	0.1
BUS047-3_TRANSFORMEF	0.6	45.7	F047-1	2.9	2.6	0.07	0	0.1
BUS049-1_MAIN	0.208	45.7	LB-31	6.5	3.4	22.23	3	2
BUS050-1_MAIN	0.6	45.7	LB-35	7.6	5.2	19.26	3	2.5
BUS050-13_COMPRESSOF	0.6	45.7	CB050-5	1.9	1.7	0.47	0	0.3
BUS050-14_VAULT SUPPL	0.6	45.7	CB050-10	5.7	4.9	0.29	0	0.2
BUS050-15_T4	0.6	45.7	CB050-10	5.6	4.8	0.29	0	0.2
BUS050-16_T3	0.6	45.7	CB050-10	5.6	4.8	0.29	0	0.2
BUS050-17_T2	0.6	45.7	CB050-10	5.6	4.8	0.29	0	0.2
BUS050-6_PANEL - PP	0.6	45.7	CB050-5	7.3	5	0.33	0	0.2
BUS050-7_PANEL - PC	0.208	45.7	CB050-4	7.9	3.7	22.66	3	2.7
BUS050-8_PANEL - PB	0.208	45.7	CB050-7	7.8	3.7	22.39	3	2.7
BUS050-9_PANEL - PA	0.208	45.7	CB050-6	11.3	4.7	29.67	4	3.2
BUS055-10_ELEVATOR	0.6	45.7	CB055-18	6.7	5.8	0.25	0	0.2
BUS055-11_AHU-2	0.6	45.7	CB055-17	4.7	4.1	0.17	0	0.2
BUS055-12_P-3	0.6	45.7	CB055-16	3.7	3.3	0.13	0	0.2
BUS055-13_P-1	0.6	45.7	CB055-15	3.7	3.3	0.13	0	0.2
BUS055-14_EF 3 600V	0.6	45.7	CB055-14	3.7	3.3	0.13	0	0.2
BUS055-15_P-2	0.6	45.7	CB055-13	3.7	3.3	0.13	0	0.2
BUS055-2_D.P. MECHANIC	0.6	45.7	CB056-2	7.7	6.2	0.29	0	0.2
BUS055-4_MAIN BUILDG 0!	0.6	61	CB056-2	8.3	6.4	0.19	0	0.2
BUS055-9_AHU-1	0.6	45.7	CB055-12	6.7	5.8	0.25	0	0.2
BUS056-1_BUILDING 56 M/	0.6	45.7	LB-8	9	6.5	6.89	2	1.1
BUS056-3	0.6	45.7	CB056-3	6.8	5.8	0.29	0	0.2
BUS057-10_PUMP 3	0.6	45.7	CB057-4	4.5	3.9	0.18	0	0.2
BUS057-11_PUMP 4	0.6	45.7	CB057-4	4.5	3.9	0.18	0	0.2
BUS057-12_PANEL DP1	0.6	45.7	CB056-4	7.6	6.1	0.29	0	0.2
BUS057-2_ROOF TOP UNIT	0.6	45.7	CB057-2	3.9	3.4	0.16	0	0.2
BUS057-3_ELEVATOR	0.6	45.7	CB057-3	6.2	5.3	0.21	0	0.2
BUS057-4_SPLITTER 600V	0.6	45.7	CB057-4	4.8	4.1	0.19	0	0.2
BUS057-5_HUMIDIFIER	0.6	45.7	CB057-5	3.8	3.3	0.14	0	0.2
BUS057-6_DP-2	0.6	45.7	CB057-6	6.6	5.7	0.25	0	0.2

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Equipment name	Voltage (kV)	Working distance (cm)	Upstream protection	Fault current (kA)	Arcing current (kA)	Incident energy (cal/cm²)	Energy levels	Arc flash boundary (m)
BUS057-7_AIR COMPRESS	0.6	45.7	CB057-4	4.5	3.9	0.18	0	0.2
BUS057-8_PUMP P1	0.6	45.7	CB057-4	4.5	3.9	0.18	0	0.2
BUS057-9_PUMP P2	0.6	45.7	CB057-4	4.5	3.9	0.18	0	0.2
BUS059-1_MAIN SWITCH	0.208	45.7	Fuse16	6.9	3.5	23.28	3	2
BUS059-3_PANEL DP1	0.208	45.7	F059-1	2.5	1.7	9.47	3	1.6
BUS060-1_TRANSFER SWI	0.208	45.7	CB059-1	1.9	1.4	8.37	3	1.2
BUS072-1_MAIN DISCONNI	0.208	45.7	Fuse18	8.5	3.9	23.85	3	2.8
BUS072-3_PANEL CDP-1	0.208	45.7	F072-1	7.4	3	2.86	1	0.8
BUS074-1_MAIN DISCONNI	0.208	45.7	Fuse18	7.1	3.6	23.80	3	2
BUS074-3_PANEL CDP-1	0.208	45.7	F074-1	5.9	3	18.14	3	2.4
BUS075-1_MAIN	0.208	45.7	LB-28	9.4	3.5	21.57	3	2.7
BUS076-1_MAIN SWITCH	0.6	45.7	LB-25	5.4	4	10.05	3	1.3
BUS076-10_ATS2	0.6	45.7	F076-3	4.4	3.9	0.05	0	0.1
BUS076-11_ATS-LEAD	0.6	45.7	F076-1	5	4.3	0.15	0	0.2
BUS076-12_EMI	0.6	45.7	F076-3	3.7	3.3	0.04	0	0.1
BUS076-2_SPLITTER	0.6	45.7	F076-1	5.4	4.7	0.16	0	0.2
BUS076-3_FIRE PUMPS	0.6	45.7	F076-1	5.4	4.7	0.16	0	0.2
BUS076-4_ATS#2	0.6	45.7	F076-1	5.4	4.7	0.16	0	0.2
BUS076-5_MAIN_PANEL "A	0.6	45.7	F076-1	5.4	4.7	0.16	0	0.2
BUS076-6_PANEL "A"	0.6	45.7	F076-4	5	4.1	0.13	0	0.1
BUS082-1_MAIN	0.208	45.7	Fuse20	5.3	2.9	18.92	3	1.8
BUS085-1_MAIN	0.208	45.7	LB-28	6.4	3.2	19.34	3	2.5
BUS088_ATS-2	0.6	45.7	CB088-9	5.9	5.1	0.23	0	0.2
BUS088_ATS-2A	0.6	45.7	CBK94-2	4.4	3.8	1.58	1	0.5
BUS088-14_PANEL Q	0.6	45.7	CB088-9	5.8	5	0.22	0	0.2
BUS088-15_UPSTAIRS AC	0.6	45.7	CB088-4	1.6	1.4	0.06	0	0.1
BUS088-16_UPSTAITR AHU	0.6	45.7	CB088-6	1.6	1.4	0.07	0	0.1
BUS088-2_600 VOLTS	0.6	45.7	CB088-10	4.1	3.6	0.13	0	0.2
BUS088-3_SUPPLY FAN N(	0.6	45.7	CB088-10	3.8	3.3	0.13	0	0.1
BUS088-4_SUPPLY FAN N(	0.6	45.7	CB088-10	3.8	3.3	0.13	0	0.1
BUS088-5_PANEL H	0.6	45.7	CB088-5	4.6	4	0.18	0	0.2
BUS088-6	0.6	45.7	CBK94-5	6.1	5	0.28	0	0.2
BUS088-7_EMERGENCY P	0.6	45.7	CB088-9	5.8	5	0.23	0	0.2
BUS088-8_HAMER MILL	0.6	45.7	CB088-9	5.8	5	0.22	0	0.2
BUS088-9_75 KVA TRANSF	0.6	45.7	CB088-9	5.8	5	0.22	0	0.2
BUS091-10_MAIN	0.6	45.7	LB-25	7.2	4.9	7.87	2	1.4
BUS091-2_SPLITTER	0.208	45.7	CB091-5	8.6	3.6	1.97	1	0.6
BUS091-3_BUILDING - 91A	0.208	45.7	CB091-5	8.5	3.5	1.98	1	0.6
BUS091-4_BUILDING - 91	0.208	45.7	CB091-5	8.5	3.5	1.98	1	0.6
BUS091-5A_ATS-1	0.6	45.7	CB091-7	5.3	4.6	0.23	0	0.2
BUS091-8A_ATS-1A	0.6	45.7	CB091-3	2.8	2.5	0.14	0	0.2
BUS094-1_MAIN	0.6	45.7	CBK94-2	7.2	6.1	2.64	1	0.7
BUS095-1_600V. MAIN SW.	0.6	45.7	CBK94-3	6.3	5.4	0.19	0	0.2
BUS095-2_MAIN SWITCH	0.6	45.7	F095-1	6.3	5.4	0.08	0	0.1
BUS095-3_05-200-03	0.6	45.7	F095-1	6.1	5.3	0.07	0	0.1
BUS095-4_05-200-02	0.6	45.7	F095-1	6.1	5.3	0.07	0	0.1

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Equipment name	Voltage (kV)	Working distance (cm)	Upstream protection	Fault current (kA)	Arcing current (kA)	Incident energy (cal/cm²)	Energy levels	Arc flash boundary (m)
BUS098-1_600V. JUNCTIOI	0.6	45.7	CBK94-6	2.4	2.1	0.10	0	0.1
BUS098-3_TRANSFORMAT	0.6	45.7	CB098-1	2.3	2.1	0.07	0	0.1
BUS098-5_WORK SHOP	0.6	45.7	CB098-0	1.8	1.7	0.08	0	0.1
BUS098-9	0.6	45.7	CBK94-6	2.4	2.1	0.09	0	0.1
BUS099-1_MAIN SW BDLG	0.6	45.7	CBK94-4	6.5	5.5	0.32	0	0.2
BUS099-10_600 V 100 A	0.6	45.7	F099-3	6.2	5.3	0.18	0	0.2
BUS099-11_6 KVA TRANSF	0.6	45.7	F099-3	5.7	4.9	0.17	0	0.2
BUS099-12_COOLING TOW	0.6	45.7	F099-3	5.9	5.1	0.17	0	0.2
BUS099-14_P-1 PUMP F 30	0.6	45.7	F099-3	5.7	4.9	0.17	0	0.2
BUS099-15_MAIN FEED	0.6	45.7	CBK94-6	3.4	3	0.14	0	0.2
BUS099-16_BLDG. 97.98.1(	0.6	45.7	CBK94-6	3.4	3	0.14	0	0.2
BUS099-17_BLDG.97.98	0.6	45.7	CBK94-6	3.4	3	0.14	0	0.2
BUS099-18_BLDG. 104	0.6	45.7	CBK94-6	3.4	3	0.14	0	0.2
BUS099-2_SPLITTER 600 v	0.6	45.7	CBK94-4	6.4	5.5	0.31	0	0.2
BUS099-20_300KVA-SEC-X	0.208	45.7	F099-4	8.7	4.2	28.12	4	2.2
BUS099-3_DISC 300 KVA X	0.6	45.7	CBK94-4	6.4	5.5	0.31	0	0.2
BUS099-4	0.6	45.7	CBK94-4	6.3	5.5	0.31	0	0.2
BUS099-5_05-200-03	0.6	45.7	CBK94-4	6.3	5.4	0.31	0	0.2
BUS099-6_SPLITTER 115 A	0.6	45.7	F099-2	4.6	4	0.11	0	0.1
BUS099-7_DUST EXTRACT	0.6	45.7	F099-2	4.4	3.8	0.11	0	0.1
BUS099-8_ROOF UNIT	0.6	45.7	F099-2	4.3	3.7	0.10	0	0.1
BUS099-9_COMPRESSOR	0.6	45.7	F099-2	4.3	3.7	0.10	0	0.1
BUS110_MAIN	0.6	45.7	LB-18	8	5.8	18.42	3	1.8
BUS110-2_600 V MAIN SW.	0.6	45.7	CB110-3	7	6	0.30	0	0.2
BUS110-3_05-215-1	0.6	45.7	Fuse3	6.8	5	0.14	0	0.2
BUS110-4_LIGHTING ROOI	0.6	45.7	Fuse3	6.4	4.7	0.13	0	0.2
BUS110-5_GROWTH CHAM	0.6	45.7	Fuse3	6.6	4.8	0.13	0	0.2
BUS110-6_AIR COMPRESS	0.6	45.7	Fuse3	6.6	4.8	0.13	0	0.2
BUS110-7_LIGHTING ROOI	0.6	45.7	Fuse3	6.4	4.7	0.13	0	0.2
BUS114-1_MAIN SWITCH -	0.6	45.7	CB110-5	6.1	5.2	0.27	0	0.2
BUS114-10_DISCONNECT	0.6	45.7	CB114-14	1	0.8	0.73	0	0.4
BUS114-11	0.6	45.7	CB114-1	1.2	0.9	0.11	0	0.1
BUS114-12	0.6	45.7	CB114-3	1.2	0.9	0.11	0	0.1
BUS114-13	0.6	45.7	CB114-4	1.2	0.9	0.11	0	0.1
BUS114-14	0.6	45.7	FUSE114-2	3.1	2.3	0.06	0	0.1
BUS114-15	0.6	45.7	CB114-6	1.2	0.9	0.11	0	0.1
BUS114-16	0.6	45.7	CB114-7	1.2	0.9	0.11	0	0.1
BUS114-17	0.6	45.7	FUSE114-2	1.2	0.9	0.32	0	0.2
BUS114-18	0.6	45.7	CB114-9	1.2	0.9	0.11	0	0.1
BUS114-19	0.6	45.7	CB114-10	1.2	0.9	0.11	0	0.1
BUS114-2_SPLITTER	0.6	45.7	F114-1	6.1	5.2	0.07	0	0.1
BUS114-20	0.6	45.7	FUSE114-2	3.1	2.3	0.06	0	0.1
BUS114-21	0.6	45.7	CB114-12	1.2	0.9	0.11	0	0.1
BUS114-22	0.6	45.7	CB114-13	1.2	1.1	0.08	0	0.1
BUS114-3_PANEL P DISCC	0.6	45.7	F114-1	6	5.2	0.07	0	0.1
BUS114-4_PANEL P	0.6	45.7	FUSE114-2	5.8	4.7	0.06	0	0.1

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Equipment name	Voltage (kV)	Working distance (cm)	Upstream protection	Fault current (kA)	Arcing current (kA)	Incident energy (cal/cm²)	Energy levels	Arc flash boundary (m)
BUS114-5_SURGE SUPPRI	0.6	45.7	F114-1	6	5.1	0.07	0	0.1
BUS114-7_PRESSURE WA:	0.6	45.7	F114-1	5.8	5	0.07	0	0.1
BUS114-9_DISCONNECT	0.6	45.7	FUSE114-2	2	1.8	0.05	0	0.1
BUS134-1_MAIN	0.208	45.7	CB072-1	2.2	1.5	8.52	3	1.5
BUS136-2_PANEL 452-08	0.208	45.7	F136-1	4	2.3	13.55	3	2
BUS140-1_MAIN	0.208	45.7	LB-5	13	5.7	38.64	4	2.6
BUS142-1_MAIN SW-FROM	0.6	45.7	CB110-2	4.1	3.6	0.19	0	0.2
BUS142-2_TRANSFO DISC	0.6	45.7	CB110-2	4	3.5	0.18	0	0.2
BUS143-10	0.6	45.7	CB143-16	2	1.8	0.10	0	0.1
BUS143-11	0.6	45.7	CB143-17	2	1.8	0.10	0	0.1
BUS143-12	0.6	45.7	CB143-18	2	1.8	0.10	0	0.1
BUS143-13_05-200-03	0.6	45.7	CB143-1	3.5	3.1	0.18	0	0.2
BUS143-14_SPLITTER-PA	0.6	45.7	CB143-1	3.5	3.1	0.18	0	0.2
BUS143-15_R.F. #1R	0.6	45.7	CB143-1	3.3	2.9	0.17	0	0.2
BUS143-16_R.F. #3R	0.6	45.7	CB143-1	3.3	2.9	0.17	0	0.2
BUS143-17_R.F. #2R	0.6	45.7	CB143-1	3.3	2.9	0.17	0	0.2
BUS143-18_S.F. #1S	0.6	45.7	CB143-1	3.3	2.9	0.17	0	0.2
BUS143-19_S.F. #3S	0.6	45.7	CB143-1	3.3	2.9	0.17	0	0.2
BUS143-2_PANEL LA	0.6	45.7	CB143-2	3.8	3.3	0.21	0	0.2
BUS143-20_S.F. #2S	0.6	45.7	CB143-1	3.3	2.9	0.17	0	0.2
BUS143-21_HUMIDIFICATE	0.6	45.7	CB143-1	3.4	3	0.17	0	0.2
BUS143-22_05-200-04	0.6	45.7	CB143-5	3.7	3.2	0.19	0	0.2
BUS143-23_SPLITTER-PC	0.6	45.7	CB143-5	3.6	3.2	0.19	0	0.2
BUS143-24_PUMP #1	0.6	45.7	CB143-5	3.4	3	0.18	0	0.2
BUS143-25_PUMP #2	0.6	45.7	CB143-5	3.4	3	0.18	0	0.2
BUS143-26_CONTROL CON	0.6	45.7	CB143-5	3.4	3	0.18	0	0.2
BUS143-27_AIR COMP.	0.6	45.7	CB143-5	3.4	3	0.18	0	0.2
BUS143-28_MAIN SWITCHI	0.6	45.7	CB143-6	3.3	2.9	0.17	0	0.2
BUS143-29_SPLITTER	0.6	45.7	CB143-6	3.2	2.8	0.17	0	0.2
BUS143-30_DUST COLL. #:	0.6	45.7	CB143-6	3	2.7	0.16	0	0.2
BUS143-31_DUST COLL. #:	0.6	45.7	CB143-6	3	2.7	0.16	0	0.2
BUS143-32_DUST COLL. #:	0.6	45.7	CB143-6	3	2.7	0.16	0	0.2
BUS143-33_MAIN DISCONN	0.6	45.7	CB143-7	3.6	3.2	0.17	0	0.2
BUS143-34_SPLITTER-PE	0.6	45.7	CB143-7	3.5	3.1	0.16	0	0.2
BUS143-35_DUST COLLEC	0.6	45.7	CB143-7	3.4	3	0.16	0	0.2
BUS143-36_DUST COLLEC	0.6	45.7	CB143-7	3.4	3	0.16	0	0.2
BUS143-38_DUST COLL C5	0.6	45.7	CB143-7	2.6	2.3	0.13	0	0.1
BUS143-39_DUST COLL C4	0.6	45.7	CB143-7	2.6	2.3	0.13	0	0.1
BUS143-4	0.6	45.7	CB143-10	2	1.8	0.10	0	0.1
BUS143-40_MAIN	0.6	45.7	LB-14	4	3	6.61	2	1.1
BUS143-5	0.6	45.7	CB143-11	2	1.8	0.10	0	0.1
BUS143-6	0.6	45.7	CB143-12	2.4	2.2	0.13	0	0.2
BUS143-7	0.6	45.7	CB143-13	2	1.8	0.10	0	0.1
BUS143-8	0.6	45.7	CB143-14	2	1.8	0.10	0	0.1
BUS143-9	0.6	45.7	CB143-15	2.4	2.2	0.13	0	0.2
BUS151-1_MAIN SWITCH	0.6	45.7	CB091-6	2.5	2.2	0.14	0	0.2

DESSAU

Central Experimental Farm - 960 Carling Avenue, Ottawa,Ontario

Arc flash study

Equipment name	Voltage (kV)	Working distance (cm)	Upstream protection	Fault current (kA)	Arcing current (kA)	Incident energy (cal/cm²)	Energy levels	Arc flash boundary (m)
BUS151-2_SPLITTER	0.6	45.7	CB091-6	2.5	2.2	0.14	0	0.2
BUS151-3_TRANSFORMER	0.6	45.7	CB091-6	2.5	2.2	0.14	0	0.2
BUS151-4	0.6	45.7	CB091-6	2.5	2.2	0.14	0	0.2
BUS151-6_SPLITTER	0.6	45.7	F151-3	2.3	2.1	0.03	0	0.1
BUS151-7_TRANSFORMER	0.6	45.7	F151-3	2.2	2	0.03	0	0.1
BUS151-8_CONVEYOR MO	0.6	45.7	F151-3	2.2	2	0.03	0	0.1
BUSK94-1_E-K94-K94-P	0.6	61	LB-11	8.1	5.3	11.87	3	2.9
PS1-T1	12.8	45.7	LB-2	20	19.2	0.79	0	0.4
PS2-T2	12.8	45.7	LB-5	19.6	18.8	0.77	0	0.4
PS3-T3	12.8	45.7	LB-8	19.3	18.5	0.76	0	0.4
PS4-T4	12.8	45.7	LB-11	19.1	18.3	0.75	0	0.4
PS5-T5	12.8	45.7	LB-14	18.6	17.9	0.74	0	0.4
PS6-T6	12.8	45.7	LB-18	18.4	17.7	0.73	0	0.4
PS7-T7	12.8	45.7	LB-21	18.5	17.8	0.73	0	0.4
PS8-T8	12.8	45.7	LB-25	18.5	17.8	0.73	0	0.4
PS9-T9	12.8	45.7	LB-28	18.6	17.9	0.74	0	0.4
PS10-T10	12.8	45.7	LB-35	19	18.3	0.75	0	0.4
PS11-T11	12.8	45.7	LB-31	18.9	18.2	0.75	0	0.4
PS-1	12.8	45.7	CB2	20.2	19.4	56.20	> 4	3.1
PS-2	12.8	45.7	CB2	19.8	19	42.69	> 4	2.7
PS-3	12.8	45.7	CB2	19.5	18.8	37.32	4	2.5
PS-4	12.8	45.7	CB2	19.3	18.5	31.52	4	2.3
PS-5	12.8	45.7	CB2	18.8	18	20.75	3	1.9
PS-6	12.8	45.7	CB2	18.7	18	18.78	3	1.8
PS-7	12.8	45.7	CB4	18.7	18	17.09	3	1.7
PS-8	12.8	45.7	CB4	18.7	18	18.83	3	1.8
PS-9	12.8	45.7	CB4	18.8	18.1	22.16	3	2
PS-10	12.8	45.7	CB4	19.3	18.5	32.78	4	2.4
PS-11	12.8	45.7	CB4	19.1	18.3	28.51	4	2.2
PT145	13.2	45.7	Fuse16	3.1	3.1	0.09	0	0.1
PT146	13.2	45.7	Fuse18	3.1	3	0.10	0	0.1
PT221	12.8	45.7	Fuse19	3.3	3.2	0.09	0	0.1
SG-1_PRIM_XFO	12.8	91.4	CB1	20.3	19.5	13.19	3	10.7
SG-1_SEC_XFO	0.6	61		18.3	13	55.95	> 4	8.3
SPLTR037-1_SPLITTER	0.6	45.7	CB040-1	3.5	3.1	0.89	0	0.4
SPLTR047-1_SPLITTER	0.6	45.7	F047-1	3	2.7	0.07	0	0.1
SUBSTATION-3_PANEL-SP	0.6	45.7	CB020-15	9.5	7.5	0.41	0	0.2
T-1000	12.8	45.7	Fuse20	3.3	3.2	0.09	0	0.1

DESSAU

Annexe 2 Short-circuit results

DESSAU

Project:	CEF - ARC FLASH STUDY	ETAP		Page:	1
Location:	Central Experimental Farm	12.5.0C		Date:	07-02-2014
Contract:	B-0000430			SN:	DESSAU-INC
Engineer:			Study Case: SC	Revision:	Base
Filename:	20140203_B-0000430			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.	
BLDG#20_MAIN BUS	12.800	F9	5 cy Tot CB	3.0	21.398	3.5	1.000	21.398	15.500		9.290	11.250	*
		F10	5 cy Tot CB	3.0	21.398	3.5	1.000	21.398	15.500		9.290	11.250	*
BLDG#22	12.800	F6	5 cy Tot CB	3.0	20.805	3.4	1.000	20.805	15.500		9.290	11.250	*
BUS012-1_PANEL SPP1	0.600	F012-1	Fuse		4.470	0.5	1.000	4.470	0.600	20.00	200.000	200.000	
BUS012-2	0.600				4.391	0.5							
BUS012-3_CIRC PUMP	0.600				4.115	0.5							
BUS012-4_AC	0.600				4.213	0.5							
BUS012-5_TRANSFORMER	0.600				4.360	0.5							
BUS018-1	0.600	CB018-1	Molded Case		9.883	1.6	1.000	9.883	0.600	20.00	25.000	25.000	
BUS018-2	0.600	CB018-4	Molded Case		9.745	1.6	1.000	9.745	0.600	30.00	18.000	18.000	
BUS018-3_SPLITTER SP1	0.600				8.534	1.2							
BUS018-4_AHU#1	0.600				7.761	1.0							
BUS018-5_H-1	0.600				8.035	1.0							
BUS018-6_CU-1	0.600	F012-5	Fuse		8.035	1.0	1.000	8.035	0.600	15.00	200.000	200.000	
BUS018-7_VENT	0.600				6.016	0.7							
BUS019-2_SPLITTER	0.600				4.328	0.3							
BUS019-3_PANEL A	0.600				4.146	0.3							
BUS019-4_RADIATOR FANS	0.600				4.146	0.3							
BUS019-5_HEATER RAD. ROOM	0.600				4.046	0.3							
BUS019-6	0.600				4.046	0.3							
BUS019-7_FUEL PUMPS	0.600				4.046	0.3							
BUS019-8_MAIN SWITCH	0.600	Fuse17	Fuse		4.367	0.3	1.000	4.367	0.600	15.00	200.000	200.000	
BUS020-1_SWITCHGEAR #1	0.600				23.972	5.8							
BUS020-2_SWITCHGEAR#2	0.600				23.824	5.8							
BUS020-5_PANEL CDP-E1	0.600	CB020-10	Molded Case		22.491	4.7	1.000	22.491	0.600	20.00	50.000	50.000	
		CB020-11	Molded Case		22.491	4.7	1.000	22.491	0.600	20.00	50.000	50.000	
		CB020-12	Molded Case		22.491	4.7	1.000	22.491	0.600	20.00	50.000	50.000	
		CB020-13	Molded Case		22.491	4.7	1.000	22.491	0.600	20.00	50.000	50.000	
		CB020-14	Molded Case		22.491	4.7	1.000	22.491	0.600	20.00	50.000	50.000	
BUS020-6_PANEL PP1	0.600	CB020-15	MoldedFused		21.607	4.2	1.000	21.607	0.600	20.00	100.000	100.000	
		CB020-16	MoldedFused		21.607	4.2	1.000	21.607	0.600	20.00	100.000	100.000	

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.
BUS020-7_PANEL PP2	0.600	CB020-21	MoldedFused		22.168	4.5	1.000	22.168	0.600	20.00	200.000	200.000
		CB020-22	MoldedFused		22.168	4.5	1.000	22.168	0.600	20.00	200.000	200.000
		CB020-23	MoldedFused		22.168	4.5	1.000	22.168	0.600	20.00	200.000	200.000
		CB020-24	MoldedFused		22.168	4.5	1.000	22.168	0.600	20.00	200.000	200.000
		CB020-25	MoldedFused		22.168	4.5	1.000	22.168	0.600	20.00	200.000	200.000
		CB020-26	MoldedFused		22.168	4.5	1.000	22.168	0.600	20.00	200.000	200.000
		CB020-27	MoldedFused		22.168	4.5	1.000	22.168	0.600	20.00	200.000	200.000
BUS020-8_SPLITTER	0.600				14.789	2.2						
BUS020-9_FEED 30KVA TRANS	0.600				14.721	2.2						
BUS020-10_75 KVA TRANS	0.600				14.721	2.2						
BUS020-11_75 KVA TRANSF	0.600				14.721	2.2						
BUS020-12_150 KVA TRANSF	0.600	F020-1	Fuse		14.721	2.2	1.000	14.721	0.600	15.00	200.000	200.000
BUS020-13_PANEL - C	0.208				6.810	1.1						
BUS020-14_SPLITTER B14	0.600				14.332	1.2						
BUS020-15_WATER PUMP #1	0.600				14.076	1.2						
BUS020-16_WATER PUMP #2	0.600				12.261	0.9						
BUS020-17_COND PUMP #2	0.600				12.261	0.9						
BUS020-18_COND PUMP #1	0.600				12.980	1.0						
BUS020-19_UNKNOWN	0.600				12.980	1.0						
BUS020-20_EPO CONTACTOR	0.600	F020-2	Fuse		16.289	2.4	1.000	16.289	0.600	15.00	200.000	200.000
BUS020-21_PANEL PP2A	0.600	CB020-28	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000
		CB020-29	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000
		CB020-30	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000
		CB020-31	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000
		CB020-32	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000
		CB020-33	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000
		CB020-34	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000
		CB020-35	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000
		CB020-36	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000
		CB020-37	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000
		CB020-38	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000
		CB020-39	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000
		CB020-40	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000

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.	
BUS020-21_PANEL PP2A		CB020-42	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000	
		CB020-43	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000	
		CB020-44	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000	
		CB020-45	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000	
		CB020-46	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000	
		CB020-47	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000	
		CB020-48	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000	
		CB020-49	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000	
		CB020-50	Molded Case		15.649	2.2	1.000	15.649	0.600	30.00	18.000	18.000	
BUS020-44_PANEL P3	0.600				15.294	1.7							
BUS020-46_PANEL 5B	0.600	CB020-236	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-237	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-234	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-233	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-232	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-231	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-230	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-229	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-228	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-224	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-219	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-218	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
BUS020-65_PANEL P2	0.600				16.537	2.5							
BUS020-66_PANEL P4	0.600	CB020-73	Molded Case		16.406	1.9	1.000	16.406	0.600	30.00	14.000	14.000	*
		CB020-74	Molded Case		16.406	1.9	1.000	16.406	0.600	30.00	14.000	14.000	*
		CB020-76	Molded Case		16.406	1.9	1.000	16.406	0.600	30.00	14.000	14.000	*
		CB020-77	Molded Case		16.406	1.9	1.000	16.406	0.600	30.00	14.000	14.000	*
		CB020-78	Molded Case		16.406	1.9	1.000	16.406	0.600	30.00	14.000	14.000	*
BUS020-68_A C 18	0.600				12.006	1.0							
BUS020-69_TRANS LL9	0.600				14.783	1.6							
BUS020-71_TRANSFORMER LL7	0.600				5.107	0.3							
BUS020-72_TRANSFORMER LL8	0.600				12.006	1.0							
BUS020-73_TRANSFORMER LL9	0.600				5.107	0.3							

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.	
BUS020-74_PANEL P6	0.600	CB020-79	Molded Case		19.411	3.0	1.000	19.411	0.600	30.00	14.000	14.000	*
		CB020-82	Molded Case		19.411	3.0	1.000	19.411	0.600	30.00	14.000	14.000	*
		CB020-84	Molded Case		19.411	3.0	1.000	19.411	0.600	30.00	14.000	14.000	*
BUS020-75	0.600				5.468	0.3							
BUS020-78	0.600				10.469	0.7							
BUS020-80	0.600				14.019	1.1							
BUS020-82_CAFETERIA PANEL	0.600				19.188	2.8							
BUS020-83_PANEL CDP1	0.600	CB020-87	Molded Case		15.671	2.7	1.000	15.671	0.600	30.00	18.000	18.000	
		CB020-88	Molded Case		15.671	2.7	1.000	15.671	0.600	30.00	18.000	18.000	
		CB020-89	Molded Case		15.671	2.7	1.000	15.671	0.600	30.00	18.000	18.000	
		CB020-90	Molded Case		15.671	2.7	1.000	15.671	0.600	30.00	18.000	18.000	
		CB020-91	Molded Case		15.671	2.7	1.000	15.671	0.600	30.00	18.000	18.000	
		CB020-92	Molded Case		15.671	2.7	1.000	15.671	0.600	30.00	18.000	18.000	
		CB020-93	Molded Case		15.671	2.7	1.000	15.671	0.600	30.00	18.000	18.000	
		CB020-94	Molded Case		15.671	2.7	1.000	15.671	0.600	30.00	18.000	18.000	
		CB020-96	Molded Case		15.671	2.7	1.000	15.671	0.600	30.00	18.000	18.000	
		CB020-97	Molded Case		15.671	2.7	1.000	15.671	0.600	30.00	18.000	18.000	
		CB020-98	Molded Case		15.671	2.7	1.000	15.671	0.600	30.00	18.000	18.000	
		CB020-99	Molded Case		15.671	2.7	1.000	15.671	0.600	30.00	18.000	18.000	
		CB020-101	Molded Case		15.671	2.7	1.000	15.671	0.600	30.00	18.000	18.000	
		CB020-102	Molded Case		15.671	2.7	1.000	15.671	0.600	30.00	18.000	18.000	
		CB020-104	Molded Case		15.671	2.7	1.000	15.671	0.600	30.00	18.000	18.000	
		CB020-105	Molded Case		15.671	2.7	1.000	15.671	0.600	30.00	18.000	18.000	
BUS020-84_SPLIT B RM B70	0.600				8.268	0.9							
BUS020-85_SPLIT A RM B70	0.600				8.268	0.9							
BUS020-86_BOILER ROOM	0.600				4.052	0.4							
BUS020-87_GLASS BLOWER RO	0.600				1.785	0.2							
BUS020-88_FREIGHT ELEV	0.600				2.728	0.2							
BUS020-89_SPLIT RM B66 NE	0.600				4.052	0.4							
BUS020-90_B54 HALL DISCON	0.600				8.268	0.9							
BUS020-91_150 KVA TRANSFO	0.600				8.268	0.9							
BUS020-93	0.600				9.029	1.0							
BUS020-95_PANEL P7	0.600				8.268	0.9							

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.	
BUS020-96_FIRE BOOST PUMP	0.600				4.052	0.4							
BUS020-97_COMPR RM B62	0.600				1.785	0.2							
BUS020-98_PANEL P5A	0.600	CB020-110	MoldedFused		19.936	3.4	1.000	19.936	0.600	20.00	200.000	200.000	
		CB020-111	MoldedFused		19.936	3.4	1.000	19.936	0.600	20.00	200.000	200.000	
BUS020-99_PASSENGER	0.600				2.728	0.2							
BUS020-100_PANEL 5C	0.600	CB020-203	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-205	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-207	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-206	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-208	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-213	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-214	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-215	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
BUS020-102_P-1 DISCONNECT	0.600				12.023	1.4							
BUS020-103_P-2 DISCONNECT	0.600				12.023	1.4							
BUS020-104_P-3 DICONNECT	0.600				12.930	1.6							
BUS020-105_P-4 DISCONNECT	0.600				12.930	1.6							
BUS020-106_P-5 DISCONNECT	0.600				12.023	1.4							
BUS020-107_P-6 DISCONNECT	0.600				12.023	1.4							
BUS020-108_EF-1 DISCONNEC	0.600				3.623	0.2							
BUS020-109_COOL TOWER 1A	0.600				13.884	2.0							
BUS020-110_COOL TOWER 1B	0.600				7.264	0.5							
BUS020-111_COOL TOWER 2A	0.600				13.884	2.0							
BUS020-112_COOLING TOWER	0.600				7.264	0.5							
BUS020-114_AHU-4 DISCONNE	0.600				17.251	1.8							
BUS020-115_AHU-1 DISCONNE	0.600				13.103	1.1							
BUS020-116_AHU-5 DISCONNE	0.600				13.917	1.2							
BUS020-117_AHU-2 DISCONNE	0.600				14.807	1.3							
BUS020-118_AHU-3 DISCONNE	0.600				18.148	2.1							
BUS020-119_P-8 DISCONNECT	0.600				9.597	0.7							

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.
BUS020-120_P-7	0.600				9.597	0.7						
DISCONNECT BUS020-121_P-9	0.600				12.220	1.0						
DISCONNECT BUS020-122_AIR COMPRESSOR	0.600				1.654	0.1						
BUS020-123_P9	0.600				1.295	0.1						
BUS020-124_EF-4 DISCONNEC	0.600				12.859	1.0						
BUS020-126_P1A	0.600				20.336	3.2						
BUS020-127_MAIN_SWGEA R#1	0.600				23.997	5.8						
BUS020-128	0.600				15.066	3.4						
BUS020-129	0.600				15.066	3.4						
BUS020-130	0.600				8.461	0.6						
BUS020-131	0.600				9.555	0.8						
BUS020-132	0.600				8.461	0.6						
BUS020-133	0.600				7.264	0.5						
BUS020-134	0.600				8.461	0.6						
BUS020-137_550V MAIN	0.600	F020-15	Fuse		8.268	0.9	1.000	8.268	0.600	15.00	200.000	200.000
BUS020-138_SPLIT B RM B70	0.600				7.830	0.9						
BUS020-139_ROOF COND 1	0.600				7.627	0.8						
BUS020-140_MCC#2	0.600	CB020-127	MoldedFused		20.215	3.4	1.000	20.215	0.600	20.00	200.000	200.000
BUS020-141_MAIN_SWGEA R#2	0.600				23.849	5.8						
BUS020-142_MCC1	0.600	CB020-112	Molded Case		15.752	3.8	1.000	15.752	0.600	20.00	65.000	65.000
BUS020-143_ROOF COND 2	0.600				7.627	0.8						
BUS020-144_TRANS PANEL N	0.600	F020-16	Fuse		7.758	0.8	1.000	7.758	0.600	15.00	200.000	200.000
BUS020-145_05-200-11	0.600	F020-14	Fuse		8.268	0.9	1.000	8.268	0.600	20.00	200.000	200.000
BUS020-146_TRANS PANEL O	0.600				7.788	0.9						
BUS020-147_AC LIBRARY	0.600				7.788	0.9						
BUS020-148_AC LIBRARY	0.600				7.788	0.9						
BUS020-149_SPLIT B RM B70	0.600				7.830	0.9						
BUS020-150_PANEL N	0.208				7.338	0.8						
BUS020-152_30-270-52	0.600				7.788	0.9						
BUS020-153_DT1A	0.600				8.268	0.9						
BUS020-181_HUMID SYS 3	0.600				3.746	0.2						
BUS020-183_HUMID SYS 2	0.600				4.644	0.3						

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.
BUS020-184_HUMID SYS 1	0.600				5.131	0.3						
BUS020-185_CAFETERIA FAN	0.600				1.616	0.1						
BUS020-186_HUMID SYS 4	0.600				3.476	0.2						
BUS020-191_HUMID SYS 5	0.600				2.943	0.2						
BUS020-192_HOOD SYSTEM FA	0.600				2.983	0.2						
BUS020-193_AHV HOODS	0.600				3.502	0.2						
BUS020-194_PANEL 5C	0.600				16.242	1.8						
BUS020-195_COOLING MOTOR	0.600				15.636	1.6						
BUS020-196_05-200-84	0.600				13.996	1.2						
BUS020-199_PANEL 5C	0.600				2.714	0.2						
BUS020-200_COOL MOTOR 1	0.600				2.598	0.2						
BUS020-201_COOL MOTOR 2	0.600				2.667	0.2						
BUS020-204_EF-096,EF-187,	0.600				1.423	0.1						
BUS020-205_PASSENGER ELEV	0.600				11.186	0.8						
BUS020-210_PENTHOUSE PANE	0.600				5.131	0.3						
BUS020-214_COOLING TOWER	0.600				1.048	0.1						
BUS020-215_GE-189	0.600				2.714	0.2						
BUS020-216_AC-15	0.600				2.714	0.2						
BUS020-217_GE-116,GE-185	0.600				2.714	0.2						
BUS020-218_B817	0.600				2.597	0.2						
BUS020-219_FAN 310	0.600				2.843	0.2						
BUS020-220_AUTOCLAVE	0.600				5.131	0.3						
BUS020-222_FREIGHT ELEVAT	0.600				14.667	1.3						
BUS020-223_PAS ELEVATOR A	0.600				11.000	0.8						
BUS020-225_ASCO_NORMAL	0.600				23.210	5.3						
BUS021-3_GHLP-B	0.600				13.096	1.6						
BUS021-4_GHLP-A	0.600				10.031	1.1						
BUS021-5_GHLP-C	0.600				13.865	1.6						
BUS021-6_MCC-C1	0.600	CB28	Molded Case		8.663	0.9	1.000	8.663	0.600	30.00	18.000	18.000
		CB27	Molded Case		8.663	0.9	1.000	8.663	0.600	30.00	18.000	18.000
		CB26	Molded Case		8.663	0.9	1.000	8.663	0.600	30.00	18.000	18.000

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.	
BUS021-6_MCC-C1		CB25	Molded Case		8.663	0.9	1.000	8.663	0.600	30.00	18.000	18.000	
BUS021-7_DPD	0.208				6.471	1.5							
BUS021-8	0.208				6.471	1.5							
BUS021-9	0.208				6.515	1.5							
BUS021-10_P-2	0.600				3.039	0.3							
DISCONNECT BUS021-11_P-1	0.600				3.039	0.3							
DISCONNECT BUS021-12_SPLITTER-SP1	0.600	CB021-23	Molded Case		16.759	3.3	1.000	16.759	0.600	20.00	50.000	50.000	
BUS021-14_MDP-2	0.600	CB021-0	InsulUnfuse		17.987	3.4	1.000	17.987	0.600	20.00	50.000	50.000	
BUS021-15_PP11	0.600	CB021-41	Molded Case		16.502	3.4	1.000	16.502	0.600	20.00	25.000	25.000	
BUS021-50_P-3	0.600				2.751	0.2							
BUS021-51_P-4	0.600				2.751	0.2							
BUS022-0_MAIN	12.800	F022-1	Fuse		20.805	3.4	1.000	20.805	15.500	6.65	20.000	20.000	*
		F6	5 cy Tot CB	3.0	20.805	3.4	1.000	20.805	15.500		9.290	11.250	*
BUS022-2_D2	0.600				11.031	1.5							
BUS022-8_HOT WATER TANK	0.600				4.646	0.5							
BUS022-9_B10 MAT. 90	0.600				3.265	0.3							
BUS022-10_FROM PANEL W	0.600				4.646	0.5							
BUS022-11_SOLVENT STORAGE	0.600				4.646	0.5							
BUS022-12_HOT TANK RM B23	0.600				4.646	0.5							
BUS022-13_ELEVATOR	0.600				7.546	1.0							
BUS022-14_MCC1	0.600	F022-6	Fuse		11.021	3.3	1.000	11.021	0.600	15.00	200.000	200.000	
		F022-7	Fuse		11.021	3.3	1.000	11.021	0.600	20.00	200.000	200.000	
		F022-8	Fuse		11.021	3.3	1.000	11.021	0.600	20.00	200.000	200.000	
		F022-9	Fuse		11.021	3.3	1.000	11.021	0.600	20.00	200.000	200.000	
		F022-10	Fuse		11.021	3.3	1.000	11.021	0.600	20.00	200.000	200.000	
		F022-11	Fuse		11.021	3.3	1.000	11.021	0.600	20.00	200.000	200.000	
		F022-12	Fuse		11.021	3.3	1.000	11.021	0.600	20.00	200.000	200.000	
		F022-14	Fuse		11.021	3.3	1.000	11.021	0.600	15.00	200.000	200.000	
		F022-15	Fuse		11.021	3.3	1.000	11.021	0.600	15.00	200.000	200.000	
		F022-16	Fuse		11.021	3.3	1.000	11.021	0.600	20.00	200.000	200.000	
		F022-17	Fuse		11.021	3.3	1.000	11.021	0.600	20.00	200.000	200.000	
		F022-20	Fuse		11.021	3.3	1.000	11.021	0.600	20.00	200.000	200.000	

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.
BUS022-14_MCC1		F022-22	Fuse		11.021	3.3	1.000	11.021	0.600	20.00	200.000	200.000
		F022-24	Fuse		11.021	3.3	1.000	11.021	0.600	20.00	200.000	200.000
		F022-25	Fuse		11.021	3.3	1.000	11.021	0.600	15.00	200.000	200.000
		F022-21	Fuse		11.021	3.3	1.000	11.021	0.600	15.00	200.000	200.000
		F022-23	Fuse		11.021	3.3	1.000	11.021	0.600	20.00	200.000	200.000
		F022-26	Fuse		11.021	3.3	1.000	11.021	0.600	20.00	200.000	200.000
		F022-28	Fuse		11.021	3.3	1.000	11.021	0.600	15.00	200.000	200.000
		F022-29	Fuse		11.021	3.3	1.000	11.021	0.600	20.00	200.000	200.000
		F022-30	Fuse		11.021	3.3	1.000	11.021	0.600	20.00	200.000	200.000
		F022-33	Fuse		11.021	3.3	1.000	11.021	0.600	15.00	200.000	200.000
		F022-34	Fuse		11.021	3.3	1.000	11.021	0.600	20.00	200.000	200.000
		F022-35	Fuse		11.021	3.3	1.000	11.021	0.600	20.00	200.000	200.000
		F022-36	Fuse		11.021	3.3	1.000	11.021	0.600	15.00	200.000	200.000
		F022-37	Fuse		11.021	3.3	1.000	11.021	0.600	20.00	200.000	200.000
		F022-40	Fuse		11.021	3.3	1.000	11.021	0.600	20.00	200.000	200.000
BUS022-15_BOILER ROOM	0.600				9.974	2.7						
BUS022-16_MCC 2	0.600	F022-68	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
		F022-69	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
		F022-70	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
		F022-71	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
		F022-72	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
		F022-73	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
		F022-75	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
		F022-76	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
		F022-77	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
		F022-78	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
		F022-79	Fuse		10.412	2.9	1.000	10.412	0.600	15.00	200.000	200.000
		F022-80	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
		F022-81	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
		F022-82	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
		F022-83	Fuse		10.412	2.9	1.000	10.412	0.600	15.00	200.000	200.000
		F022-84	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
		F022-85	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
		F022-86	Fuse		10.412	2.9	1.000	10.412	0.600	15.00	200.000	200.000

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.
BUS022-16_MCC 2		F022-87	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
		F022-88	Fuse		10.412	2.9	1.000	10.412	0.600	15.00	200.000	200.000
		F022-89	Fuse		10.412	2.9	1.000	10.412	0.600	15.00	200.000	200.000
		F022-90	Fuse		10.412	2.9	1.000	10.412	0.600	15.00	200.000	200.000
		F022-92	Fuse		10.412	2.9	1.000	10.412	0.600	15.00	200.000	200.000
		F022-93	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
		F022-94	Fuse		10.412	2.9	1.000	10.412	0.600	15.00	200.000	200.000
		F022-98	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
		F022-99	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
		F022-100	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
		F022-102	Fuse		10.412	2.9	1.000	10.412	0.600	15.00	200.000	200.000
		F022-103	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
		F022-101	Fuse		10.412	2.9	1.000	10.412	0.600	20.00	200.000	200.000
BUS022-17_FUME FAN #192	0.600				4.670	0.5						
BUS022-18_15B	0.600				4.670	0.5						
BUS022-19_FAN SOUTH WING	0.600				4.670	0.5						
BUS022-20_FAN SOUTH WING	0.600				4.670	0.5						
BUS022-21_CHILLER #1	0.600				10.345	2.9						
BUS022-22_CHILLER #2	0.600				10.345	2.9						
BUS022-23_WATER PUMP #1	0.600				10.507	3.0						
BUS022-24_WATER PUMP #2	0.600				6.263	0.7						
BUS022-25_PUMP#2 BASEMENT	0.600				4.670	0.5						
BUS022-26_PUMP #1 3RD FLO	0.600				4.670	0.5						
BUS022-27_GLYCOL PRIME #1	0.600				6.424	0.7						
BUS022-28_GLYCOL STANDBY	0.600				6.424	0.7						
BUS022-31_RETURN AIR FAN	0.600				4.670	0.5						
BUS022-32_AIR FAN 2ND FLO	0.600				7.741	1.0						
BUS022-33_AIR UNIT 2ND FL	0.600				9.872	1.9						
BUS022-34_AIRUNIT SOUTH W	0.600				8.220	1.2						
BUS022-35_SYS FAN #161	0.600				3.413	0.3						
BUS022-36_AIR UNIT MUA-3	0.600				9.283	1.6						

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.
BUS022-37_CIRC PUMP P5	0.600				4.670	0.5						
BUS022-39_UNKNOWN	0.600				4.670	0.5						
BUS022-40_FUME FAN #160	0.600				2.673	0.3						
BUS022-41_FUME FAN #153	0.600				4.670	0.5						
BUS022-44_157	0.600				3.413	0.3						
BUS022-45_FUME FAN #154	0.600				3.413	0.3						
BUS022-46_156	0.600				3.413	0.3						
BUS022-47_MUA GLYCOL LOCA	0.600				3.413	0.3						
BUS022-48_EXHST FAN #162	0.600				3.413	0.3						
BUS022-50_TRANSFORMER VAU	0.600				1.422	0.1						
BUS022-51_MUAU GLYCOL LOC	0.600				4.670	0.5						
BUS022-53_MCC1A	0.600	F022-43	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-44	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-45	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-46	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-47	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-48	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-49	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-50	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-51	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-52	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-53	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-54	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-55	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-56	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-57	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-58	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-60	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-61	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-62	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-63	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-64	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-59	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000

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.
BUS022-53_MCC1A		F022-65	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-66	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
		F022-67	Fuse		4.767	0.6	1.000	4.767	0.600	20.00	200.000	200.000
BUS022-54_L.E.S. FAN #171	0.600				2.237	0.3						
BUS022-55_CANOPY FAN #175	0.600				2.237	0.3						
BUS022-56_L.E.S. FAN #174	0.600				2.237	0.3						
BUS022-57_FUME FAN #173	0.600				2.237	0.3						
BUS022-58_FUME FAN #172	0.600				1.890	0.2						
BUS022-59_30-270-47-H	0.600				1.890	0.2						
BUS022-60_EXHAUST RM 327	0.600				2.237	0.3						
BUS022-61_EXHAUST RM 313	0.600				2.237	0.3						
BUS022-62_30-270-67-H	0.600				1.890	0.2						
BUS022-63_30-270-68-H	0.600				2.237	0.3						
BUS022-64_30-270-65-H	0.600				2.237	0.3						
BUS022-65_30-270-66-H	0.600				2.734	0.3						
BUS022-66_30-270-37-H	0.600				2.734	0.3						
BUS022-67_30-270-64-H	0.600				2.237	0.3						
BUS022-68_30-270-39-H	0.600				1.890	0.2						
BUS022-69_30-270-69-H	0.600				2.734	0.3						
BUS022-70_30-270-35-H	0.600				2.237	0.3						
BUS022-71_TRANSFORMER	0.600				3.000	0.4						
BUS022-72_30-270-20-H	0.600				1.890	0.2						
BUS022-73_30-270-22-H	0.600				1.890	0.2						
BUS022-74_30-270-70-H	0.600				1.890	0.2						
BUS022-75_FUME FAN #170	0.600				2.237	0.3						
BUS022-76_EF-105	0.600				1.890	0.2						
BUS022-77_EF-111	0.600				2.237	0.3						
BUS022-78_EF-112	0.600				2.237	0.3						
BUS022-79_PANEL PB	0.600	CB022-25	Molded Case		6.913	0.9	1.000	6.913	0.600	30.00	14.000	14.000
		CB022-24	Molded Case		6.913	0.9	1.000	6.913	0.600	30.00	14.000	14.000
BUS022-80_AIR COND RM B10	0.600				4.997	0.6						
BUS022-81_MUA-1	0.600				4.564	0.5						
BUS022-82_CIRC PUMP P-4	0.600				4.564	0.5						

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.
BUS022-83_FUME FAN #192	0.600				3.346	0.3						
BUS022-84_15B	0.600				3.346	0.3						
BUS022-85_FAN SOUTH WING	0.600				4.540	0.5						
BUS022-86_FAN SOUTH WING	0.600				4.540	0.5						
BUS022-87_CHILLER #1	0.600				3.346	0.3						
BUS022-88_CHILLER #2	0.600				2.633	0.3						
BUS022-90_WATER PUMP #2	0.600				2.633	0.3						
BUS022-91_PUMP#2 BASEMENT	0.600				3.346	0.3						
BUS022-92_PUMP #1 3RD FLO	0.600				3.346	0.3						
BUS022-93_GLYCOL PUMP PRI	0.600				4.540	0.5						
BUS022-94_GLYCOL PUMP STA	0.600				4.540	0.5						
BUS022-95_COOLING TOWER P	0.600				4.540	0.5						
BUS022-96_COOLING TOWER P	0.600				4.540	0.5						
BUS022-97_RETURN AIR FAN	0.600				3.346	0.3						
BUS022-98_SUPPLY FAN 2ND	0.600				4.540	0.5						
BUS022-99_LOC FAN #161	0.600				2.633	0.3						
BUS022-100_MAKEUP AIRUNIT	0.600				3.346	0.3						
BUS022-101_AIR UNIT MUA-3	0.600				2.633	0.3						
BUS022-102_AIR UNIT 2ND F	0.600				2.633	0.3						
BUS022-103_UNKNOWN	0.600				3.346	0.3						
BUS022-104_FUME HOOD	0.600				4.540	0.5						
BUS022-106_CIRC PUMP P5	0.600				3.346	0.3						
BUS022-107_FUME FAN #153	0.600				2.633	0.3						
BUS022-108_FOR GLYCOL COI	0.600				2.633	0.3						
BUS022-109_COOLING MTR #1	0.600				2.633	0.3						
BUS022-113_MUA GLYCOL LOC	0.600				4.540	0.5						
BUS022-114_LOC FAN #162	0.600				4.540	0.5						
BUS022-115_FUME FAN #159	0.600				3.346	0.3						
BUS022-116_MUAU GLYCOL LO	0.600				3.346	0.3						
BUS022-117_WEST STAIR CAB	0.600				3.346	0.3						

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.
BUS022-118_WEST STAIR CAB	0.600				4.540	0.5						
BUS022-119_TE3	0.600				1.621	0.2						
BUS022-120_TE2	0.600				1.621	0.2						
BUS022-121_TEG	0.600				1.621	0.2						
BUS022-122_TEB	0.600				2.808	0.4						
BUS022-123_5HP POMP	0.600				1.278	0.2						
BUS022-124_20HP COMP	0.600				1.858	0.2						
BUS022-125_SPLIT RM B31	0.600				4.934	0.8						
BUS022-126_GEN ENCLOSURE	0.600				1.429	0.2						
BUS022-127_COMPR RM 127	0.600				1.858	0.2						
BUS022-128_VSD FUME HOODS	0.600				5.110	0.8						
BUS022-129_HEAT PUMP #1	0.600				1.621	0.2						
BUS022-130_HEAT PUMP #2	0.600				1.621	0.2						
BUS022-131_PANEL F	0.600				2.578	0.4						
BUS022-132_CHILLER SYSTEM	0.600				4.934	0.8						
BUS022-133_FUME ROOM 216	0.600				1.429	0.2						
BUS022-134_PUMPS 3A 3B	0.600				1.278	0.2						
BUS022-135_FUME ROOM 125	0.600				1.621	0.2						
BUS022-136_FUME ROOM 125	0.600				1.621	0.2						
BUS022-137_COOLING TOWER	0.600				1.621	0.2						
BUS022-139_EEB	0.600	CB022-36	MoldedFused		6.505	1.2	1.000	6.505	0.600	20.00	100.000	100.000
		CB022-37	MoldedFused		6.505	1.2	1.000	6.505	0.600	20.00	100.000	100.000
		CB022-38	MoldedFused		6.505	1.2	1.000	6.505	0.600	20.00	100.000	100.000
		CB022-39	MoldedFused		6.505	1.2	1.000	6.505	0.600	20.00	100.000	100.000
		CB022-40	MoldedFused		6.505	1.2	1.000	6.505	0.600	20.00	100.000	100.000
		CB022-41	MoldedFused		6.505	1.2	1.000	6.505	0.600	20.00	100.000	100.000
		CB022-42	MoldedFused		6.505	1.2	1.000	6.505	0.600	20.00	100.000	100.000
		CB022-43	MoldedFused		6.505	1.2	1.000	6.505	0.600	20.00	100.000	100.000
		CB022-44	MoldedFused		6.505	1.2	1.000	6.505	0.600	20.00	100.000	100.000
		CB022-45	MoldedFused		6.505	1.2	1.000	6.505	0.600	20.00	100.000	100.000
		CB022-46	MoldedFused		6.505	1.2	1.000	6.505	0.600	20.00	100.000	100.000
		CB022-47	MoldedFused		6.505	1.2	1.000	6.505	0.600	20.00	100.000	100.000

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.
BUS022-139_EEB		CB022-48	MoldedFused		6.505	1.2	1.000	6.505	0.600	20.00	100.000	100.000
		CB022-49	MoldedFused		6.505	1.2	1.000	6.505	0.600	20.00	100.000	100.000
		CB022-50	MoldedFused		6.505	1.2	1.000	6.505	0.600	20.00	100.000	100.000
		CB022-51	MoldedFused		6.505	1.2	1.000	6.505	0.600	20.00	100.000	100.000
		CB022-52	MoldedFused		6.505	1.2	1.000	6.505	0.600	20.00	100.000	100.000
		CB022-53	MoldedFused		6.505	1.2	1.000	6.505	0.600	20.00	100.000	100.000
		CB022-54	MoldedFused		6.505	1.2	1.000	6.505	0.600	20.00	100.000	100.000
BUS022-140	0.600	CB022-0	Molded Case		11.318	3.4	1.000	11.318	0.600	20.00	100.000	100.000
BUS022-141_ATS	0.600				8.101	1.2						
BUS022-200_EEB-2	0.600	CB022-35	Molded Case		6.577	1.2	1.000	6.577	0.600	20.00	35.000	35.000
BUS023-1_600V MAIN SWITCH	0.600	F023-1	Fuse		6.355	1.0	1.000	6.355	0.600	20.00	200.000	200.000
BUS023-2_SPLITTER	0.600				6.335	1.0						
BUS023-4_600V SW. NO.2	0.600				6.117	0.9						
BUS037-2_BUILDING-34	0.600				3.566	1.4						
BUS037-3_TRANSF_75VKA	0.600				3.555	1.4						
BUS037-4_MAIN	0.600	F037-1	Fuse		3.584	1.4	1.000	3.584	0.600	20.00	200.000	200.000
BUS047-1_MAIN	0.600	F047-1	Fuse		3.190	1.1	1.000	3.190	0.600	15.00	200.000	200.000
BUS047-2_TRANSFORMER	0.600				3.167	1.1						
BUS047-3_TRANSFORMER	0.600				3.108	1.1						
BUS049-1_MAIN	0.208				7.002	1.7						
BUS050-1_MAIN	0.600	T-10	Molded Case		7.714	1.6	1.000	7.714	0.600	20.00	35.000	35.000
BUS050-6_PANEL - PP	0.600	CB050-9	Molded Case		7.492	1.6	1.000	7.492	0.600	30.00	14.000	14.000
		CB050-10	Molded Case		7.492	1.6	1.000	7.492	0.600	30.00	14.000	14.000
BUS050-7_PANEL - PC	0.208				8.183	1.5						
BUS050-8_PANEL - PB	0.208				8.077	1.4						
BUS050-9_PANEL - PA	0.208				11.609	1.6						
BUS050-13_COMPRESSOR	0.600				2.196	0.3						
BUS050-14_VAULT SUPPLY FA	0.600				6.049	1.0						
BUS050-15_T4	0.600				5.989	1.0						
BUS050-16_T3	0.600				5.989	1.0						
BUS050-17_T2	0.600				5.989	1.0						
BUS055-2_D.P. MECHANICAL	0.600	CB055-12	Molded Case		8.117	1.3	1.000	8.117	0.600	30.00	18.000	18.000
		CB055-18	Molded Case		8.117	1.3	1.000	8.117	0.600	30.00	18.000	18.000

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.
BUS055-2_D.P. MECHANICAL		CB055-17	Molded Case		8.117	1.3	1.000	8.117	0.600	30.00	18.000	18.000
		CB055-16	Molded Case		8.117	1.3	1.000	8.117	0.600	30.00	18.000	18.000
		CB055-15	Molded Case		8.117	1.3	1.000	8.117	0.600	30.00	18.000	18.000
		CB055-14	Molded Case		8.117	1.3	1.000	8.117	0.600	30.00	18.000	18.000
		CB055-13	Molded Case		8.117	1.3	1.000	8.117	0.600	30.00	18.000	18.000
BUS055-4_MAIN BUILDG 055	0.600	CB055-19	MoldedFused		8.632	1.4	1.000	8.632	0.600	20.00	200.000	200.000
BUS055-9_AHU-1	0.600				7.199	1.0						
BUS055-10_ELEVATOR	0.600				7.199	1.0						
BUS055-11_AHU-2	0.600				5.289	0.6						
BUS055-12_P-3	0.600				4.290	0.5						
BUS055-13_P-1	0.600				4.290	0.5						
BUS055-14_EF 3 600V	0.600				4.290	0.5						
BUS055-15_P-2	0.600				4.290	0.5						
BUS056-1_BUILDING 56 MAIN	0.600	CB056-1	Molded Case		9.213	1.6	1.000	9.213	0.600	20.00	35.000	35.000
BUS056-3	0.600				7.267	1.0						
BUS057-2_ROOF TOP UNIT	0.600				4.417	0.6						
BUS057-3_ELEVATOR	0.600				6.718	1.0						
BUS057-4_SPLITTER 600V	0.600				5.316	0.7						
BUS057-5_HUMIDIFIER	0.600				4.329	0.5						
BUS057-6_DP-2	0.600				7.114	1.2						
BUS057-7_AIR COMPRESSOR	0.600				5.074	0.6						
BUS057-8_PUMP P1	0.600				5.074	0.6						
BUS057-9_PUMP P2	0.600				5.074	0.6						
BUS057-10_PUMP 3	0.600				5.074	0.6						
BUS057-11_PUMP 4	0.600				5.074	0.6						
BUS057-12_PANEL DP1	0.600	CB057-1	Molded Case		7.958	1.5	1.000	7.958	0.600	20.00	25.000	25.000
BUS059-1_MAIN SWITCH	0.208	F059-1	Fuse		7.301	1.6	1.000	7.301	0.600	20.00	10.000	10.000
BUS059-3_PANEL DP1	0.208	CB059-1	Molded Case		6.757	1.5	1.000	6.757	0.240	20.00	65.000	65.000
BUS060-1_TRANSFER SWITCH	0.208				4.238	0.9						
BUS072-1_MAIN DISCONNECT	0.208	F072-1	Fuse		8.900	2.7	1.000	8.900	0.600	20.00	10.000	10.000
BUS072-3_PANEL CDP-1	0.208	CB072-1	Molded Case		7.882	1.9	1.000	7.882	0.600	30.00	14.000	14.000
BUS074-1_MAIN DISCONNECT	0.208	F074-1	Fuse		7.612	2.6	1.000	7.612	0.600	20.00	10.000	10.000
BUS074-3_PANEL CDP-1	0.208				6.488	2.3						

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.
BUS075-1_MAIN	0.208	CB075-1	Molded Case		9.701	1.6	1.000	9.701	0.240	20.00	42.000	42.000
BUS076-1_MAIN SWITCH	0.600	F076-1	Fuse		5.740	1.1	1.000	5.740	0.600	20.00	200.000	200.000
BUS076-2_SPLITTER	0.600				5.719	1.1						
BUS076-3_FIRE PUMPS	0.600	F076-2	Fuse		5.691	1.1	1.000	5.691	0.600	15.00	200.000	200.000
BUS076-4_ATS#2	0.600	F076-3	Fuse		5.698	1.1	1.000	5.698	0.600	20.00	200.000	200.000
BUS076-5_MAIN_PANEL "A"	0.600				5.698	1.1						
BUS076-6_PANEL "A"	0.600				5.303	1.0						
BUS076-10_ATS2	0.600				4.816	0.8						
BUS076-11_ATS-LEAD	0.600				5.342	1.0						
BUS076-12_EMI	0.600				4.119	0.7						
BUS082-1_MAIN	0.208				5.671	2.1						
BUS085-1_MAIN	0.208				7.003	1.8						
BUS088-2_600 VOLTS	0.600				4.538	0.6						
BUS088-3_SUPPLY FAN N0.1	0.600				4.257	0.6						
BUS088-4_SUPPLY FAN N0.2	0.600				4.257	0.6						
BUS088-5_PANEL H	0.600				5.064	0.8						
BUS088-6	0.600	CB088-1	Molded Case		6.464	1.1	1.000	6.464	0.600	20.00	25.000	25.000
BUS088-7_EMERGENCY POWER	0.600				6.205	1.1						
BUS088-8_HAMER MILL	0.600				6.143	1.0						
BUS088-9_75 KVA TRANSFORM	0.600				6.143	1.0						
BUS088-14_PANEL Q	0.600				6.143	1.0						
BUS088-15_UPSTAIRS AC UNI	0.600				1.863	0.2						
BUS088-16_UPSTAITR AHU	0.600				1.863	0.2						
BUS088_ATS-2	0.600				6.269	1.1						
BUS088_ATS-2A	0.600				4.841	0.8						
BUS091-2_SPLITTER	0.208				8.708	1.5						
BUS091-3_BUILDING - 91A	0.208				8.606	1.6						
BUS091-4_BUILDING - 91	0.208				8.606	1.6						
BUS091-5A_ATS-1	0.600				5.644	1.0						
BUS091-8A_ATS-1A	0.600				3.191	0.5						
BUS091-10_MAIN	0.600	CB091-0	Molded Case		7.228	1.5	1.000	7.228	0.600	20.00	35.000	35.000
BUS094-1_MAIN	0.600				7.392	1.6						
BUS095-1_600V. MAIN SW.	0.600	F095-1	Fuse		6.614	1.2	1.000	6.614	0.600	15.00	200.000	200.000

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.
BUS095-2_MAIN SWITCH	0.600				6.586	1.2						
BUS095-3_05-200-03	0.600				6.458	1.1						
BUS095-4_05-200-02	0.600				6.458	1.1						
BUS098-1_600V. JUNCTION B	0.600				2.764	0.4						
BUS098-3_TRANSFORMATEUR	0.600				2.715	0.4						
BUS098-5_WORK SHOP	0.600				2.152	0.3						
BUS098-9	0.600	CB098-0	Molded Case		2.745	0.4	1.000	2.745	0.600	30.00	18.000	18.000
BUS099-1_MAIN SW BDLG.99	0.600				6.742	1.4						
BUS099-2_SPLITTER 600 V	0.600				6.715	1.4						
BUS099-3_DISC 300 KVA XFO	0.600	F099-4	Fuse		6.700	1.4	1.000	6.700	0.600	20.00	200.000	200.000
BUS099-4	0.600	F099-3	Fuse		6.650	1.4	1.000	6.650	0.600	20.00	10.000	10.000
BUS099-5_05-200-03	0.600	F099-2	Fuse		6.595	1.3	1.000	6.595	0.600	15.00	200.000	200.000
BUS099-6_SPLITTER 115 A	0.600				5.034	0.8						
BUS099-7_DUST EXTRACTOR	0.600				4.829	0.8						
BUS099-8_ROOF UNIT	0.600				4.715	0.7						
BUS099-9_COMPRESSOR CABIN	0.600				4.715	0.7						
BUS099-10_600 V 100 A	0.600				6.523	1.3						
BUS099-11_6 KVA TRANSFORM	0.600				6.088	1.1						
BUS099-12_COOLING TOWER	0.600				6.244	1.2						
BUS099-14_P-1 PUMP F 30 A	0.600				6.088	1.1						
BUS099-15_MAIN FEED	0.600				3.861	0.5						
BUS099-16_BLDG_97.98.104	0.600				3.842	0.5						
BUS099-17_BLDG.97.98	0.600	F099-5	Fuse		3.823	0.5	1.000	3.823	0.600	20.00	200.000	200.000
BUS099-18_BLDG_104	0.600				3.823	0.5						
BUS099-20_300KVA-SEC-XFO	0.208				8.929	1.4						
BUS110-2_600 V MAIN SW.	0.600	Fuse3	Fuse		7.232	1.2	1.000	7.232	0.600	20.00	200.000	200.000
BUS110-3_05-215-1	0.600				7.101	1.2						
BUS110-4_LIGHTING ROOM 2	0.600				6.753	1.1						
BUS110-5_GROWTH CHAMBER C	0.600				6.876	1.1						
BUS110-6_AIR COMPRESSOR	0.600				6.876	1.1						
BUS110-7_LIGHTING ROOM 1	0.600				6.753	1.1						

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.
BUS110_MAIN	0.600	CB110-0	Molded Case		8.050	1.5	1.000	8.050	0.600	20.00	35.000	35.000
BUS114-1_MAIN SWITCH - FR	0.600	F114-1	Fuse		6.424	1.4	1.000	6.424	0.600	15.00	200.000	200.000
BUS114-2_SPLITTER	0.600				6.424	1.4						
BUS114-3_PANEL P DISCON	0.600	FUSE114-2	Fuse		6.364	1.4	1.000	6.364	0.600	20.00	200.000	200.000
BUS114-4_PANEL P	0.600	CB114-1	Molded Case		6.132	1.3	1.000	6.132	0.600	20.00	22.000	22.000
		CB114-2	Molded Case		6.132	1.3	1.000	6.132	0.600	30.00	14.000	14.000
		CB114-3	Molded Case		6.132	1.3	1.000	6.132	0.600	20.00	22.000	22.000
		CB114-4	Molded Case		6.132	1.3	1.000	6.132	0.600	20.00	22.000	22.000
		CB114-5	Molded Case		6.132	1.3	1.000	6.132	0.600	30.00	14.000	14.000
		CB114-6	Molded Case		6.132	1.3	1.000	6.132	0.600	20.00	22.000	22.000
		CB114-7	Molded Case		6.132	1.3	1.000	6.132	0.600	20.00	22.000	22.000
		CB114-10	Molded Case		6.132	1.3	1.000	6.132	0.600	20.00	22.000	22.000
		CB114-11	Molded Case		6.132	1.3	1.000	6.132	0.600	30.00	14.000	14.000
		CB114-12	Molded Case		6.132	1.3	1.000	6.132	0.600	20.00	22.000	22.000
		CB114-13	Molded Case		6.132	1.3	1.000	6.132	0.600	30.00	14.000	14.000
		CB114-14	Molded Case		6.132	1.3	1.000	6.132	0.600	30.00	14.000	14.000
BUS114-5_SURGE SUPPRES	0.600				6.313	1.3						
BUS114-7_PRESSURE WASHER	0.600				6.161	1.2						
BUS114-9_DISCONNECT	0.600				2.355	0.4						
BUS114-10_DISCONNECT WELD	0.600				1.151	0.2						
BUS114-11	0.600				1.422	0.2						
BUS114-12	0.600				1.422	0.2						
BUS114-13	0.600				1.422	0.2						
BUS114-14	0.600				3.523	0.6						
BUS114-15	0.600				1.422	0.2						
BUS114-16	0.600				1.422	0.2						
BUS114-17	0.600				1.422	0.2						
BUS114-18	0.600				1.422	0.2						
BUS114-19	0.600				1.422	0.2						
BUS114-20	0.600				3.523	0.6						
BUS114-21	0.600				1.422	0.2						
BUS114-22	0.600				1.422	0.2						
BUS134-1_MAIN	0.208				2.604	0.4						

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.
BUS136-2_PANEL 452-08	0.208				4.060	3.2						
BUS140-1_MAIN	0.208				13.771	1.7						
BUS142-1_MAIN SW-FROM 110	0.600				4.602	0.8						
BUS142-2_TRANSFO DISCONNE	0.600				4.427	0.7						
BUS143-2_PANEL LA	0.600	CB143-10	Molded Case		3.845	1.4	1.000	3.845	0.600	30.00	14.000	14.000
		CB143-11	Molded Case		3.845	1.4	1.000	3.845	0.600	30.00	14.000	14.000
		CB143-12	Molded Case		3.845	1.4	1.000	3.845	0.600	30.00	14.000	14.000
		CB143-13	Molded Case		3.845	1.4	1.000	3.845	0.600	30.00	14.000	14.000
		CB143-14	Molded Case		3.845	1.4	1.000	3.845	0.600	30.00	14.000	14.000
		CB143-15	Molded Case		3.845	1.4	1.000	3.845	0.600	30.00	14.000	14.000
		CB143-16	Molded Case		3.845	1.4	1.000	3.845	0.600	30.00	14.000	14.000
		CB143-17	Molded Case		3.845	1.4	1.000	3.845	0.600	30.00	14.000	14.000
		CB143-18	Molded Case		3.845	1.4	1.000	3.845	0.600	30.00	14.000	14.000
BUS143-4	0.600				2.195	0.5						
BUS143-5	0.600				2.195	0.5						
BUS143-6	0.600				2.658	0.7						
BUS143-7	0.600				2.195	0.5						
BUS143-8	0.600				2.195	0.5						
BUS143-9	0.600				2.658	0.7						
BUS143-10	0.600				2.195	0.5						
BUS143-11	0.600				2.195	0.5						
BUS143-12	0.600				2.195	0.5						
BUS143-13_05-200-03	0.600				3.634	1.2						
BUS143-14_SPLITTER-PA	0.600				3.575	1.2						
BUS143-15_R.F. #1R	0.600				3.434	1.1						
BUS143-16_R.F. #3R	0.600				3.434	1.1						
BUS143-17_R.F. #2R	0.600				3.434	1.1						
BUS143-18_S.F. #1S	0.600				3.434	1.1						
BUS143-19_S.F. #3S	0.600				3.434	1.1						
BUS143-20_S.F. #2S	0.600				3.434	1.1						
BUS143-21_HUMIDIFICATEUR	0.600				3.485	1.1						
BUS143-22_05-200-04	0.600				3.755	1.3						
BUS143-23_SPLITTER-PC	0.600				3.694	1.2						

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.	
BUS143-24_PUMP #1	0.600				3.549	1.1							
BUS143-25_PUMP #2	0.600				3.549	1.1							
BUS143-26_CONTROL COMP.	0.600				3.549	1.1							
BUS143-27_AIR COMP.	0.600				3.549	1.1							
BUS143-28_MAIN SWITCHBOX	0.600				3.404	1.0							
BUS143-29_SPLITTER	0.600				3.348	1.0							
BUS143-30_DUST COLL. #1	0.600				3.216	0.9							
BUS143-31_DUST COLL. #3	0.600				3.216	0.9							
BUS143-32_DUST COLL. #2	0.600				3.216	0.9							
BUS143-33_MAIN DISCONNECT	0.600				3.682	1.2							
BUS143-34_SPLITTER-PE	0.600				3.643	1.2							
BUS143-35_DUST COLLEC C5	0.600	F143-5	Fuse		3.552	1.1	1.000	3.552	0.600	15.00	200.000	200.000	
BUS143-36_DUST COLLEC C4	0.600	F143-6	Fuse		3.552	1.1	1.000	3.552	0.600	20.00	10.000	10.000	
BUS143-38_DUST COLL C5	0.600				2.765	0.7							
BUS143-39_DUST COLL C4	0.600				2.765	0.7							
BUS143-40_MAIN	0.600	CB143-0	Molded Case		4.002	1.5	1.000	4.002	0.600	20.00	22.000	22.000	
BUS151-1_MAIN SWITCH	0.600	F151-1	Fuse		2.872	0.5	1.000	2.872	0.600	20.00	200.000	200.000	
BUS151-2_SPLITTER	0.600				2.839	0.5							
BUS151-3_TRANSFORMER	0.600				2.823	0.5							
BUS151-4	0.600	F151-3	Fuse		2.823	0.5	1.000	2.823	0.600	20.00	200.000	200.000	
BUS151-6_SPLITTER	0.600				2.675	0.4							
BUS151-7_TRANSFORMER	0.600				2.607	0.4							
BUS151-8_CONVEYOR MOTOR	0.600				2.607	0.4							
BUSK94-1_E-K94-K94-P	0.600	CBK94-2	Molded Case		8.163	1.5	1.000	8.163	0.600	20.00	50.000	50.000	
PS-1	12.800	LB-2	Fuse		20.766	3.4	1.000	20.766	17.000	6.65	14.000	14.000	*
PS1-T1	12.800				20.571	3.2							
PS-2	12.800	LB-5	Fuse		20.367	3.3	1.000	20.367	17.000	6.65	14.000	14.000	*
PS2-T2	12.800				20.216	3.2							
PS-3	12.800	LB-8	Fuse		20.179	3.2	1.000	20.179	17.000	6.65	14.000	14.000	*
PS3-T3	12.800				19.992	3.1							
PS-4	12.800	LB-11	Fuse		19.954	3.2	1.000	19.954	17.000	6.65	14.000	14.000	*
PS4-T4	12.800				19.771	3.1							
PS-5	12.800	LB-14	Fuse		19.529	3.1	1.000	19.529	17.000	6.65	14.000	14.000	*

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.	
PS5-T5	12.800				19.352	3.0							
PS-6	12.800	LB-18	Fuse		19.473	3.1	1.000	19.473	17.000	6.65	14.000	14.000	*
PS6-T6	12.800				19.215	2.9							
PS-7	12.800	LB-21	Fuse		19.444	3.1	1.000	19.444	17.000	6.65	14.000	14.000	*
PS7-T7	12.800				19.268	3.0							
PS-8	12.800	LB-25	Fuse		19.467	3.1	1.000	19.467	17.000	6.65	14.000	14.000	*
PS8-T8	12.800				19.291	3.0							
PS-9	12.800	LB-28	Fuse		19.562	3.2	1.000	19.562	17.000	6.65	14.000	14.000	*
PS9-T9	12.800				19.385	3.0							
PS-10	12.800	LB-35	Fuse		19.972	3.3	1.000	19.972	17.000	6.65	14.000	14.000	*
PS10-T10	12.800				19.729	3.1							
PS-11	12.800	LB-31	Fuse		19.805	3.2	1.000	19.805	17.000	6.65	14.000	14.000	*
PS11-T11	12.800				19.625	3.1							
PT145	13.200				3.097	2.9							
PT146	13.200				3.078	2.8							
PT221	12.800				3.264	2.7							
SG-1_PRIM_XFO	12.800	F5	5 cy Sym CB	3.0	20.871	3.4	1.000	20.871	15.000		28.000	32.813	
SG-1_SEC_XFO	0.600	CBSG021-1	PowerUnfuse		18.307	3.5	1.000	18.307	0.600	15.00	30.000	30.000	
		CBSG021-2	PowerUnfuse		18.307	3.5	1.000	18.307	0.600	15.00	65.000	65.000	
SPLTR037-1_SPLITTER	0.600				3.570	1.4							
SPLTR047-1_SPLITTER	0.600				3.181	1.1							
SUBSTATION-3_PANEL-SPP	0.600	CBMSS-1	Molded Case		10.750	1.7	1.000	10.750	0.600	20.00	25.000	25.000	
T-1000	12.800				3.287	2.8							

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

* Indicates a device with interrupting duty exceeding the device capability
** Indicates that the circuit breaker has been flagged as a generator circuit breaker. However, ETAP could not detect a single path, without a transformer, to the specified generator. Therefore, this circuit breaker is treated as a regular circuit breaker in short-circuit calculations.
\+ The prefault voltage exceeds the rated maximum kV limit of the circuit breaker - The rated interrupting kA must be derated.

Annexe 2 Short-circuit Exceeded

DESSAU

Project:	CEF - ARC FLASH STUDY	ETAP		Page:	1
Location:	Central Experimental Farm	11.1.1C		Date:	08-05-2013
Contract:	B-0000430			SN:	DESSAU-INC
Engineer:	D. Desjardins, P. Eng.		Study Case: SC	Revision:	Base
Filename:	20130507_B-0000430			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.	
BUS022-0_MAIN	12.800	F022-1	Fuse		20.805	3.4	1.000	20.805	15.500	6.65	20.000	20.000	*
		F6	5 cy Tot CB	3.0	20.805	3.4	1.000	20.805	15.500		9.290	11.250	*
BLDG#20_MAIN BUS	12.800	F9	5 cy Tot CB	3.0	21.398	3.5	1.000	21.398	15.500		9.290	11.250	*
		F10	5 cy Tot CB	3.0	21.398	3.5	1.000	21.398	15.500		9.290	11.250	*
BLDG#22	12.800	F6	5 cy Tot CB	3.0	20.805	3.4	1.000	20.805	15.500		9.290	11.250	*
BUS020-100_PANEL 5C	0.600	CB020-203	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-205	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-207	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-206	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-208	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-213	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-214	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-215	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
BUS020-46_PANEL 5B	0.600	CB020-236	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-237	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-234	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-233	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-232	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-231	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-230	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-229	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-228	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-224	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-219	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
		CB020-218	Molded Case		16.683	1.9	1.000	16.683	0.600	30.00	14.000	14.000	*
BUS020-66_PANEL P4	0.600	CB020-73	Molded Case		16.406	1.9	1.000	16.406	0.600	30.00	14.000	14.000	*
		CB020-74	Molded Case		16.406	1.9	1.000	16.406	0.600	30.00	14.000	14.000	*
		CB020-76	Molded Case		16.406	1.9	1.000	16.406	0.600	30.00	14.000	14.000	*
		CB020-77	Molded Case		16.406	1.9	1.000	16.406	0.600	30.00	14.000	14.000	*
		CB020-78	Molded Case		16.406	1.9	1.000	16.406	0.600	30.00	14.000	14.000	*
BUS020-74_PANEL P6	0.600	CB020-79	Molded Case		19.411	3.0	1.000	19.411	0.600	30.00	14.000	14.000	*
		CB020-82	Molded Case		19.411	3.0	1.000	19.411	0.600	30.00	14.000	14.000	*

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.	
BUS020-74_PANEL P6		CB020-84	Molded Case		19.411	3.0	1.000	19.411	0.600	30.00	14.000	14.000	*
PS-1	12.800	LB-2	Fuse		20.766	3.4	1.000	20.766	17.000	6.65	14.000	14.000	*
PS-2	12.800	LB-5	Fuse		20.367	3.3	1.000	20.367	17.000	6.65	14.000	14.000	*
PS-3	12.800	LB-8	Fuse		20.179	3.2	1.000	20.179	17.000	6.65	14.000	14.000	*
PS-4	12.800	LB-11	Fuse		19.954	3.2	1.000	19.954	17.000	6.65	14.000	14.000	*
PS-5	12.800	LB-14	Fuse		19.529	3.1	1.000	19.529	17.000	6.65	14.000	14.000	*
PS-6	12.800	LB-18	Fuse		19.473	3.1	1.000	19.473	17.000	6.65	14.000	14.000	*
PS-7	12.800	LB-21	Fuse		19.444	3.1	1.000	19.444	17.000	6.65	14.000	14.000	*
PS-8	12.800	LB-25	Fuse		19.467	3.1	1.000	19.467	17.000	6.65	14.000	14.000	*
PS-9	12.800	LB-28	Fuse		19.562	3.2	1.000	19.562	17.000	6.65	14.000	14.000	*
PS-10	12.800	LB-35	Fuse		19.972	3.3	1.000	19.972	17.000	6.65	14.000	14.000	*
PS-11	12.800	LB-31	Fuse		19.805	3.2	1.000	19.805	17.000	6.65	14.000	14.000	*

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.

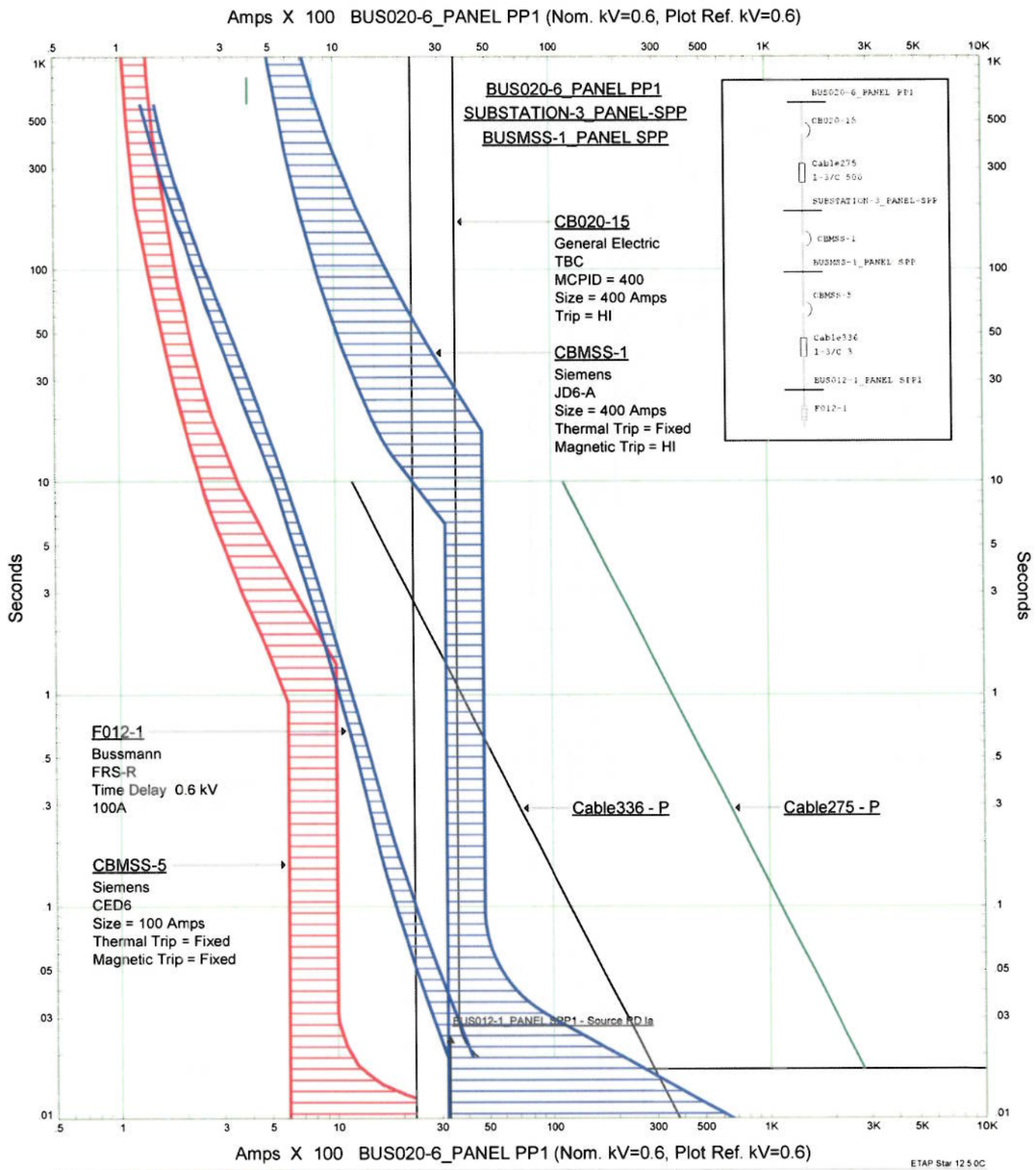
* Indicates a device with interrupting duty exceeding the device capability.

** 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.

Annexe 3 Coordination curves

DESSAU



ETAP Star 12.5.0C

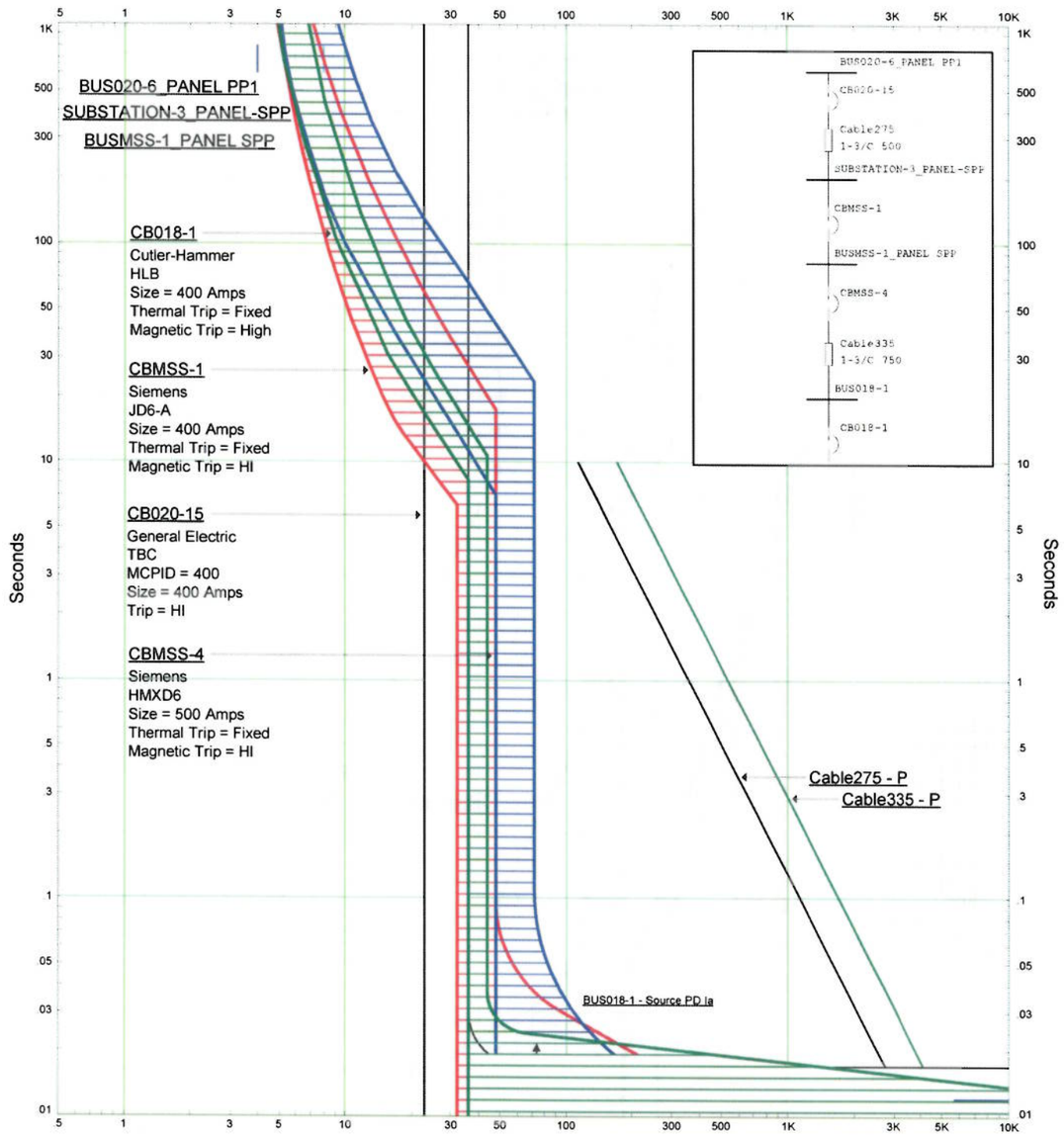
DESSAU

Building 12 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

Amps X 100 BUSMSS-1_PANEL SPP (Nom. kV=0.6, Plot Ref. kV=0.6)



Amps X 100 BUSMSS-1_PANEL SPP (Nom. kV=0.6, Plot Ref. kV=0.6)

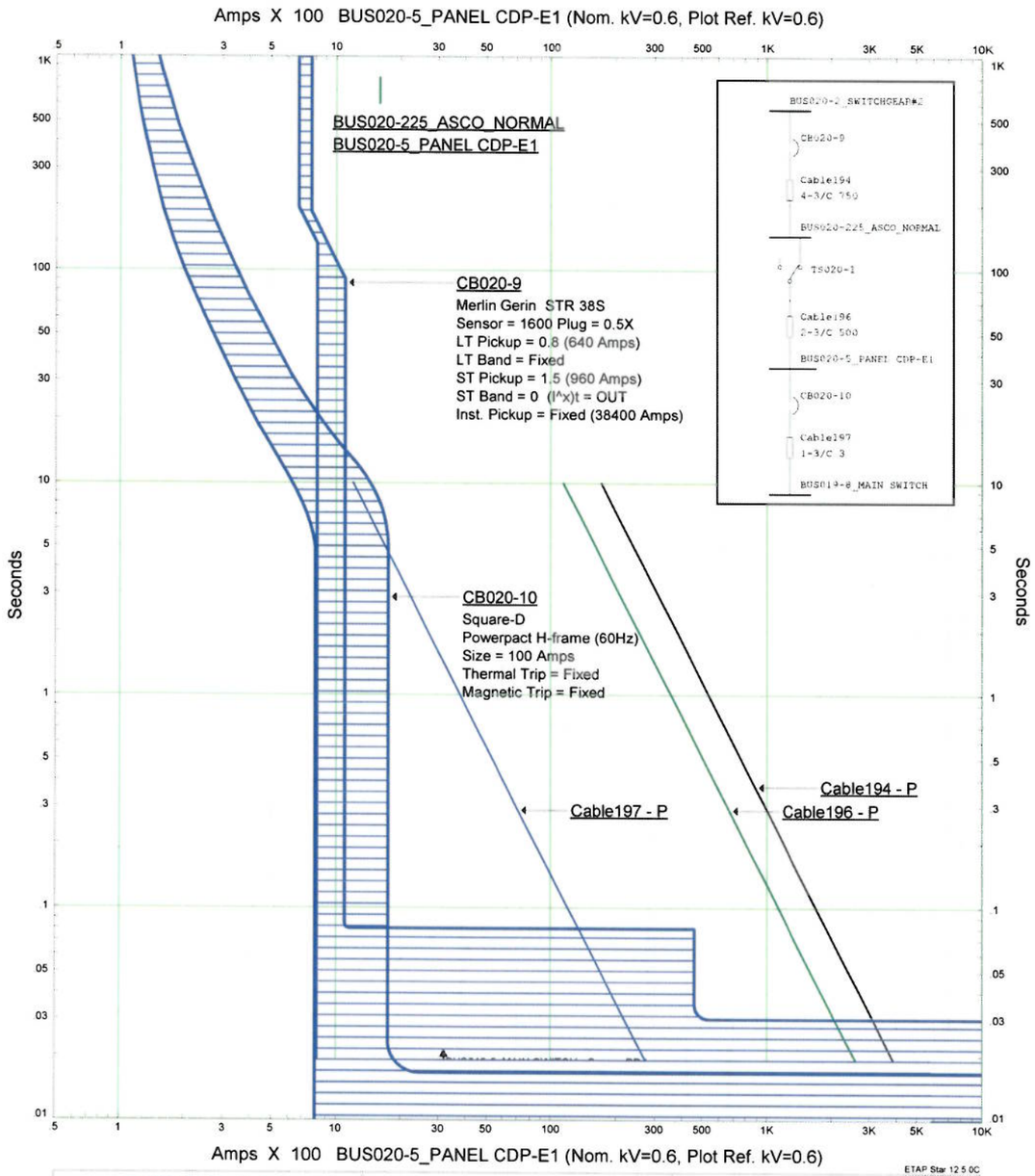
ETAP Star 12.5.0C

DESSAU

Building 18 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

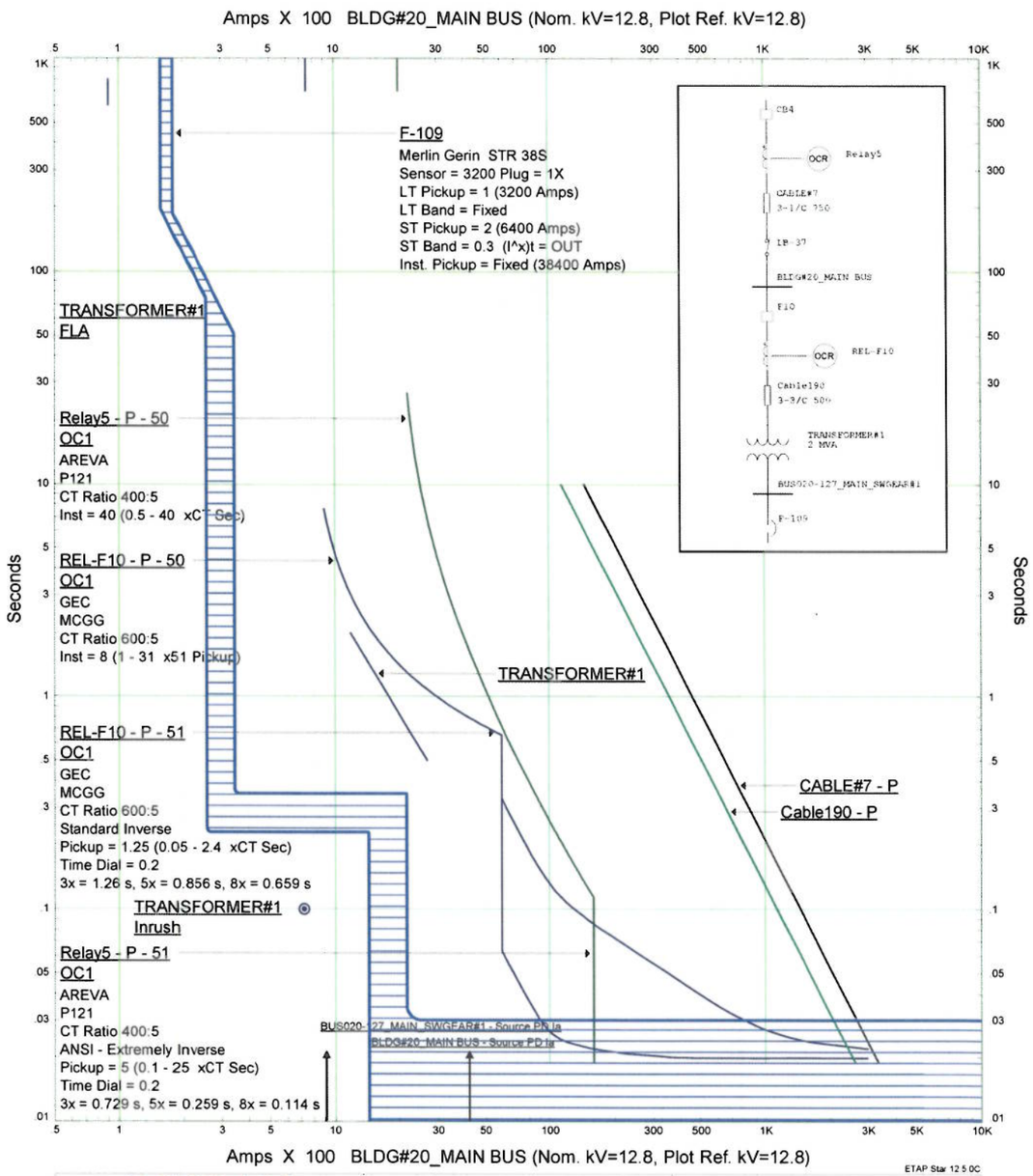


DESSAU

Building 19 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

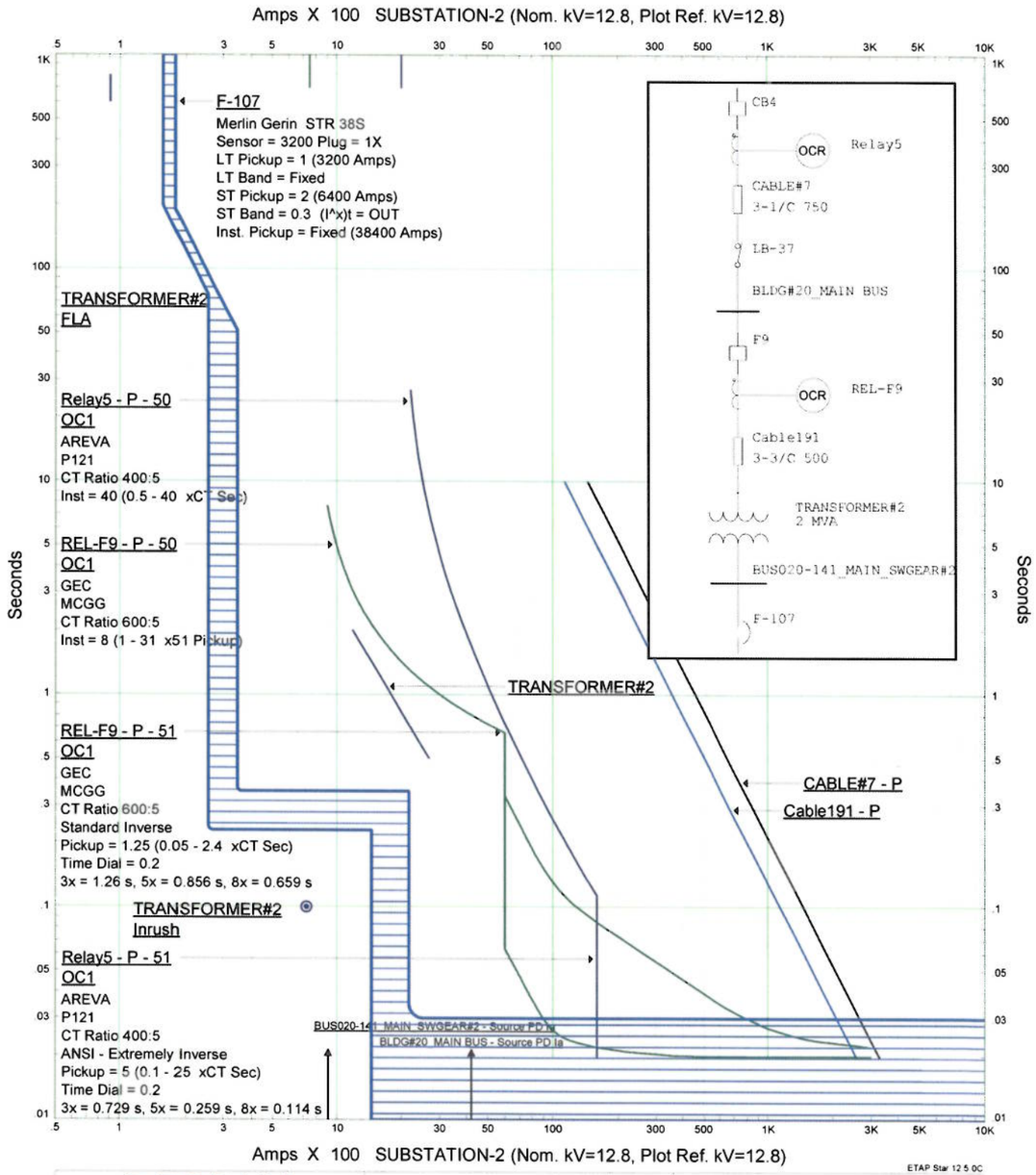


DESSAU

Building 20 - Feeder #1

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-000043O

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

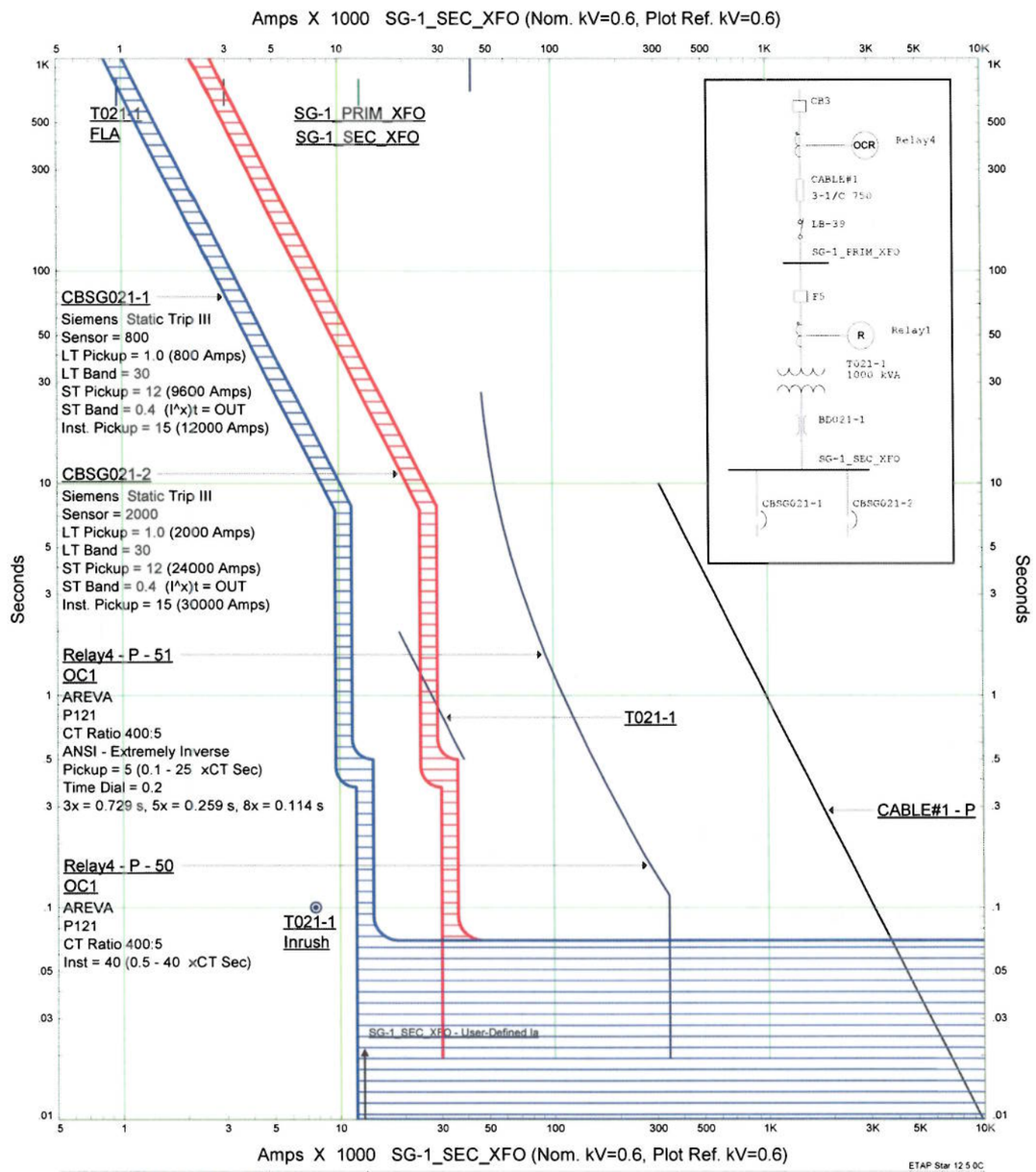


DESSAU

Building 20 - Feeder #2

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

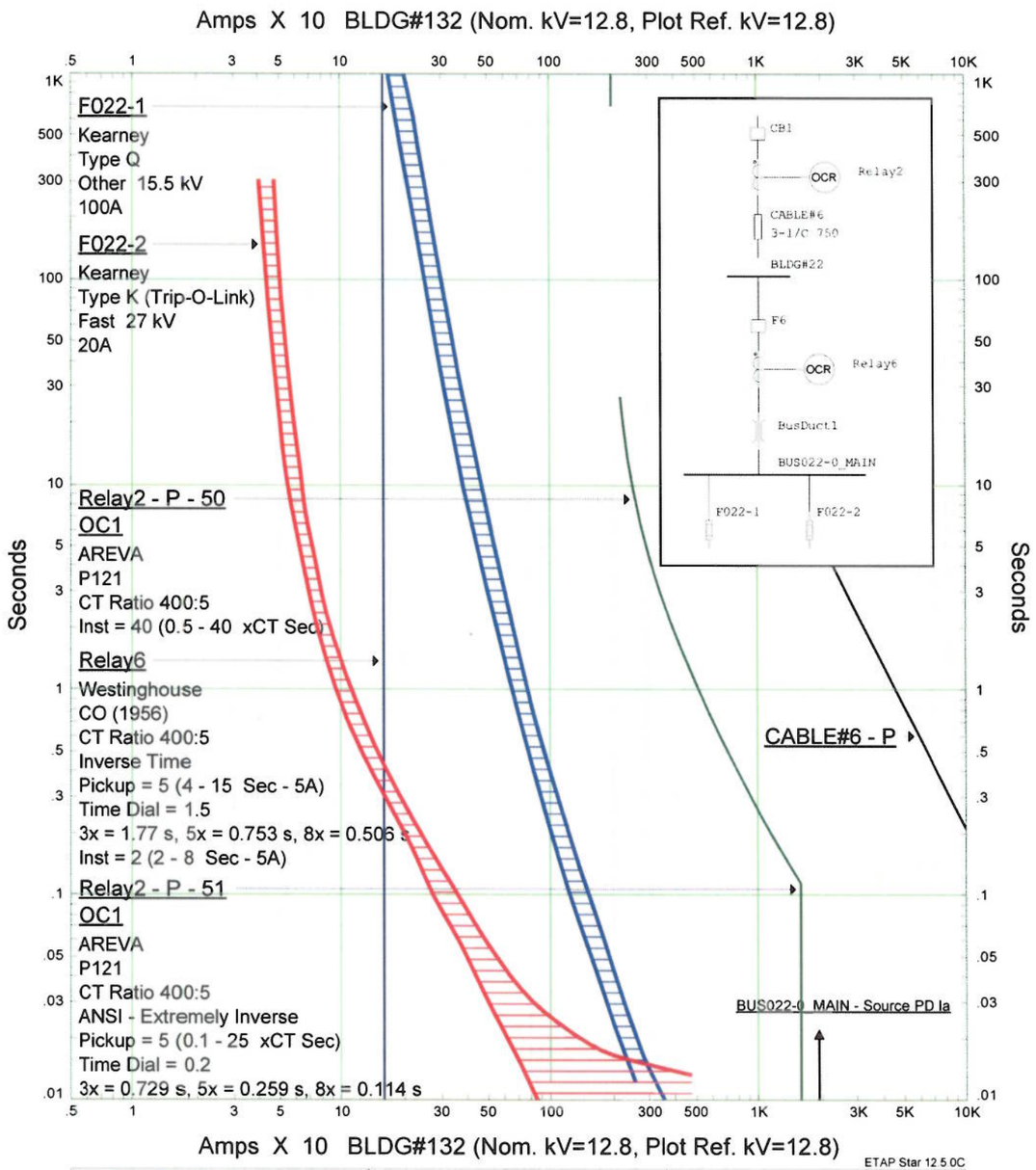


DESSAU

Building 21 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase



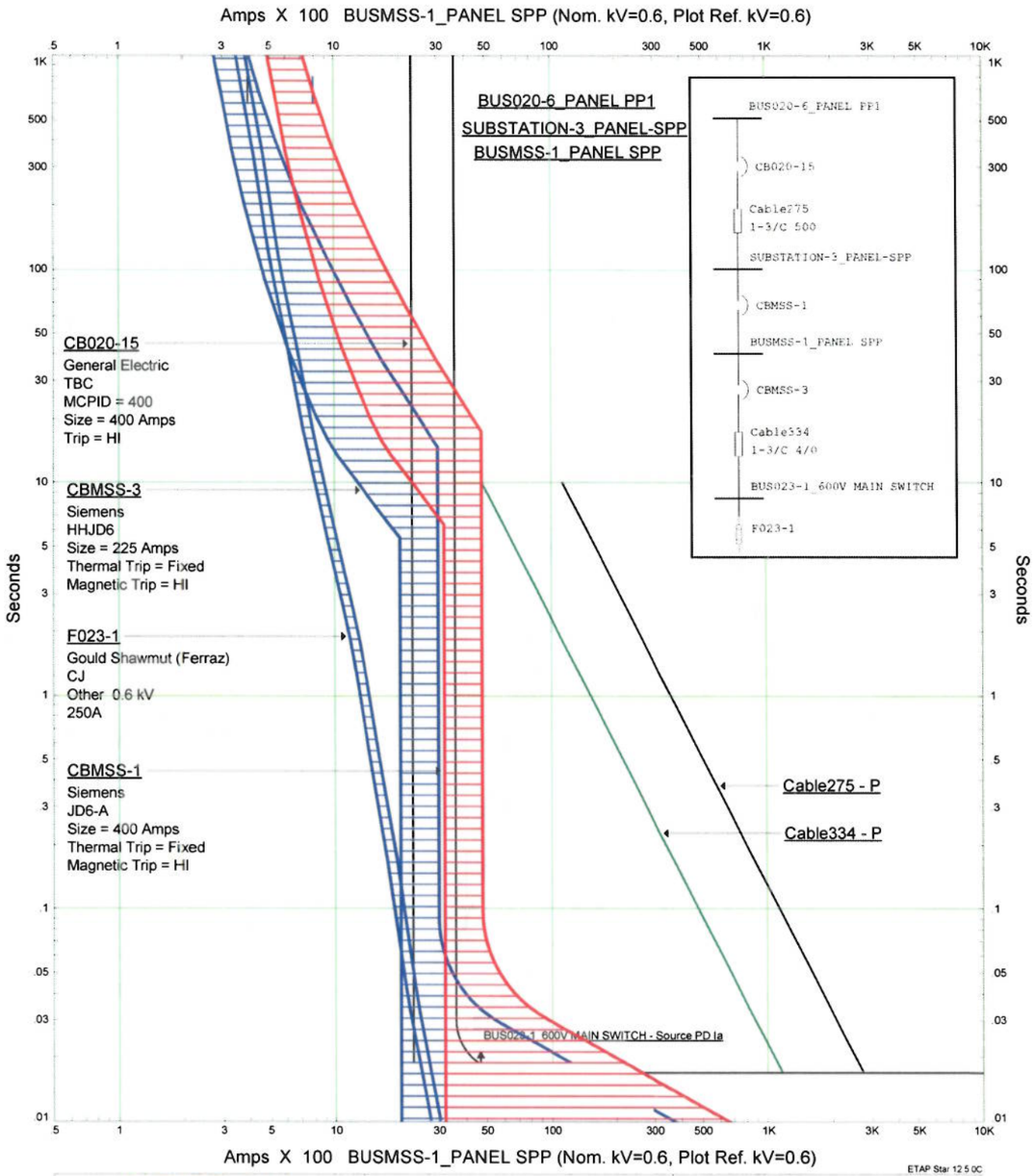
ETAP Star 12.5.0C

DESSAU

Building 22 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

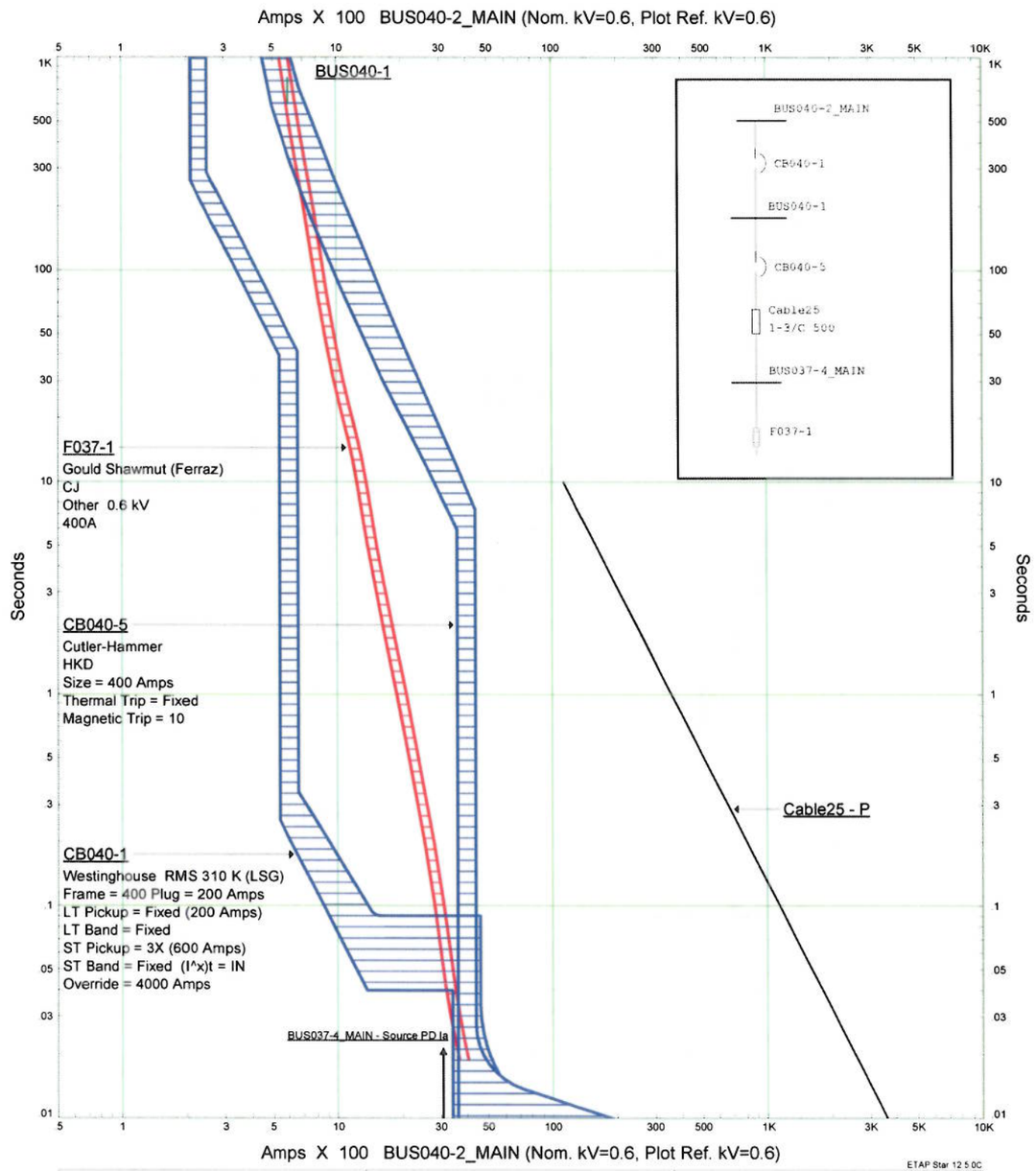


DESSAU

Building 23 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase



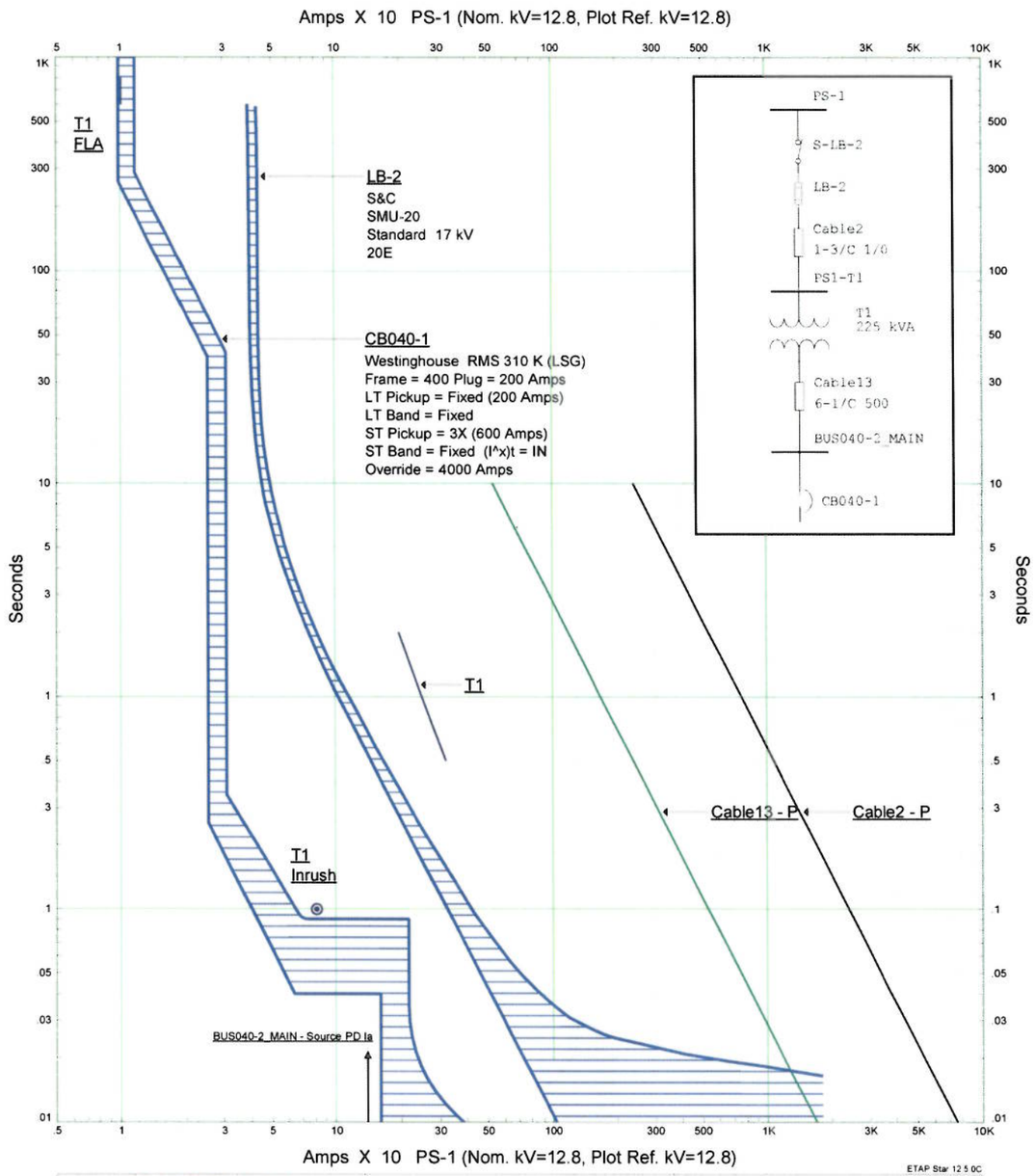
ETAP Star 12.5.0C

DESSAU

Building 37 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

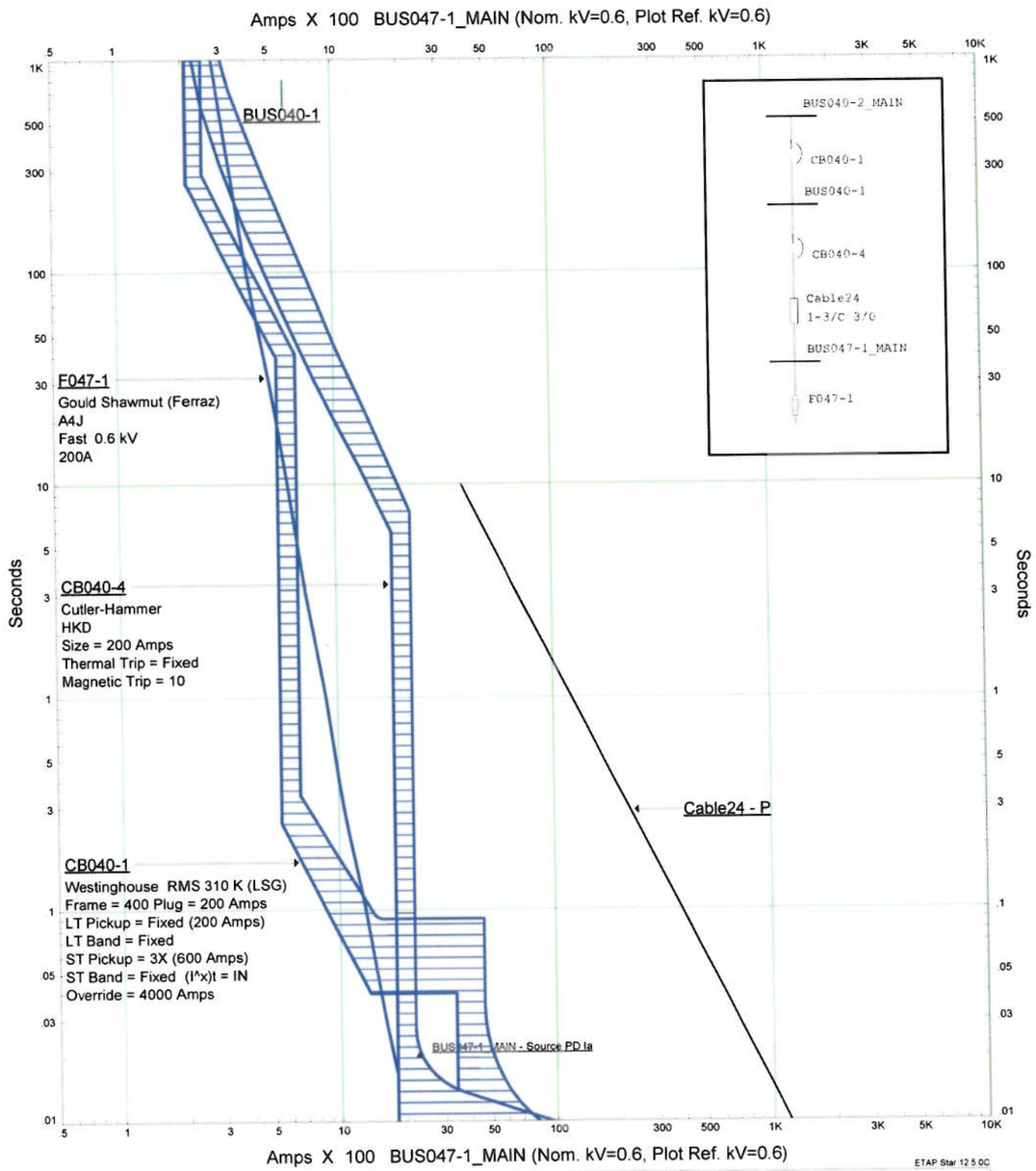


DESSAU

Building 40 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase



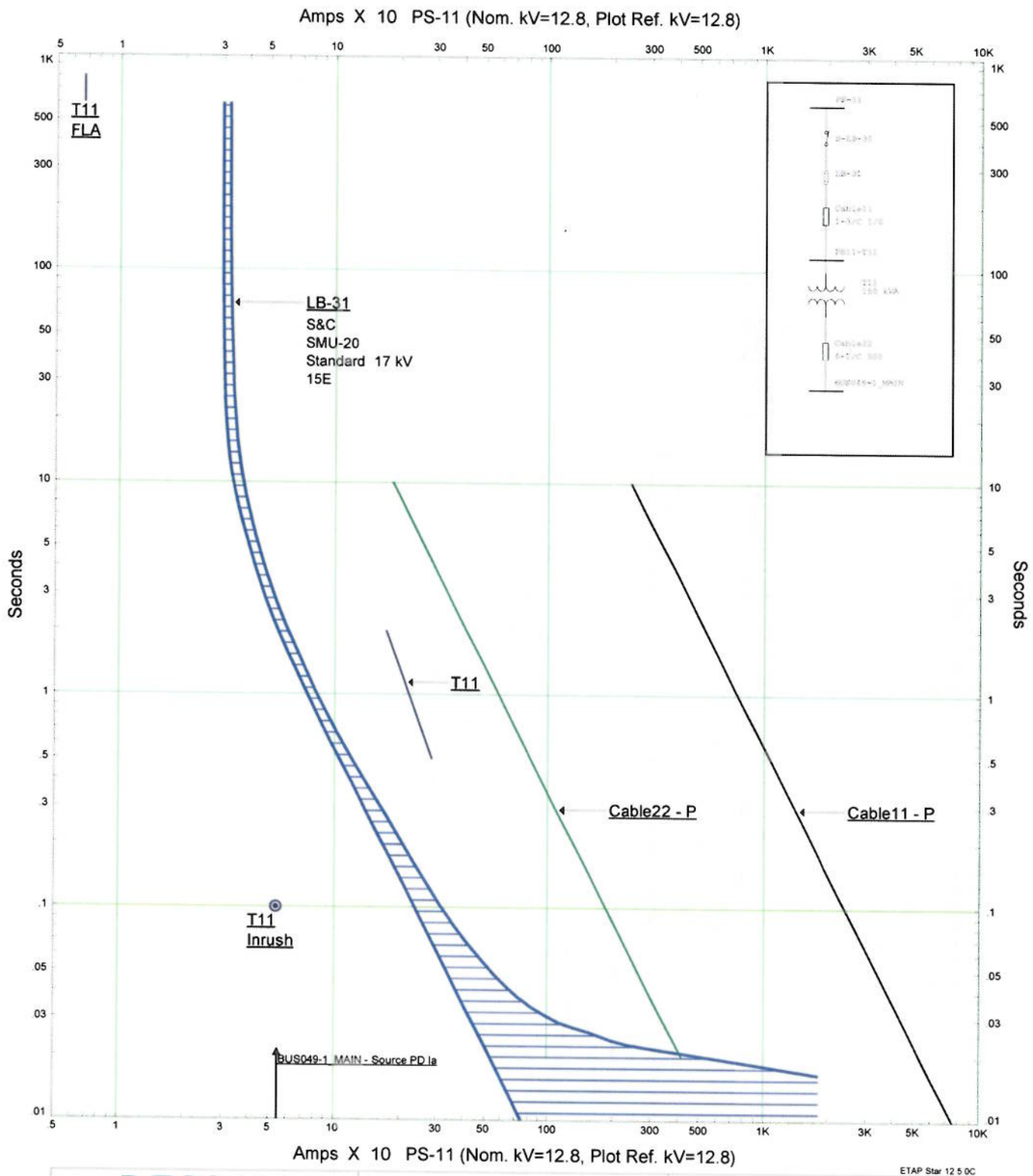
ETAP Star 12.5.0C

DESSAU

Building 47 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase



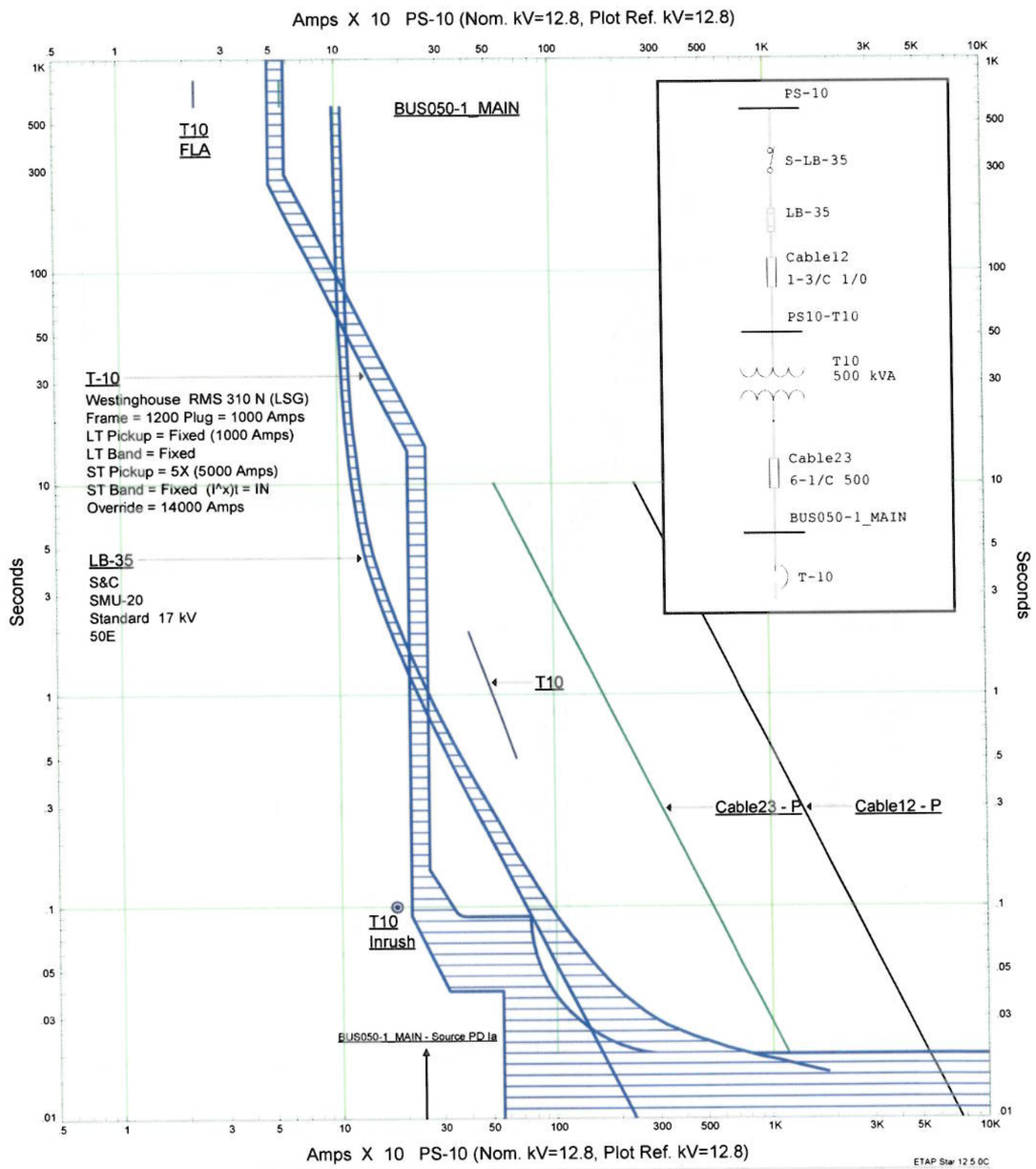
ETAP Star 12.5.0C

DESSAU

Building 49 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

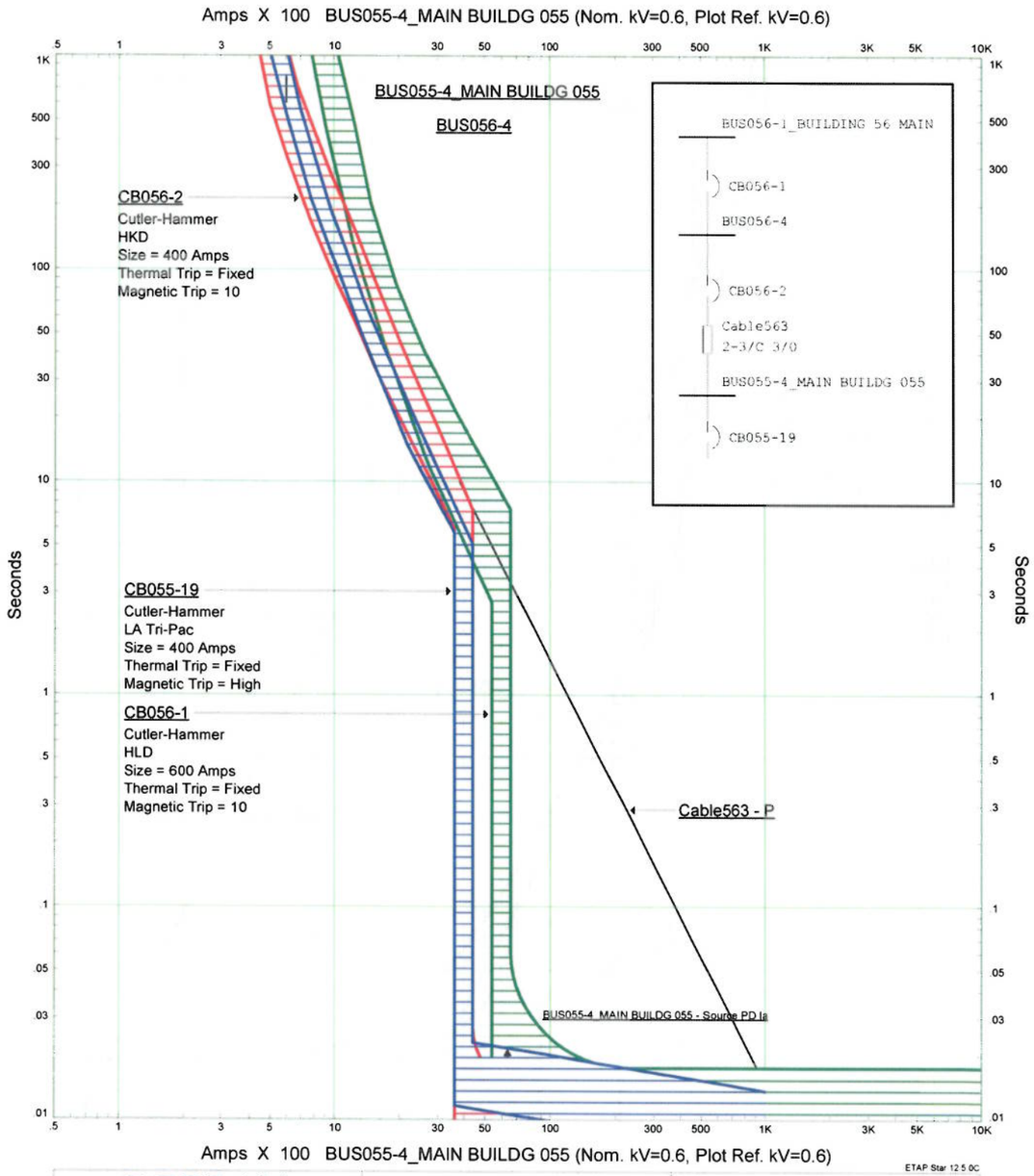


DESSAU

Building 50 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase



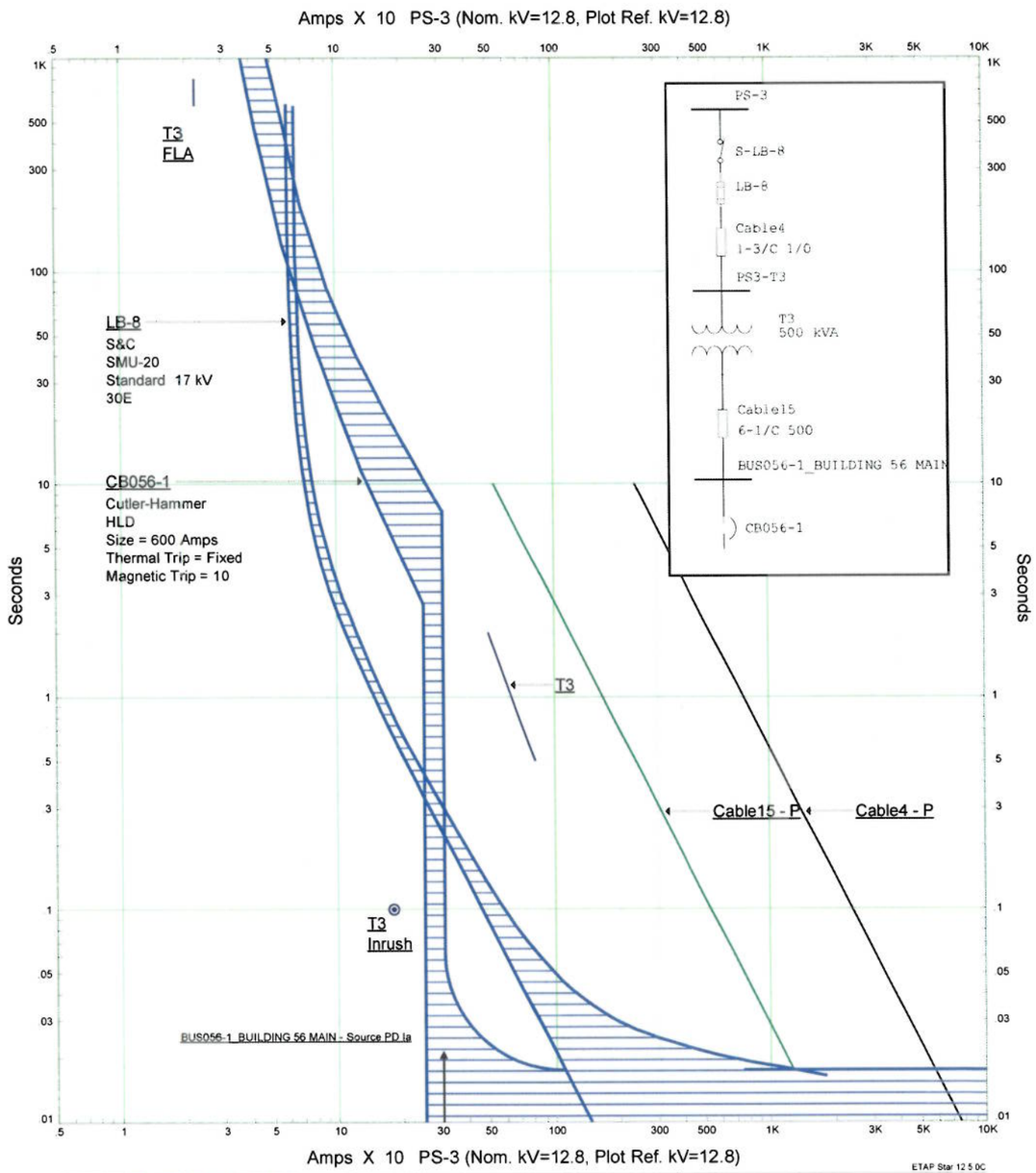
ETAP Star 12.5.0C

DESSAU

Building 55 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

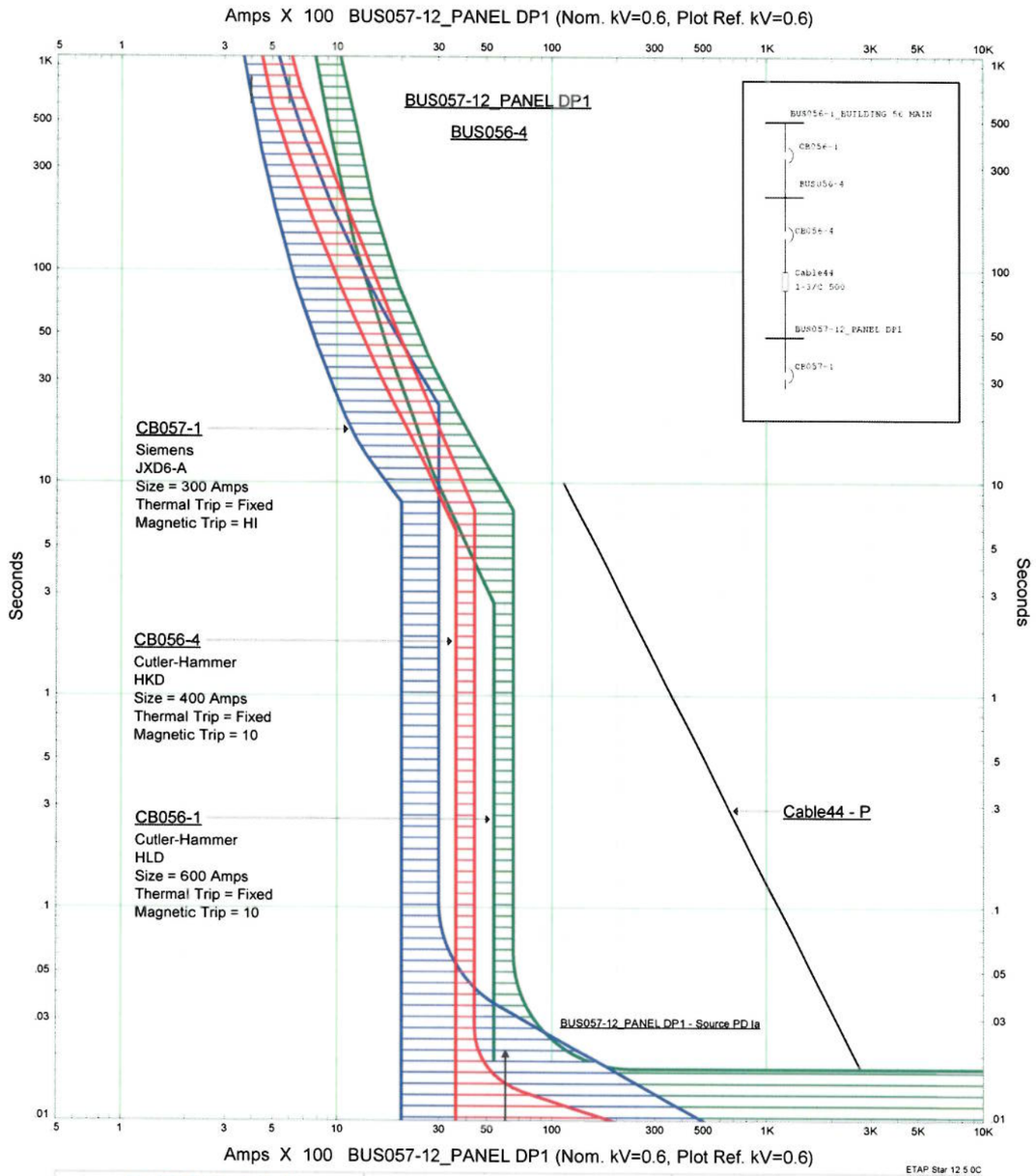


DESSAU

Building 56 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

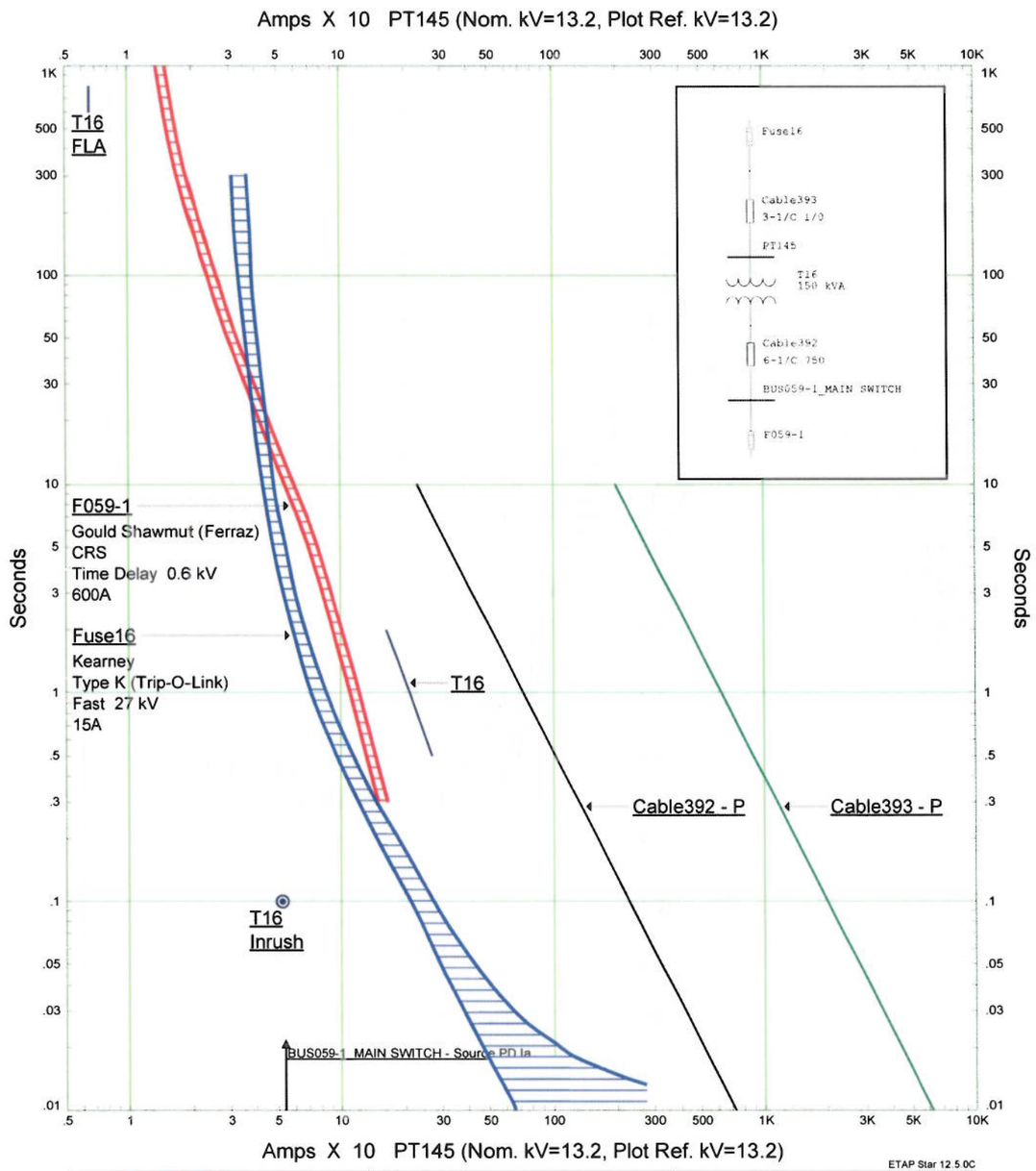


DESSAU

Building 57 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase



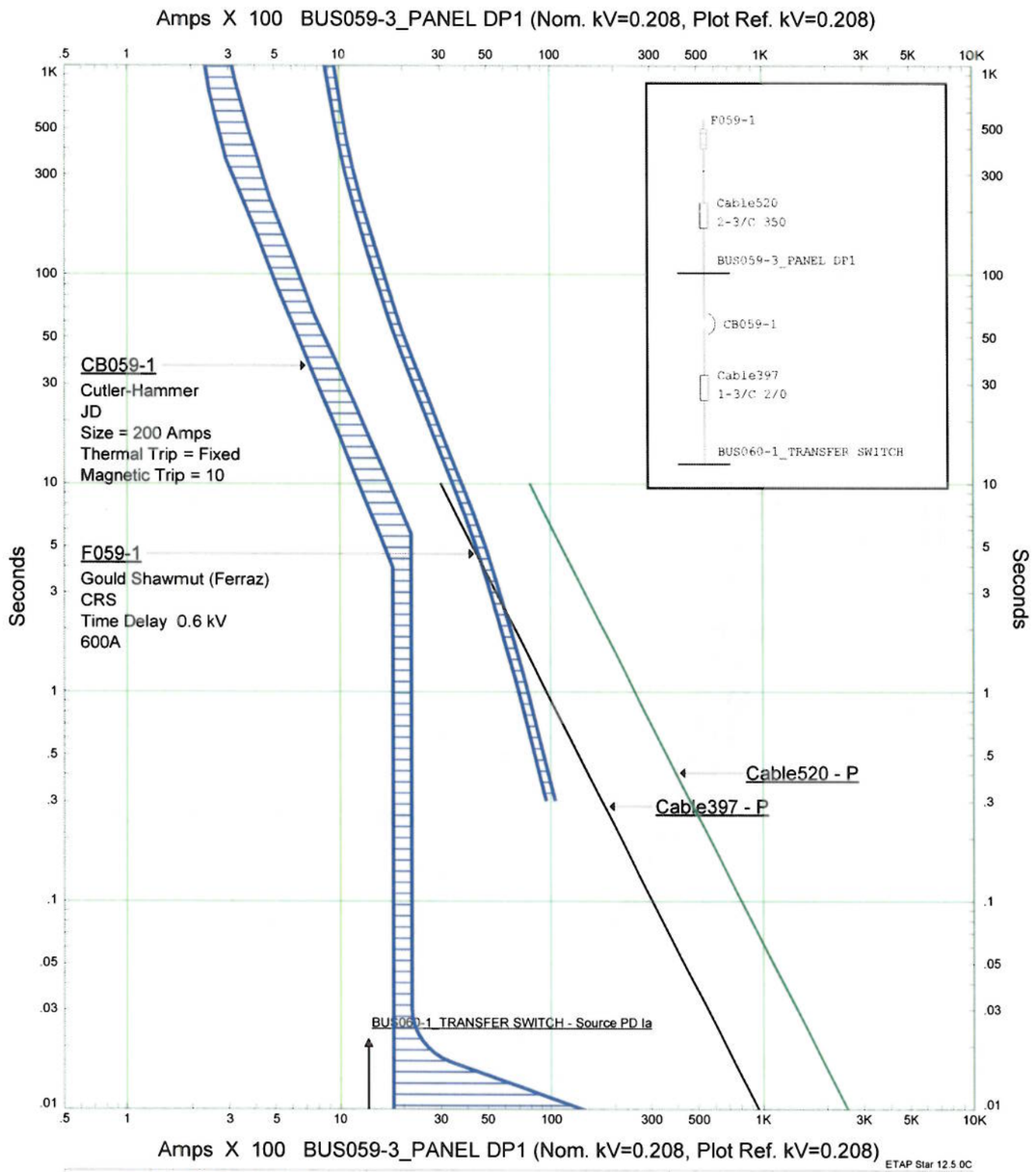
ETAP Star 12.5.0C

DESSAU

Building 59 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

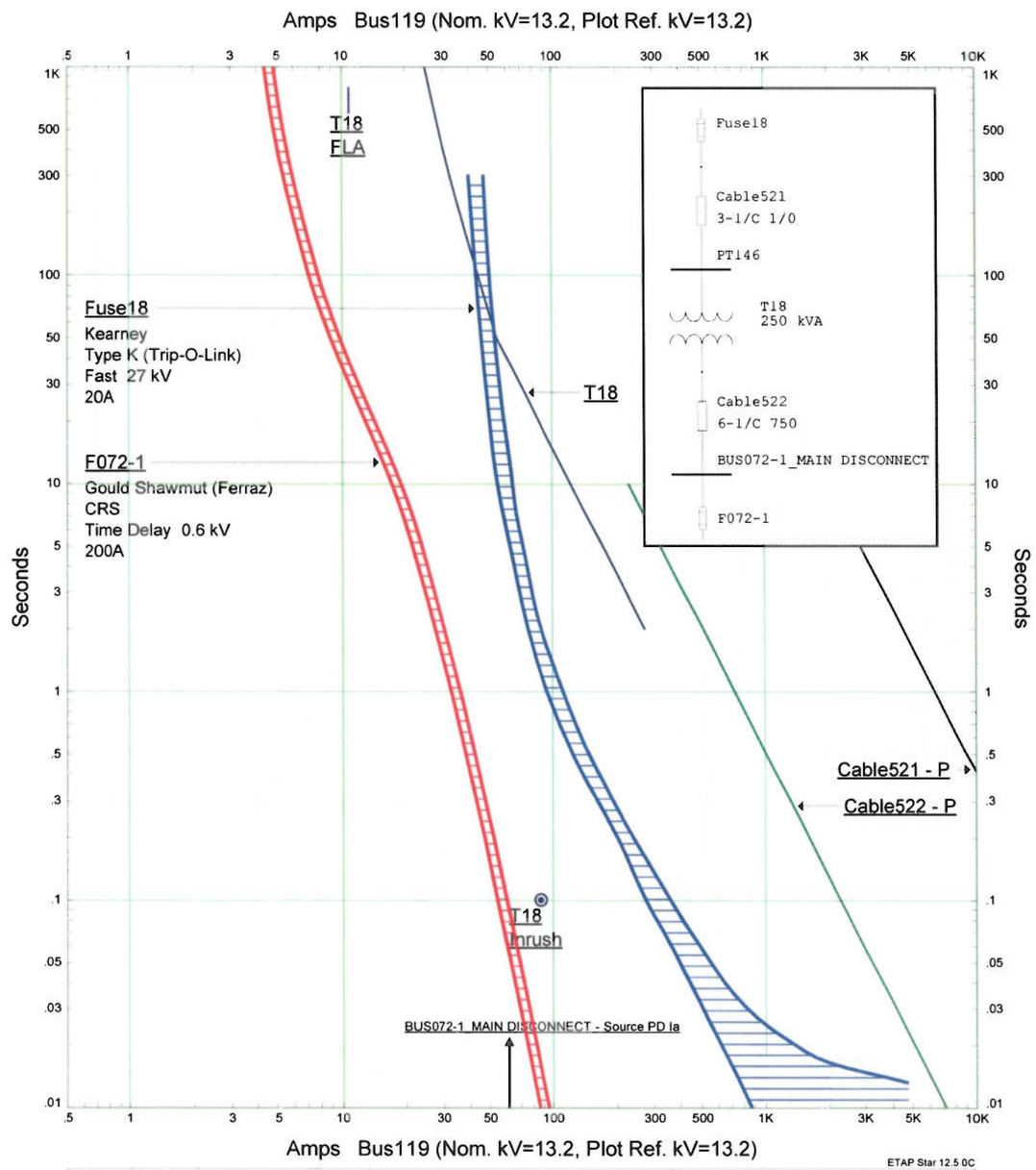


DESSAU

Building 60 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase



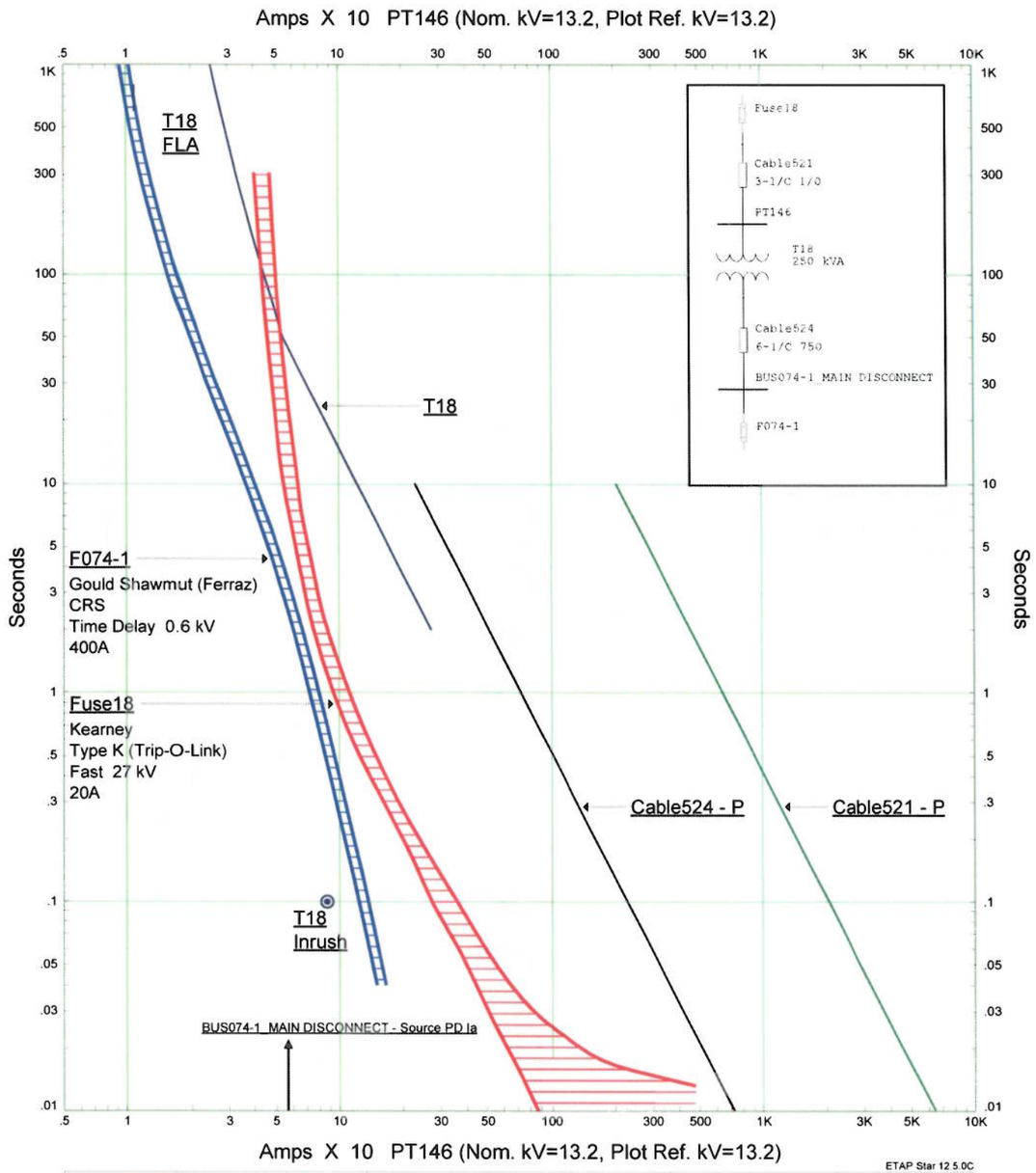
ETAP Star 12.5.0C

DESSAU

Building 72 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

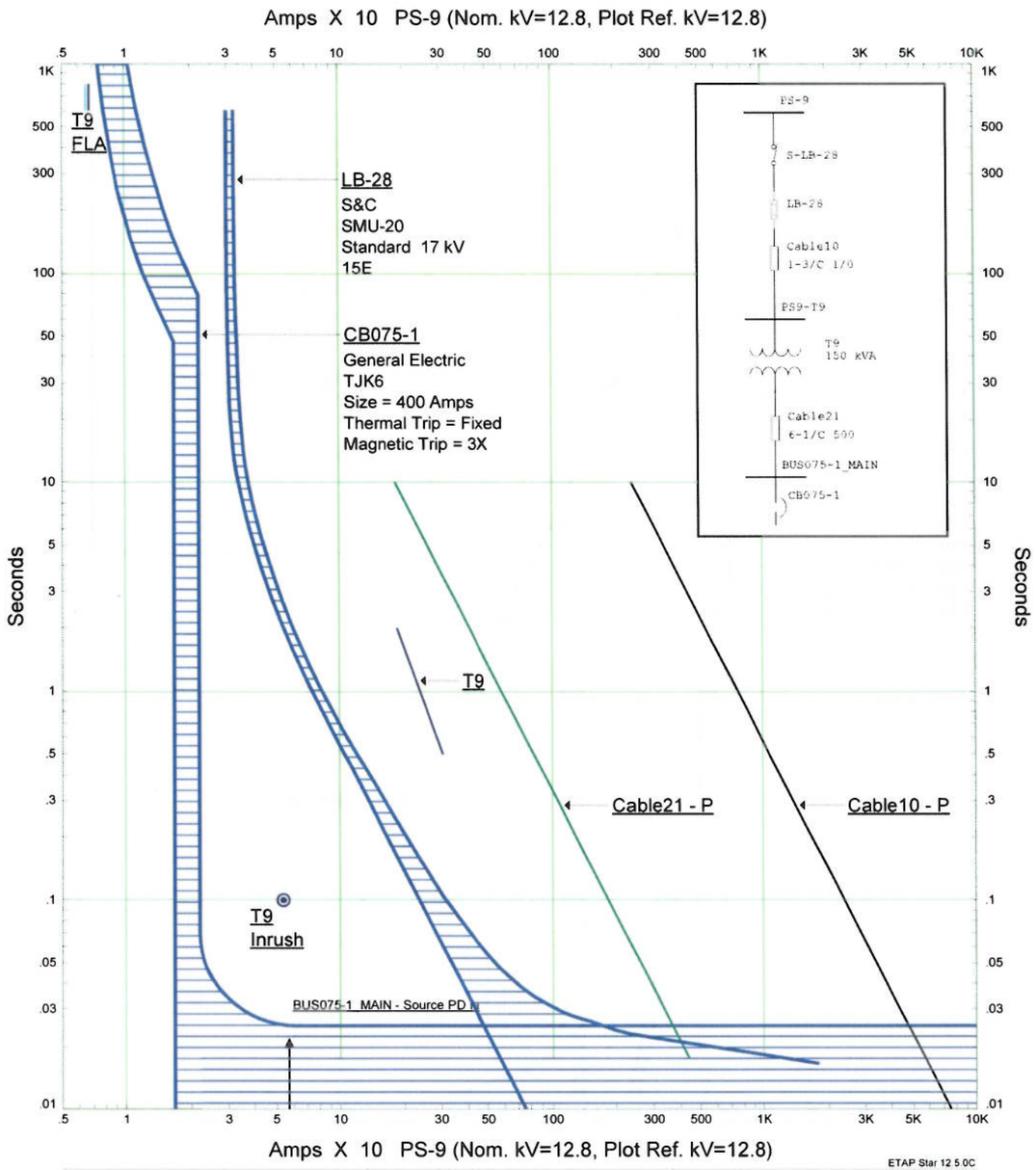


DESSAU

Building 74 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

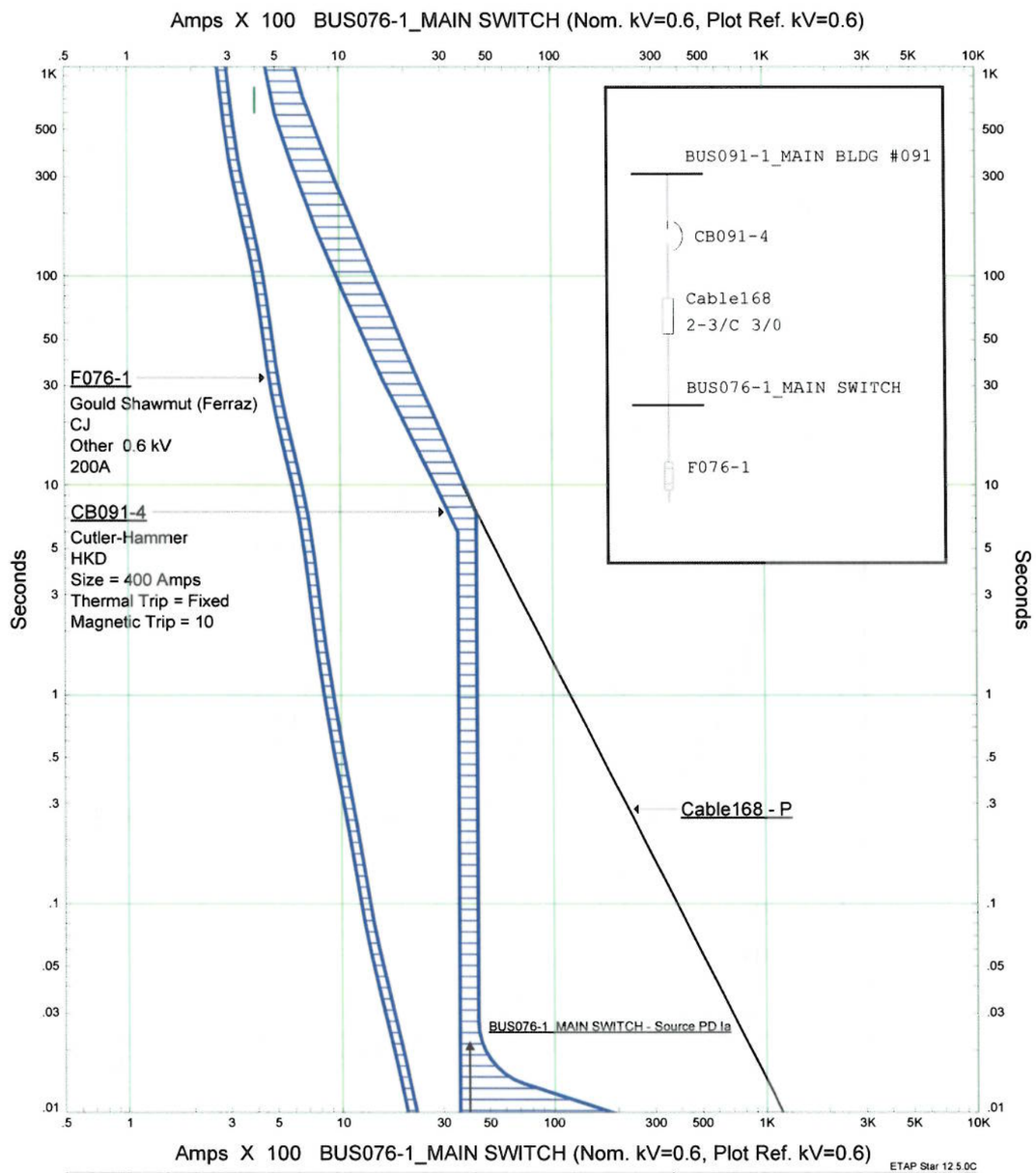


DESSAU

Building 75 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

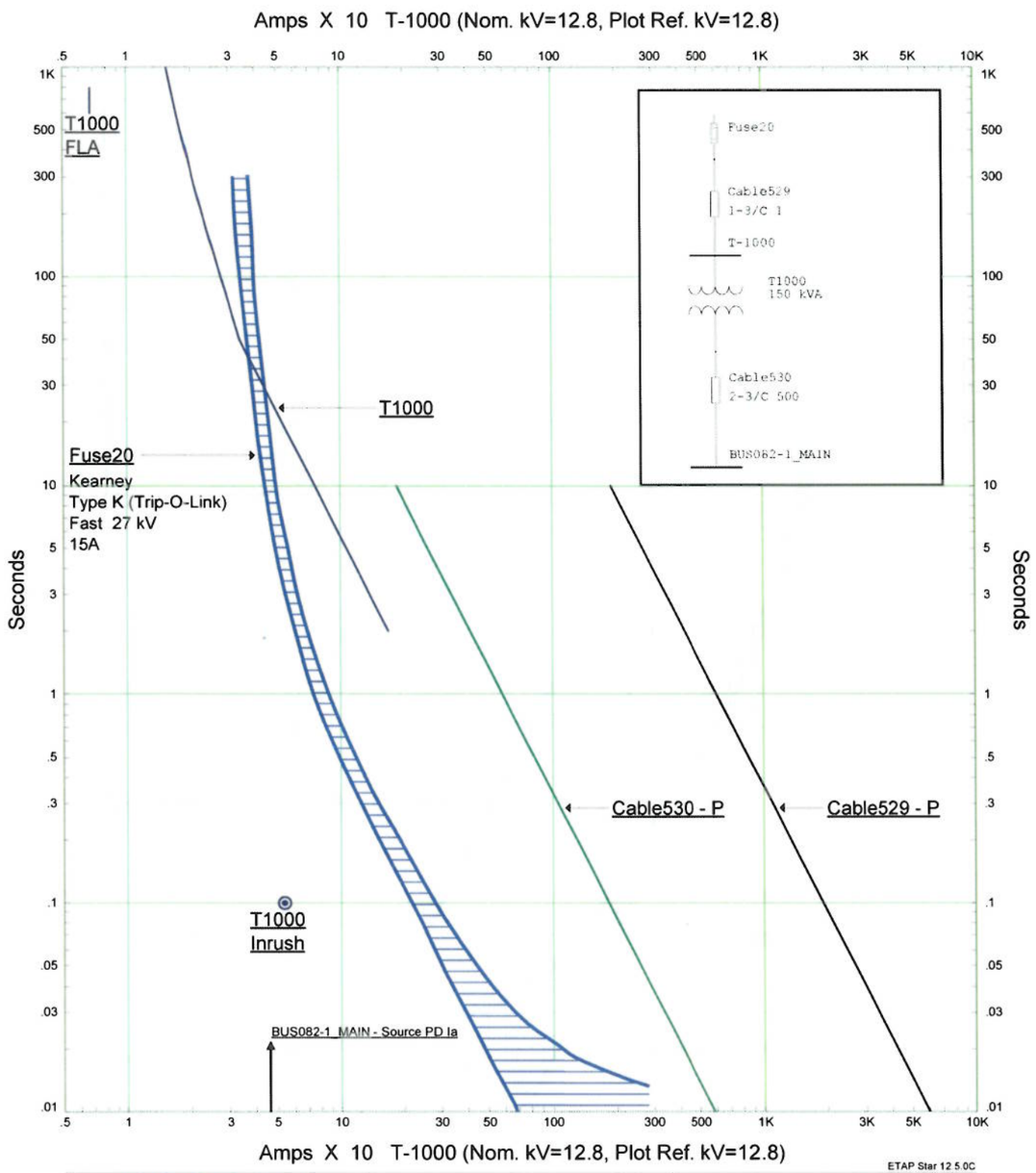


DESSAU

Building 76 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase



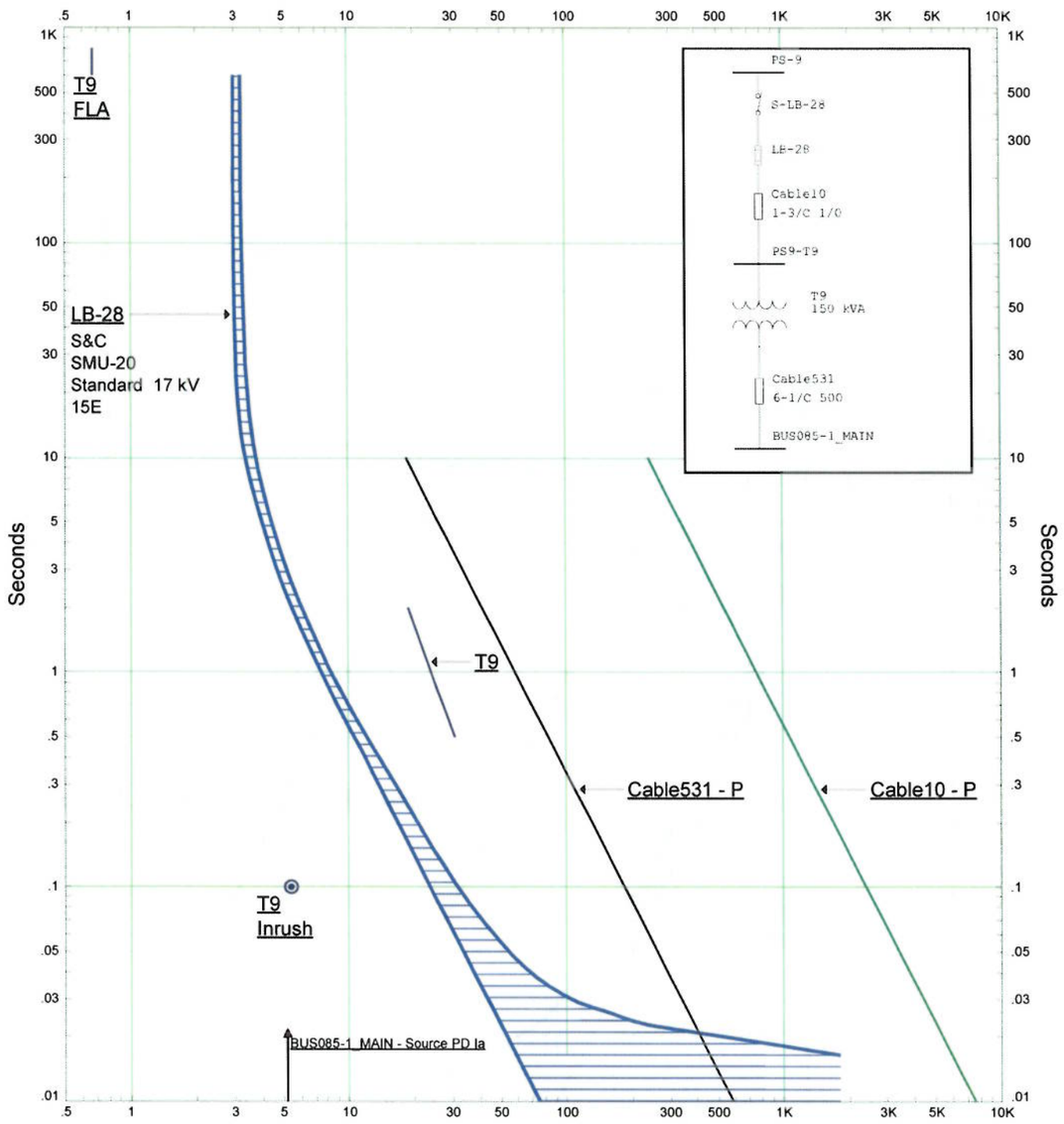
DESSAU

Building 82 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

Amps X 10 PS9-T9 (Nom. kV=12.8, Plot Ref. kV=12.8)



Amps X 10 PS9-T9 (Nom. kV=12.8, Plot Ref. kV=12.8)

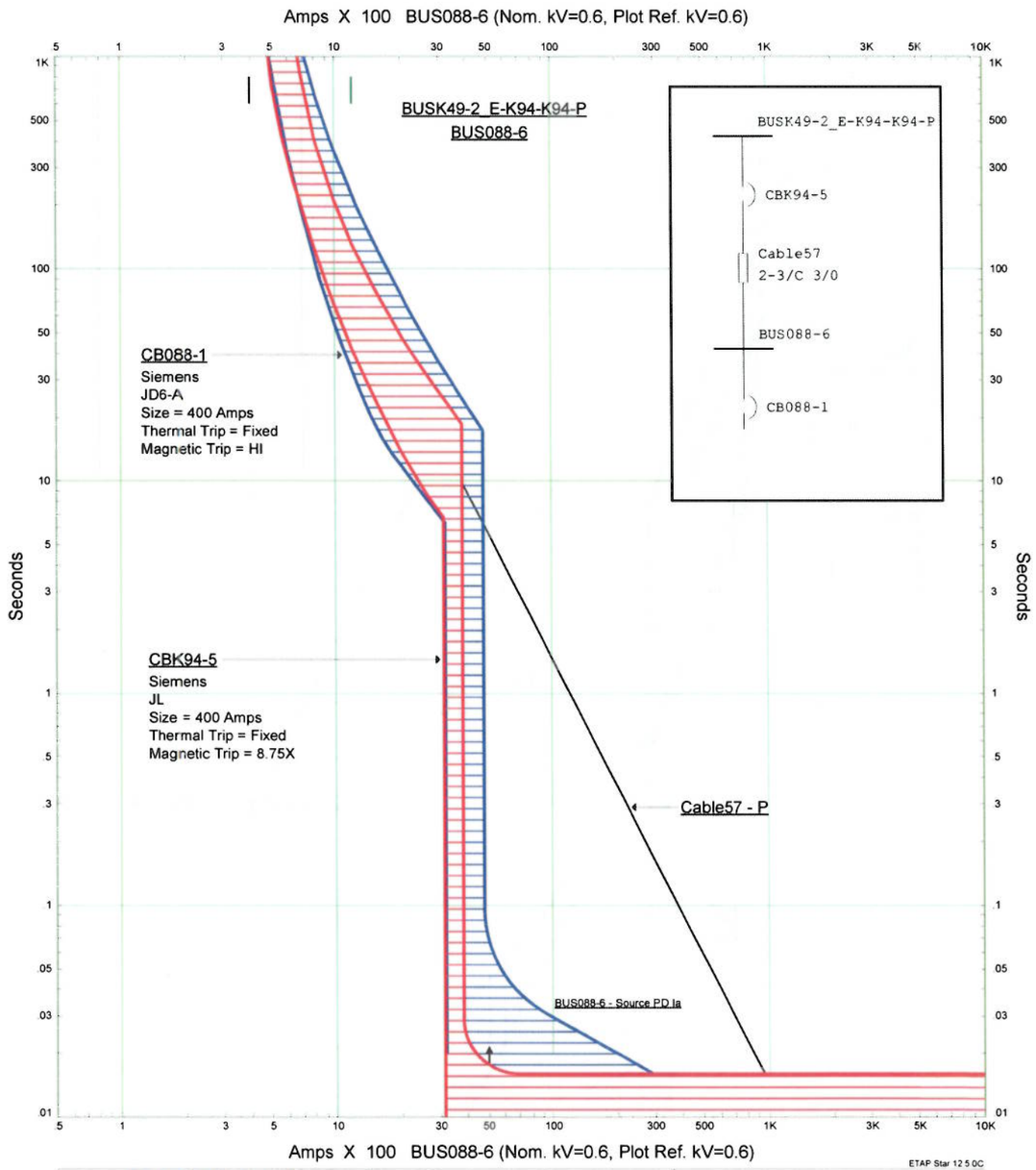
ETAP Star 12.5.0C

DESSAU

Building 85 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase



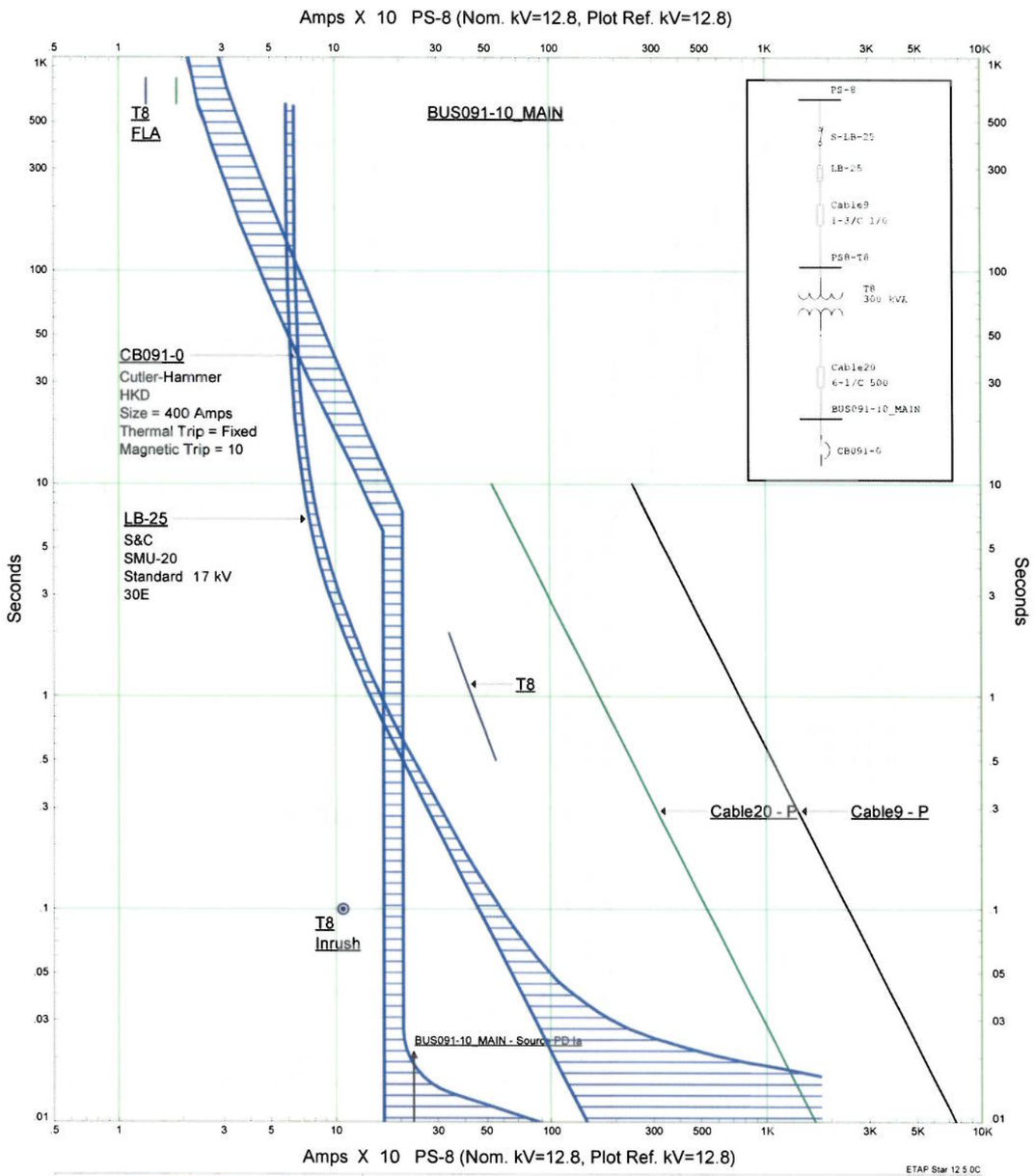
ETAP Star 12.5.0C

DESSAU

Building 88 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-000043O

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase



Amps X 10 PS-8 (Nom. kV=12.8, Plot Ref. kV=12.8)

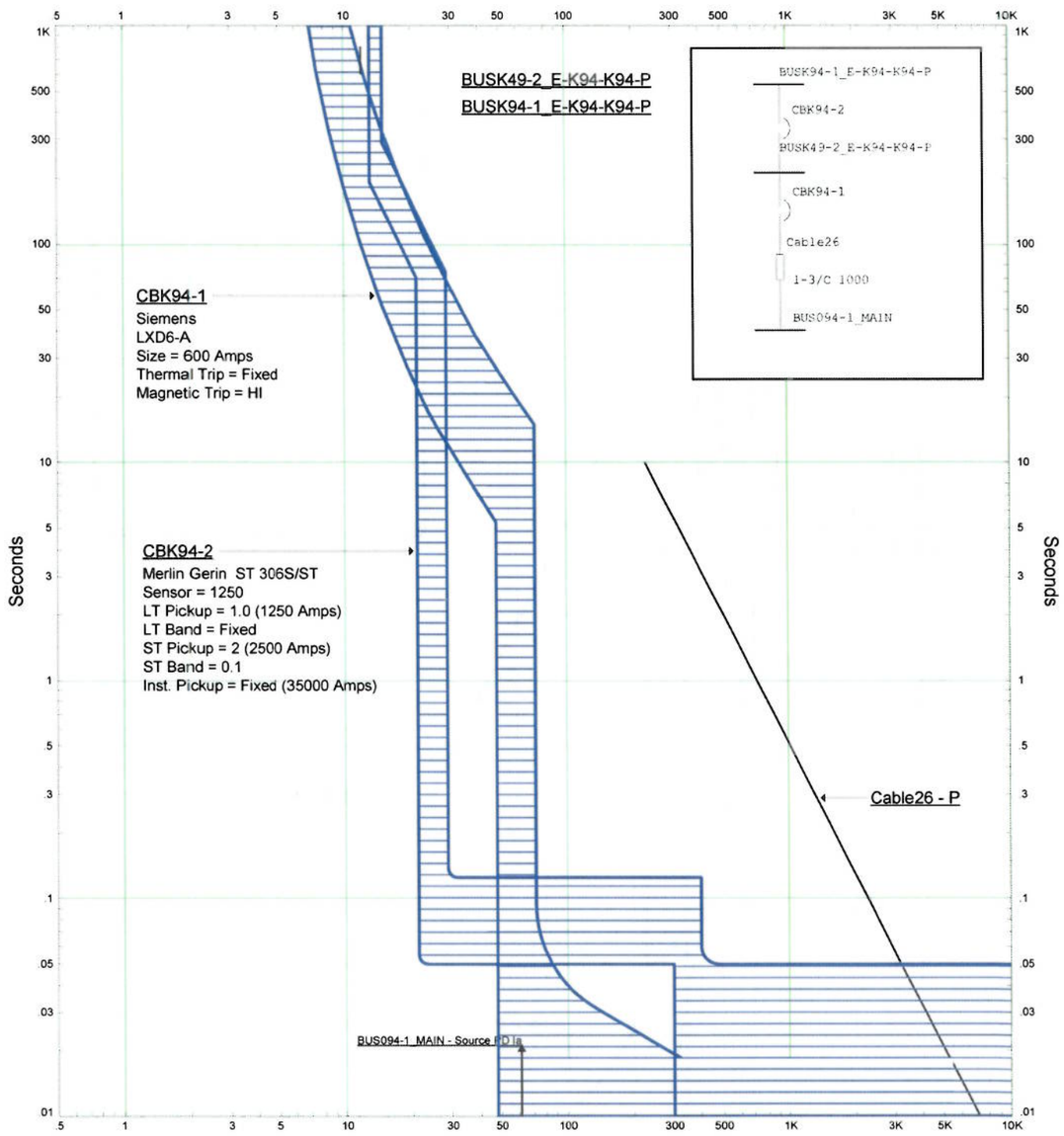
DESSAU

Building 91 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

Amps X 100 BUSK49-2_E-K94-K94-P (Nom. kV=0.6, Plot Ref. kV=0.6)



Amps X 100 BUSK49-2_E-K94-K94-P (Nom. kV=0.6, Plot Ref. kV=0.6)

ETAP Star 12.5.0C

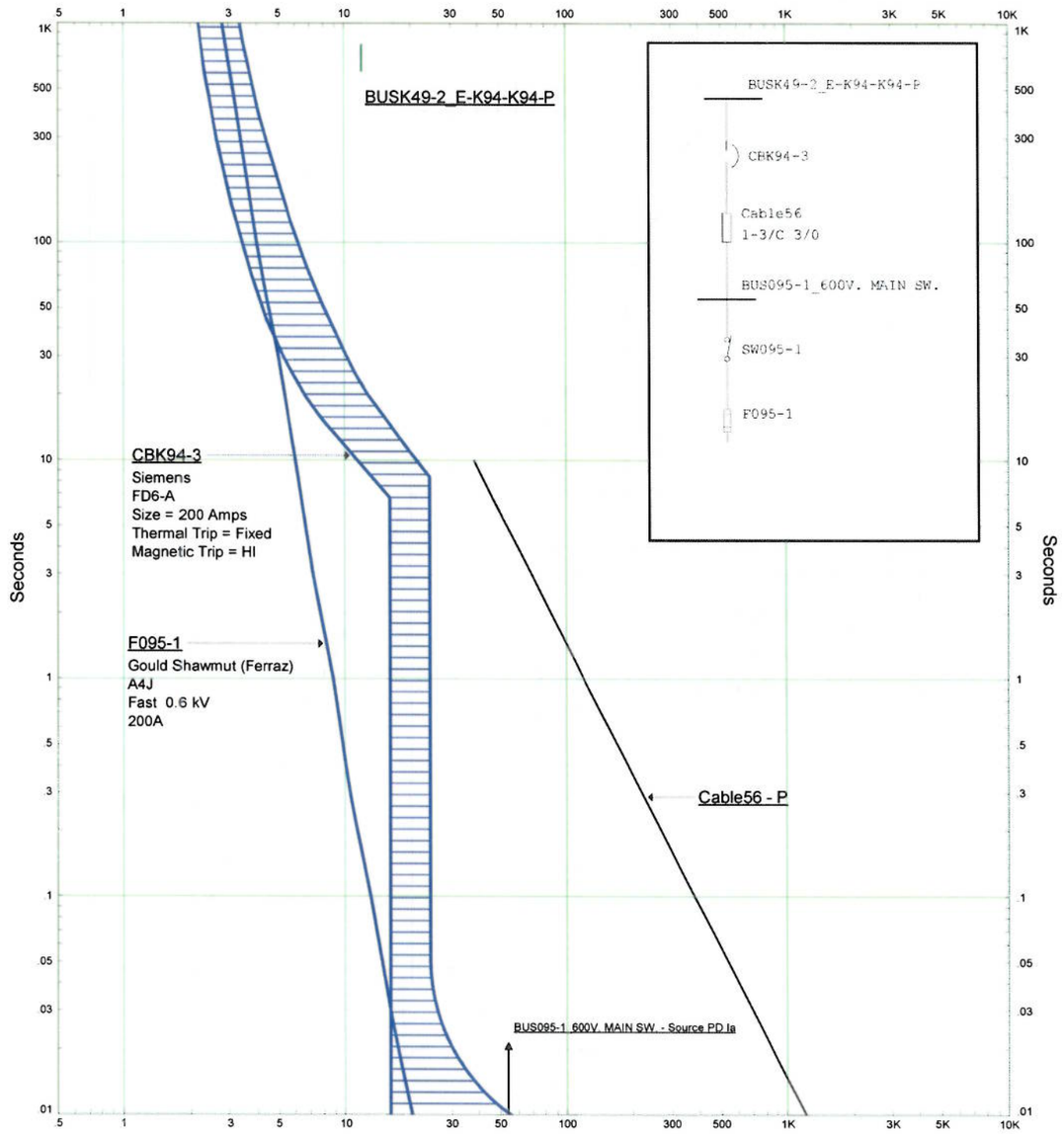
DESSAU

Building 94 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

Amps X 100 BUS095-1_600V. MAIN SW. (Nom. kV=0.6, Plot Ref. kV=0.6)



Amps X 100 BUS095-1_600V. MAIN SW. (Nom. kV=0.6, Plot Ref. kV=0.6)

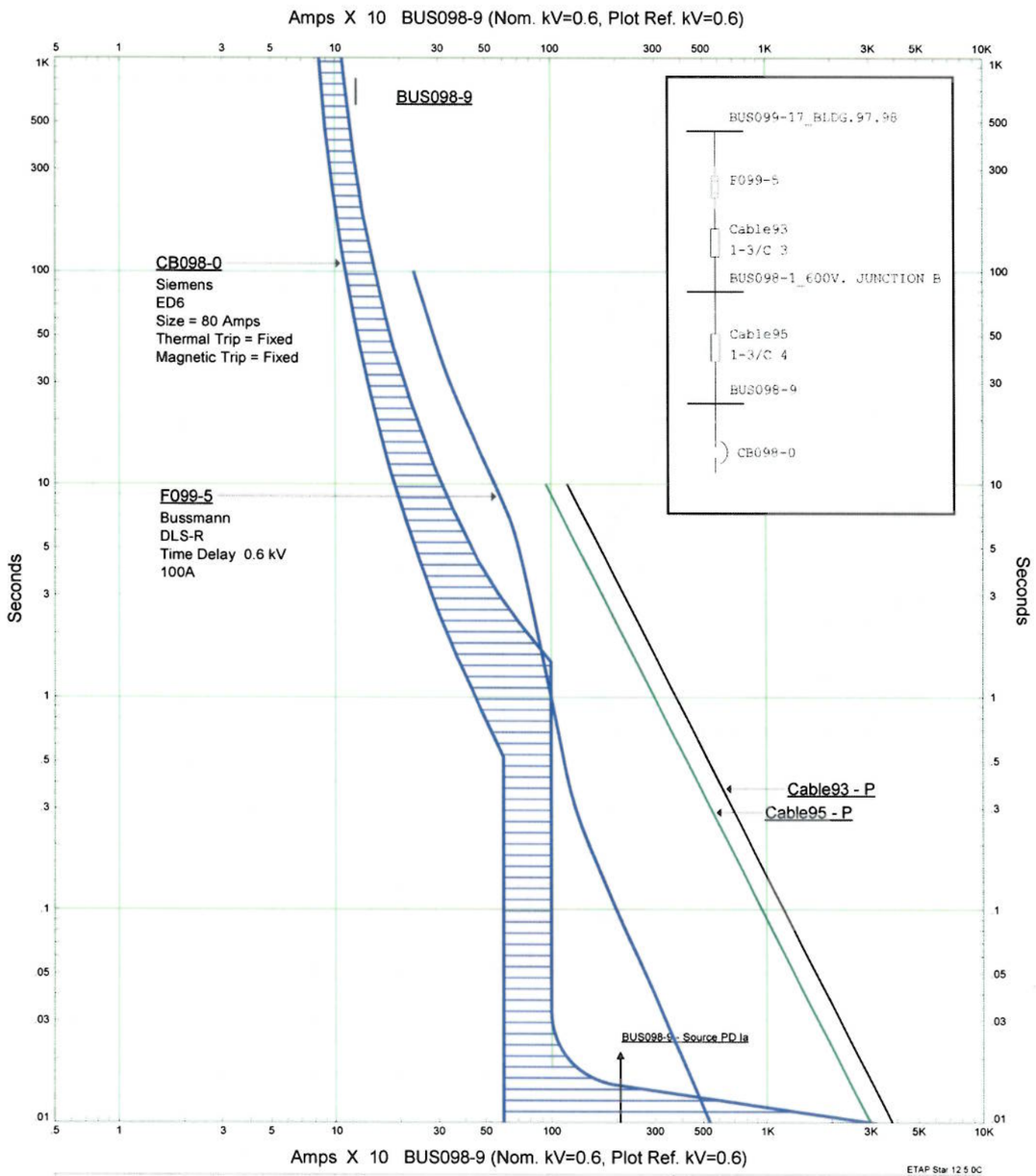
ETAP Star 12.5.0C

DESSAU

Building 95 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase



ETAP Star 12.5.0C

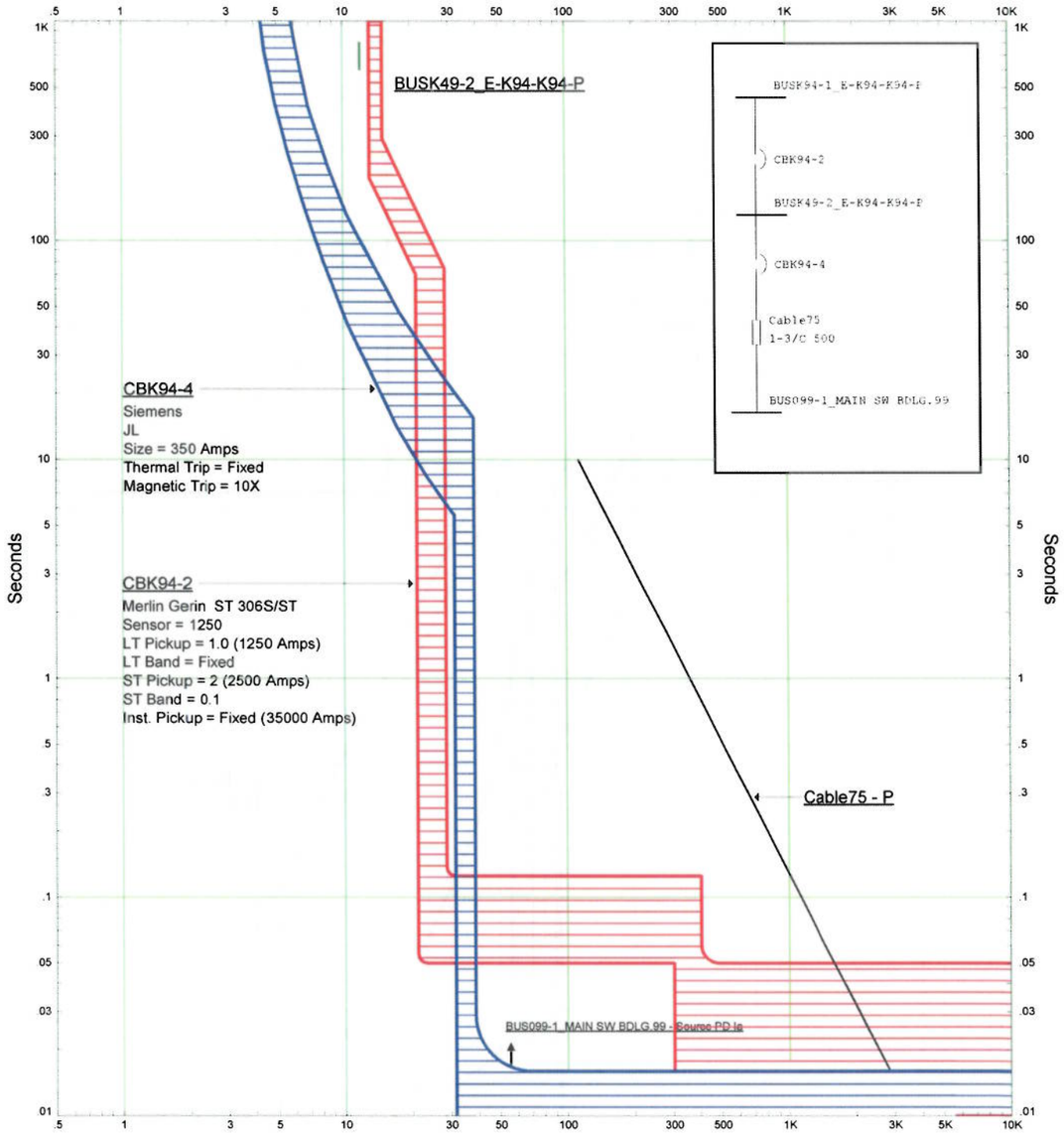
DESSAU

Building 98 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-000043C

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

Amps X 100 BUSK49-2_E-K94-K94-P (Nom. kV=0.6, Plot Ref. kV=0.6)



Amps X 100 BUSK49-2_E-K94-K94-P (Nom. kV=0.6, Plot Ref. kV=0.6)

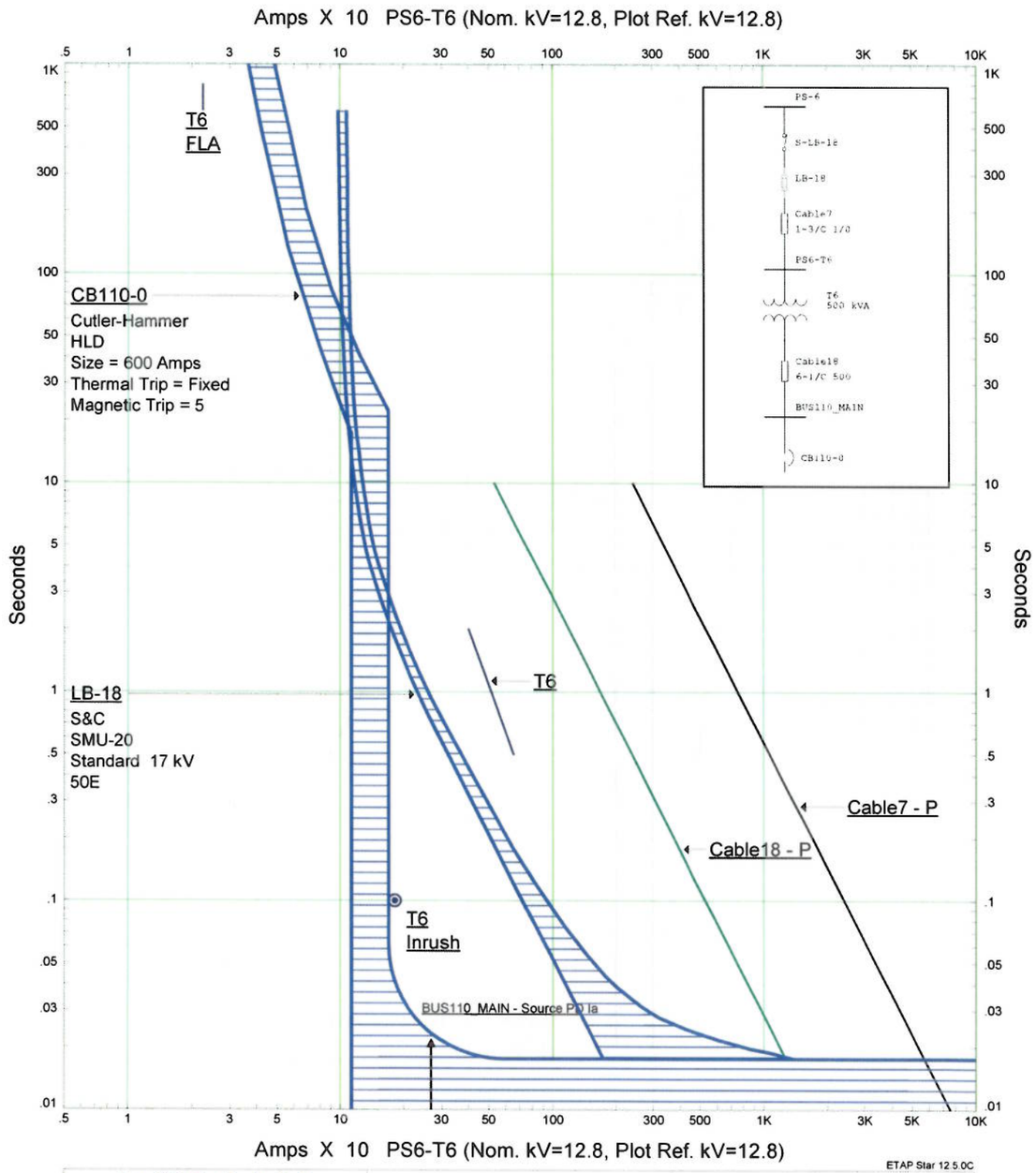
ETAP Star 12.5.0C

DESSAU

Building 99 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase



ETAP Star 12.5.0C

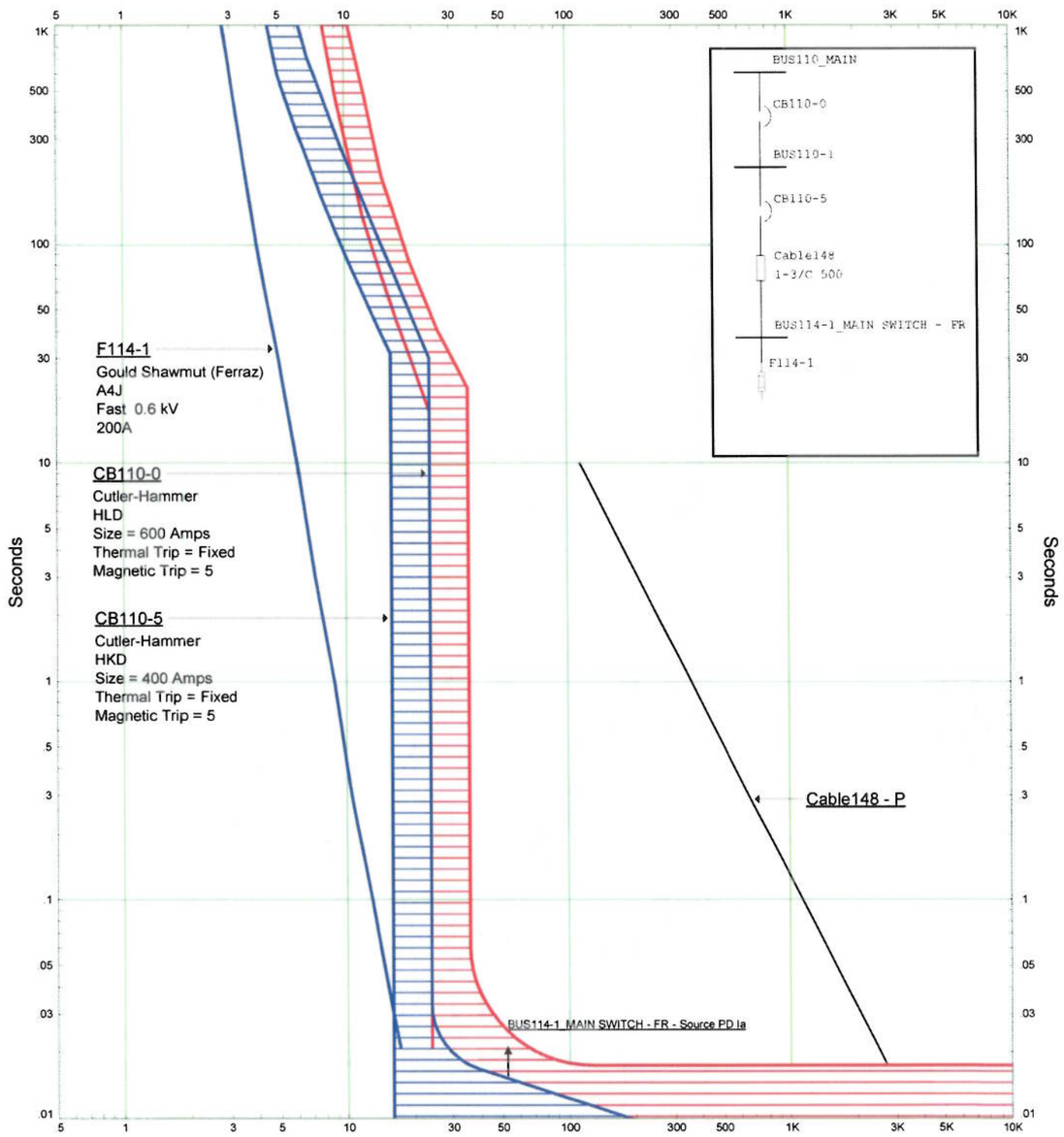
DESSAU

Building 110 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

Amps X 100 BUS114-1_MAIN SWITCH - FR (Nom. kV=0.6, Plot Ref. kV=0.6)



Amps X 100 BUS114-1_MAIN SWITCH - FR (Nom. kV=0.6, Plot Ref. kV=0.6)

ETAP Star 12.5.0C

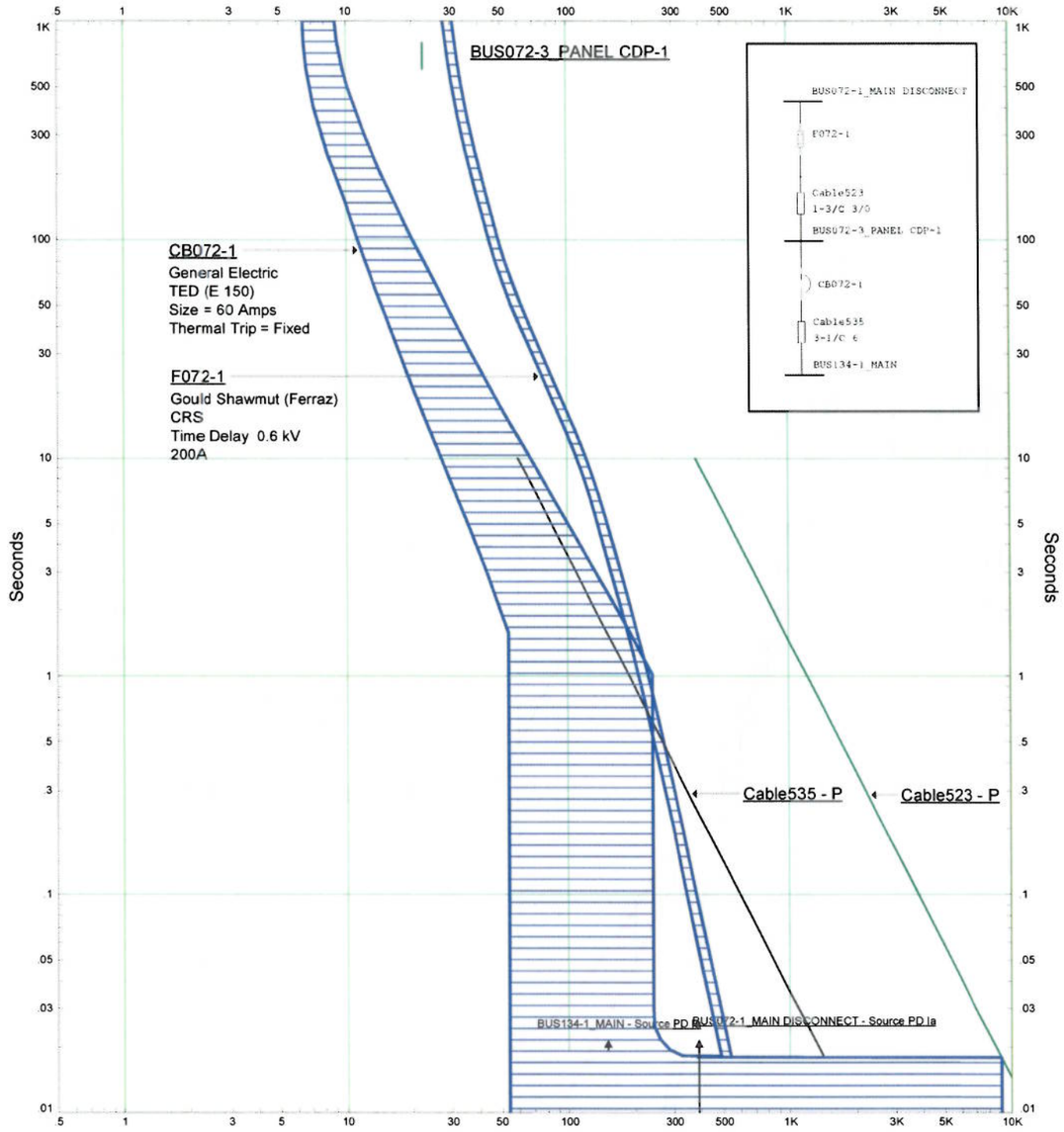
DESSAU

Building 114 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

Amps X 10 BUS072-3_PANEL CDP-1 (Nom. kV=0.208, Plot Ref. kV=0.208)



Amps X 10 BUS072-3_PANEL CDP-1 (Nom. kV=0.208, Plot Ref. kV=0.208)

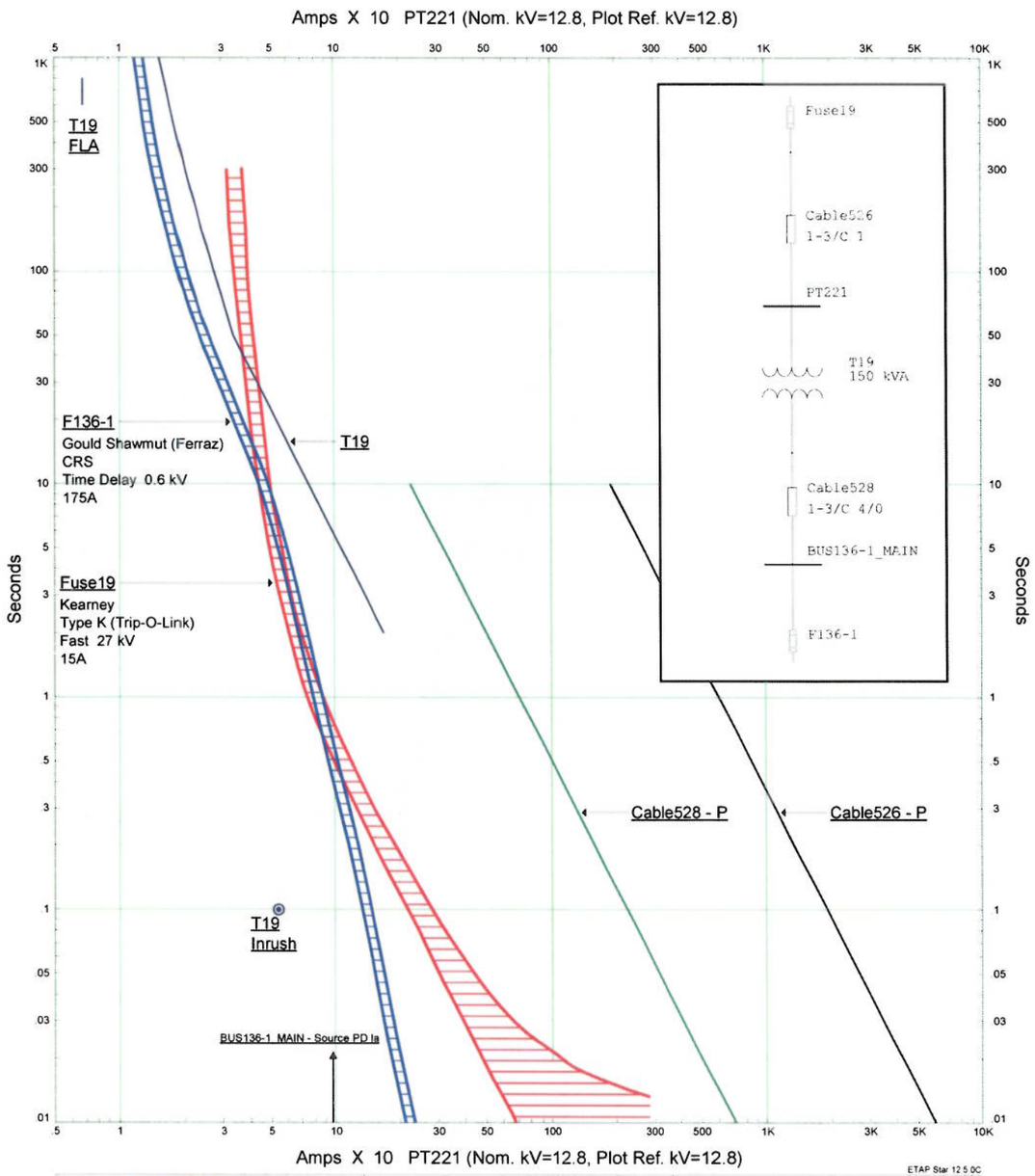
ETAP Star 12.5.0C

DESSAU

Building 134 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase



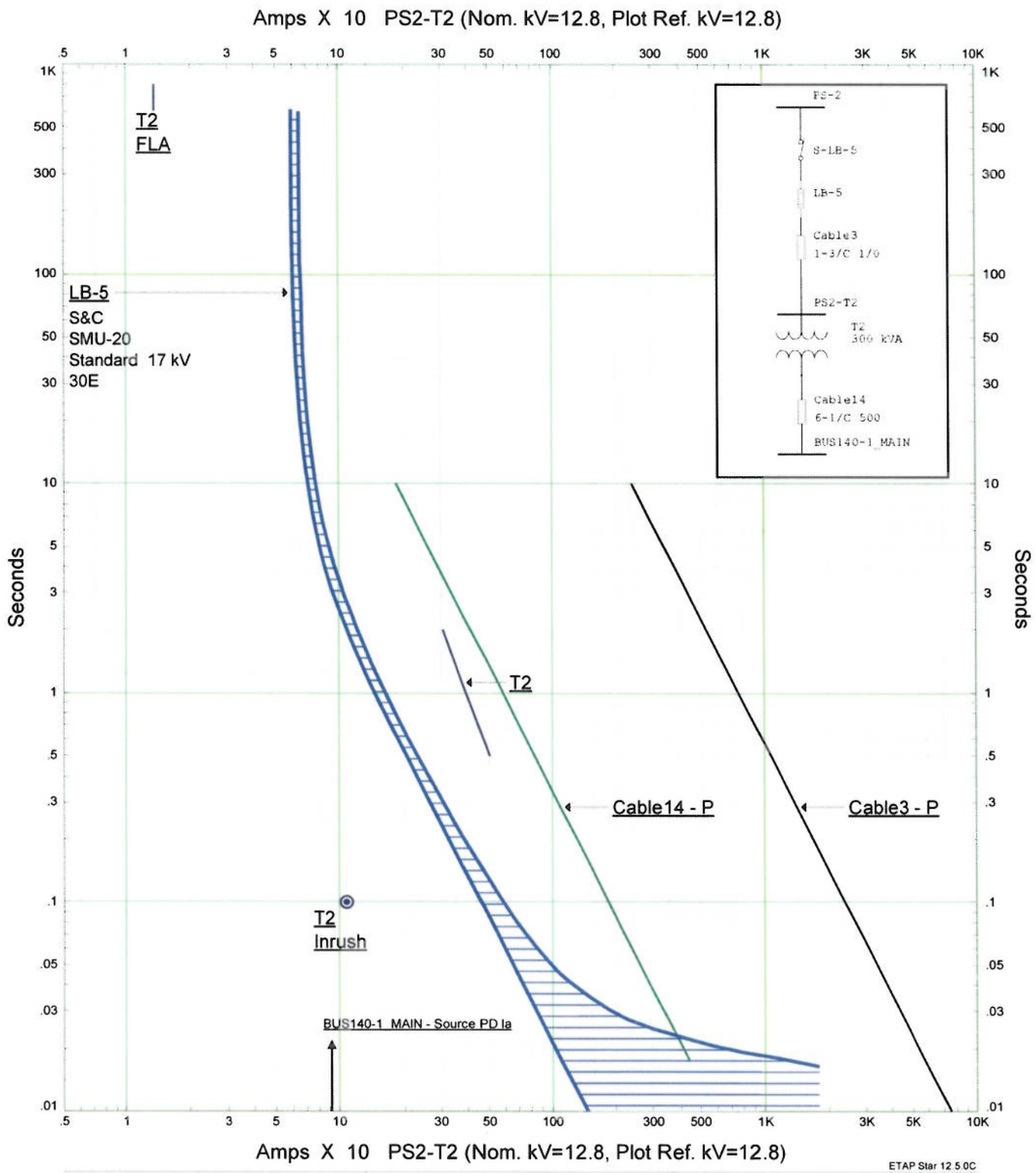
ETAP Star 12.5.0C

DESSAU

Building 136 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase



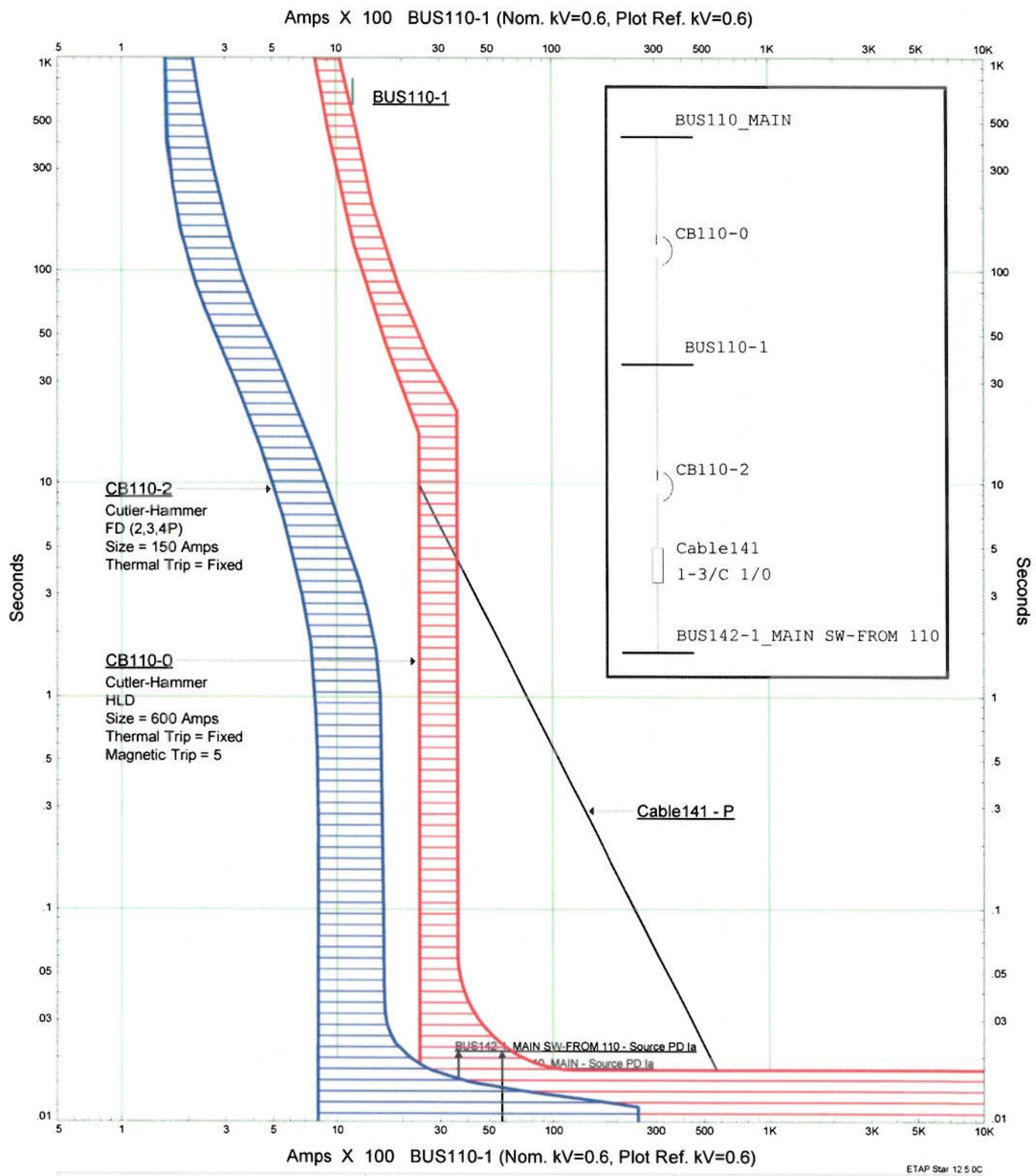
ETAP Star 12.5.0C

DESSAU

Building 140 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase



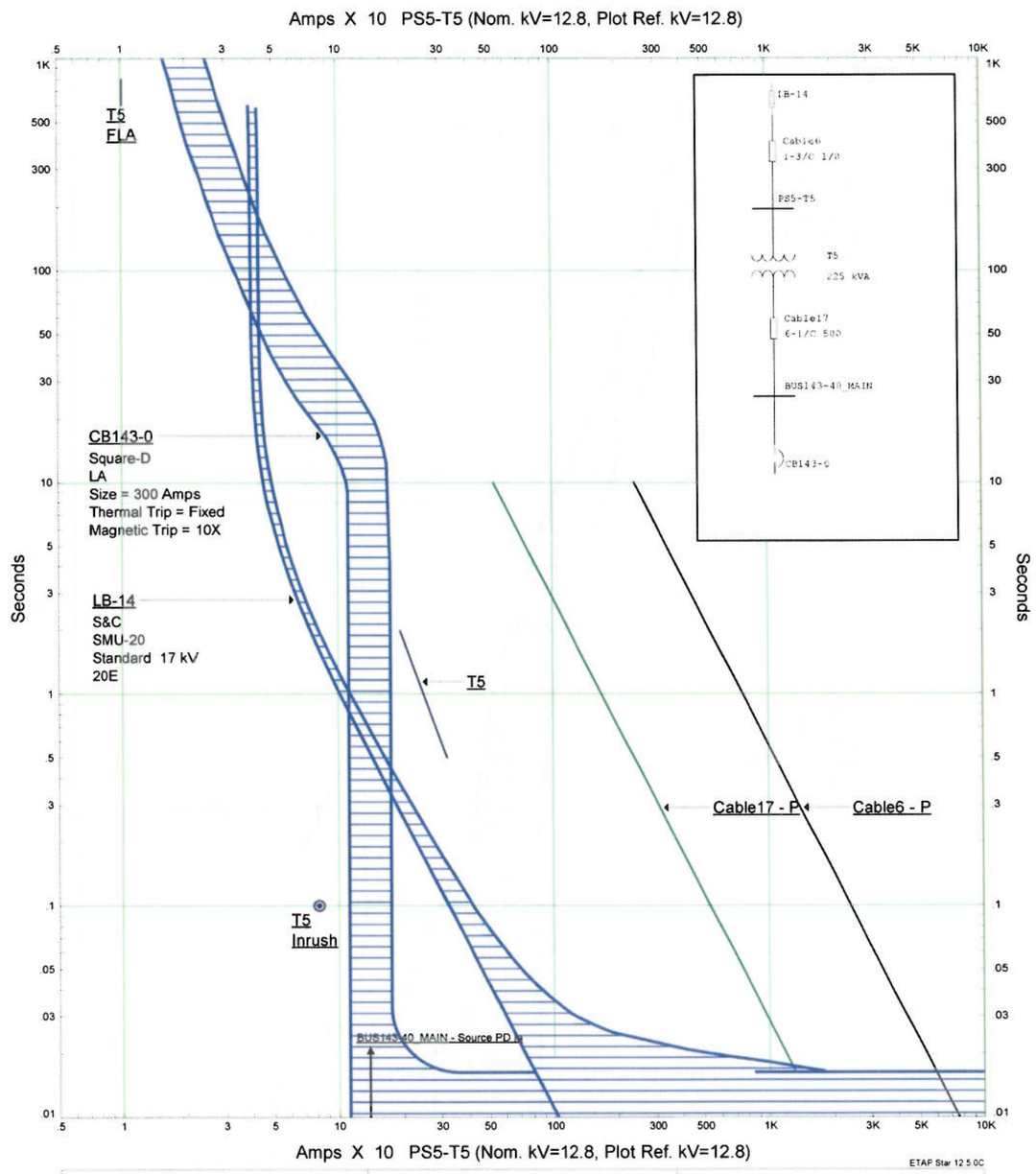
ETAP Star 12.5.0C

DESSAU

Building 142 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

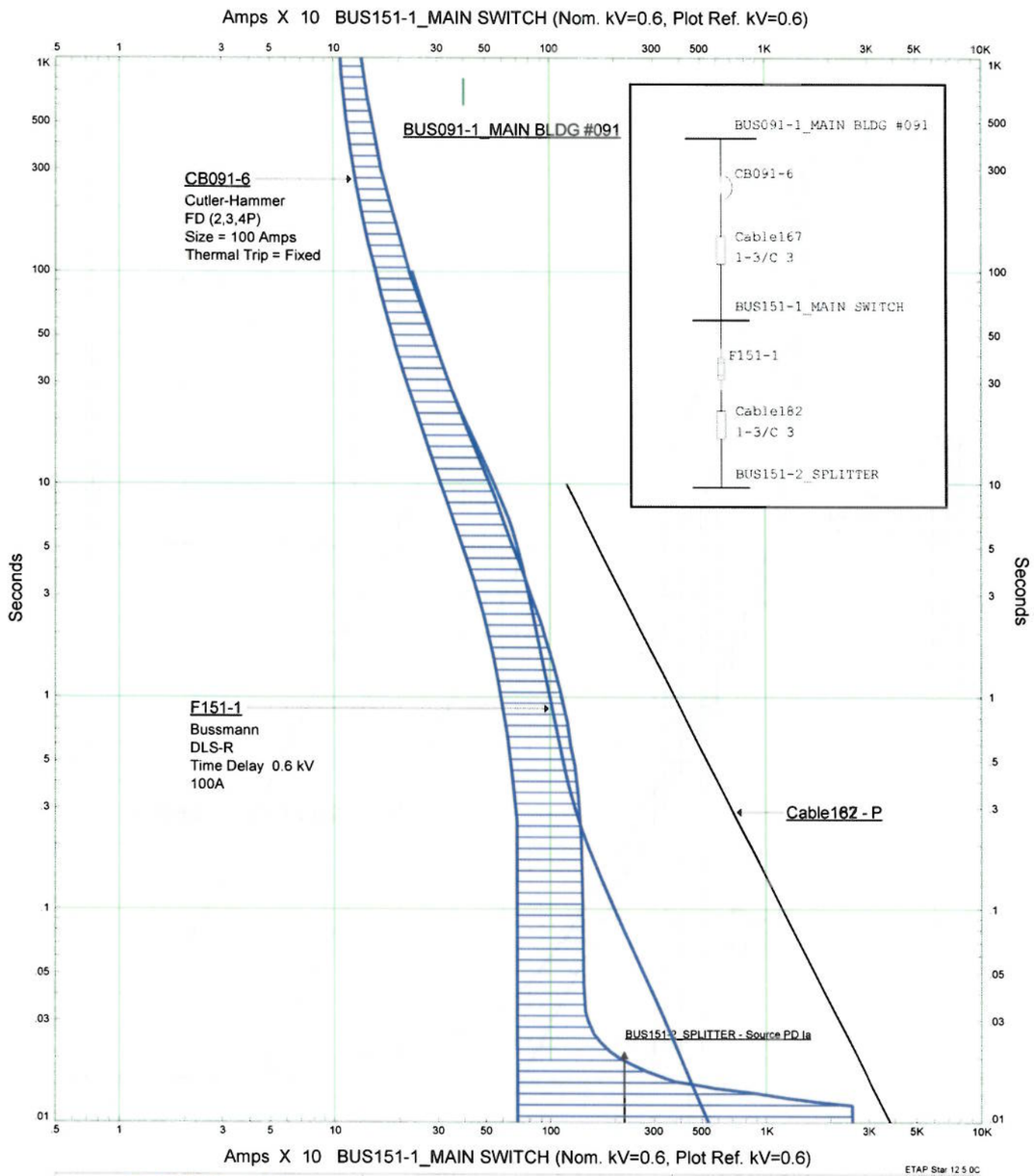


DESSAU

Building 143 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase



ETAP Star 12.5.0C

DESSAU

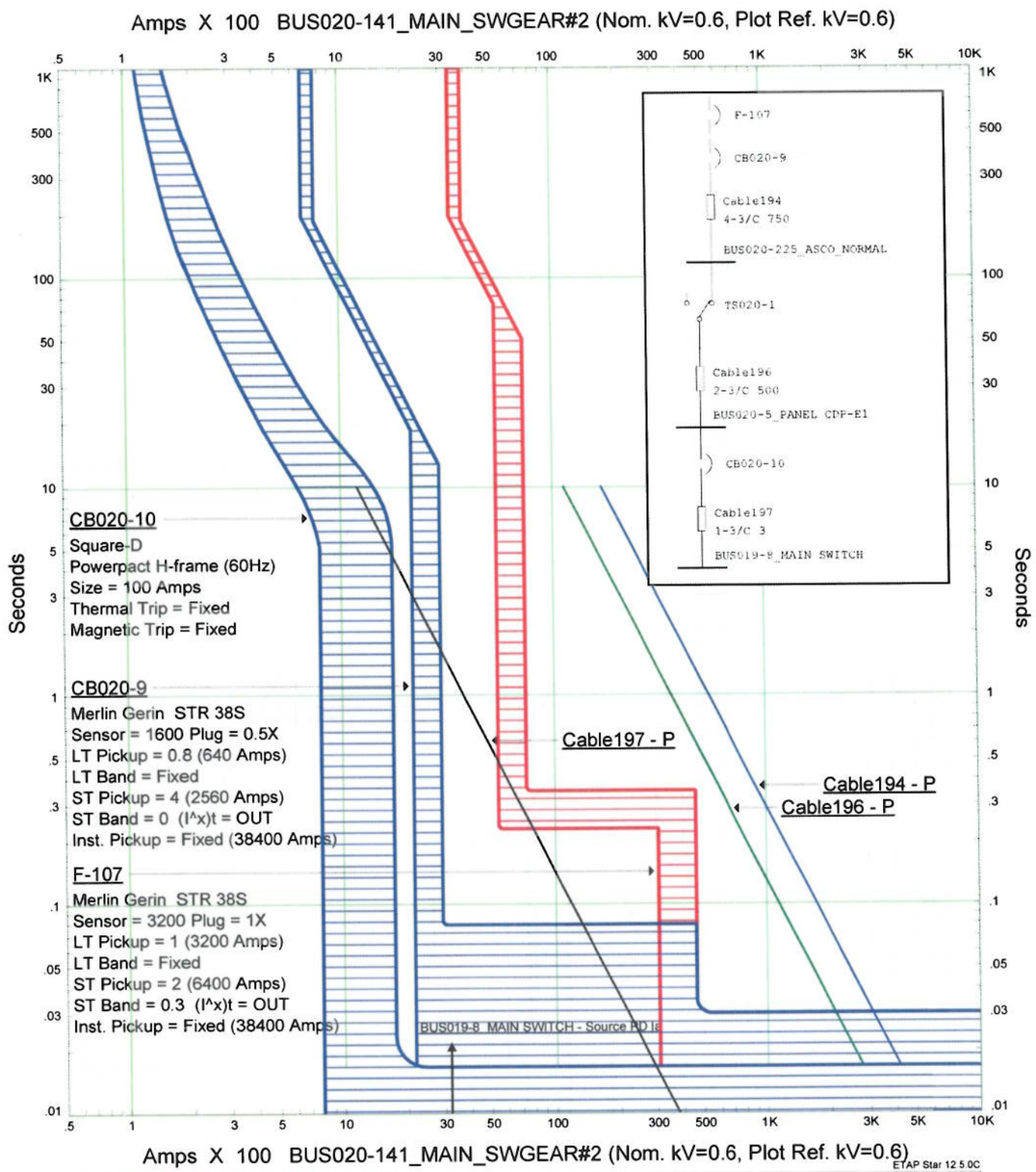
Building 151 - Feeder

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-MNT
Rev: Base
Fault: Phase

Annexe 4 Coordination curves after recommendations

DESSAU

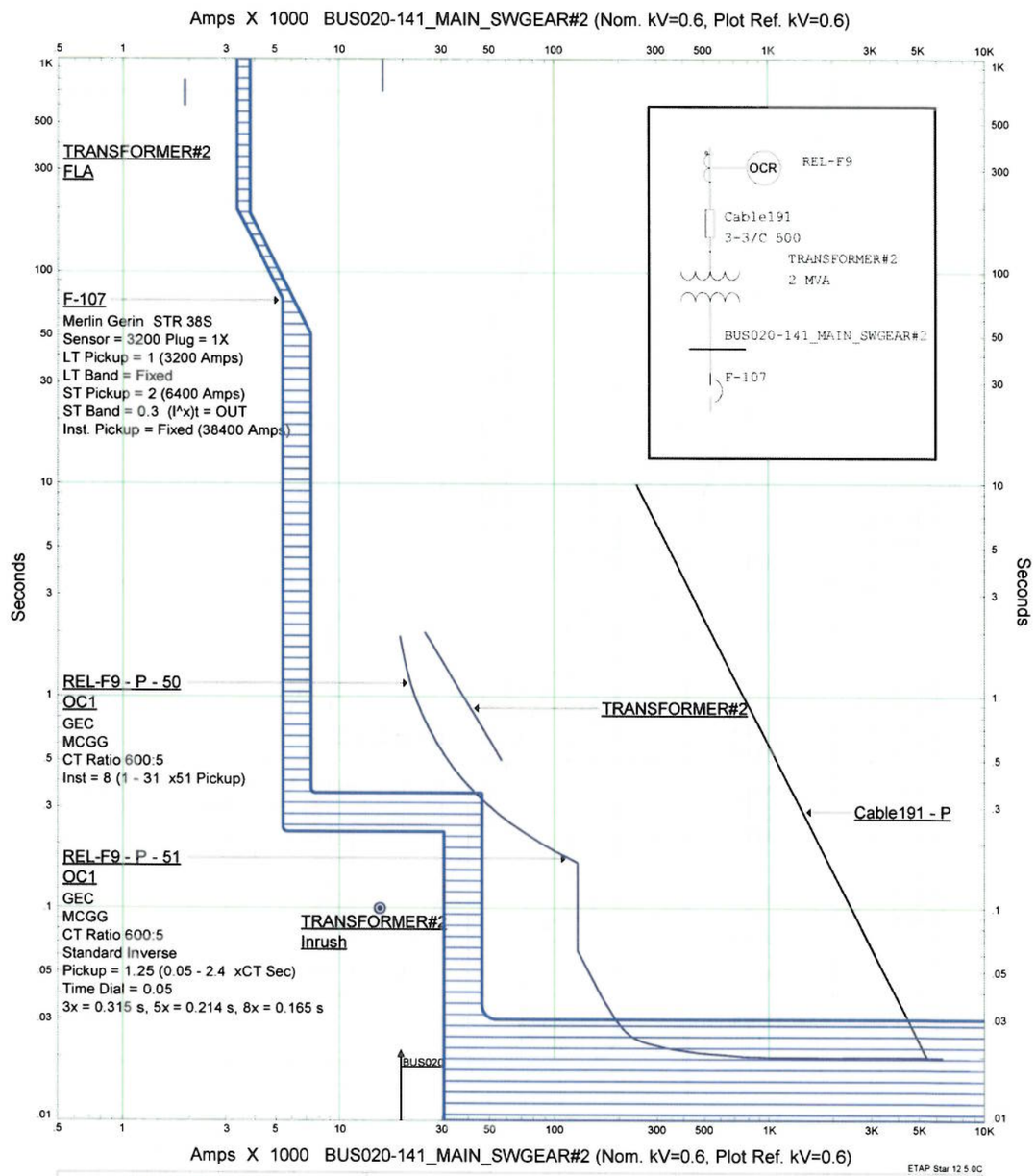


DESSAU

Building 19 - CB020-9

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-INC
Rev: Base
Fault: Phase

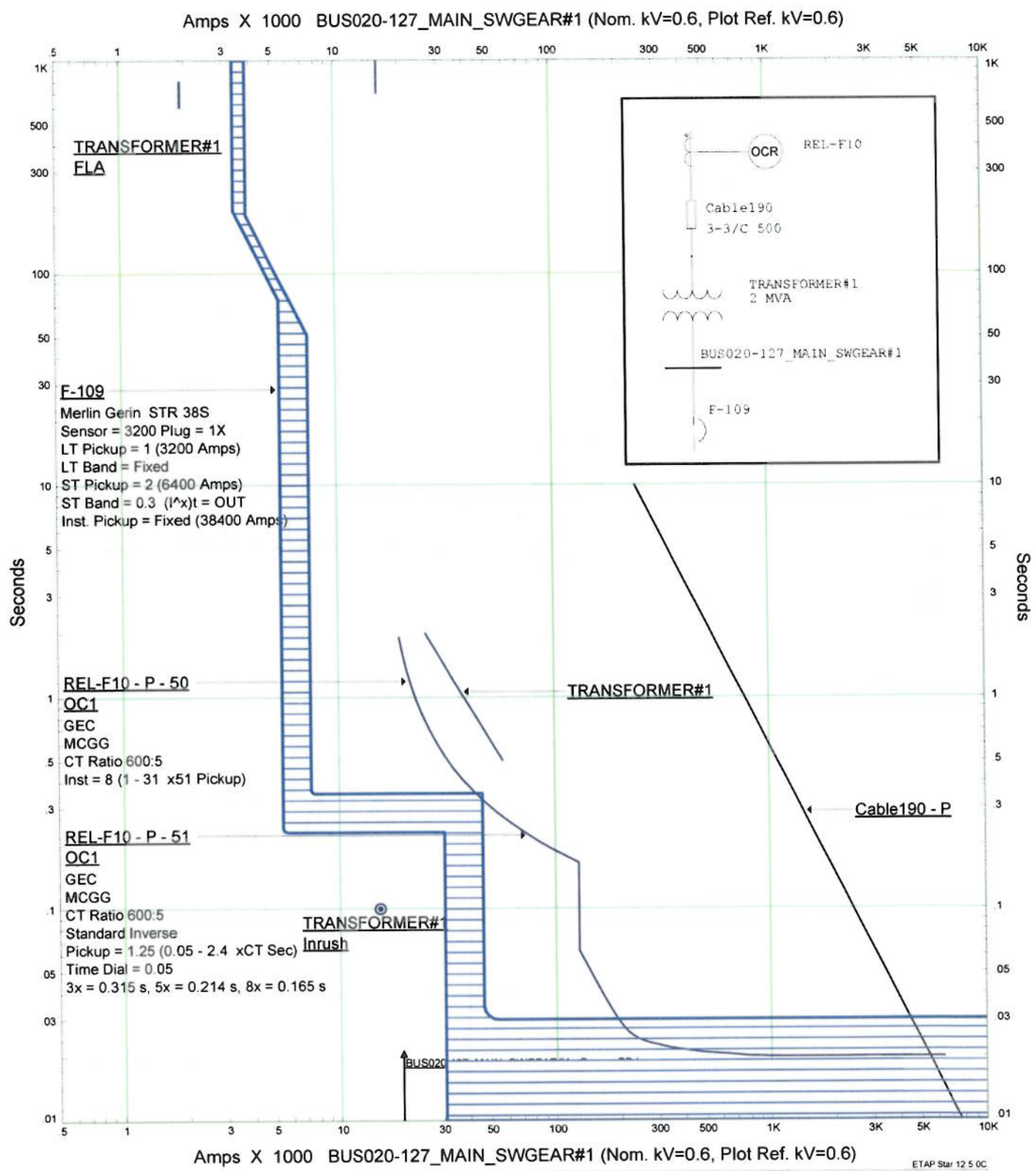


DESSAU

Building 20 - Relay F9

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-INC
Rev: Base
Fault: Phase

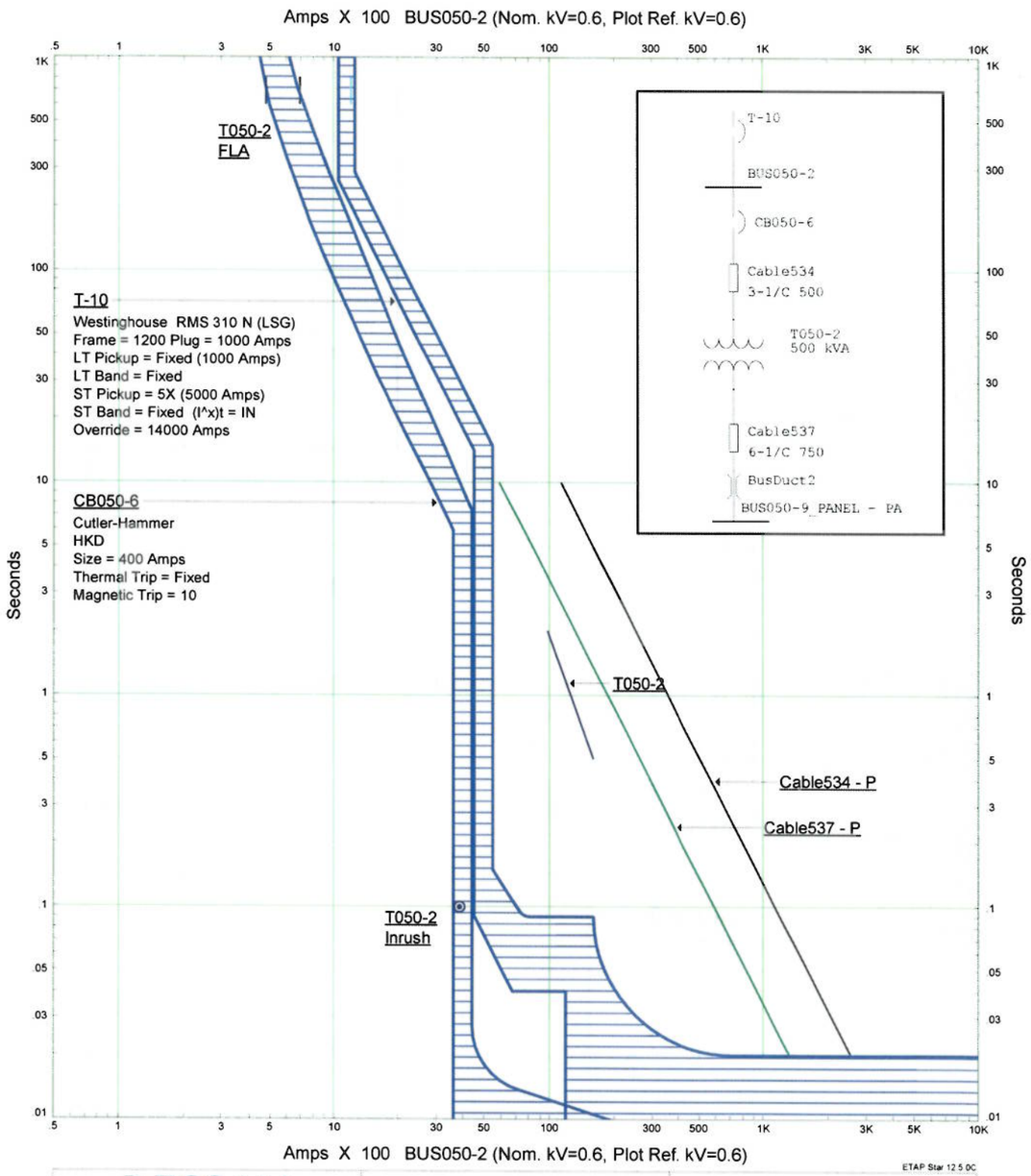


DESSAU

Building 20 - Relay F10

Project: CEF - ARC FLASH STUDY
Location: Central Experimental Farm
Contract: B-0000430

Date: 03-02-2014
SN: DESSAU-INC
Rev: Base
Fault: Phase



ETAP Star 12.5.0C

DESSAU

Building 50 - Panel PA

Project CEF - ARC FLASH STUDY
Location Central Experimental Farm
Contract B-0000430

Date 03-02-2014
SN: DESSAU-INC
Rev. Base
Fault Phase

Annexe 5 Hydro-Ottawa connection points

DESSAU

Philip Grand Maison

De: McGrath, Matthew [MatthewMcGrath@hydroottawa.com]
Envoyé: 21 novembre 2012 10:15
À: 'Massoud Nassar'
Objet: RE: Central Experimental Farm (CEF)

Hi Massoud,

Here is the information requested.

Location	Voltage (kV)	Short Circuit Levels (MVA)				LLL X/R	L-G X/R	Protection
		Phase Maximum	Ground Maximum	Phase Nominal	Ground Nominal			
VT855	13.2	279	111	279	111	3.84	1.48	HOL Substation Breakers
PT145	13.2	71	37	71	37	2.89	2.27	15A K-link Fuse
PT146	13.2	71	37	71	37	2.89	2.27	20A K-link Fuse
PT221	13.2	78	40	78	40	2.91	2.2	15A K-link Fuse
T1000 (X31453)	13.2	78	40	78	40	2.91	2.2	15A K-link Fuse

Please let me know if there is any other information you require.

Thanks,

HydroOttawa
Matthew McGrath, EIT
Distribution Engineer, Assets & Planning
Tel: 613-738-5499 ext. 7103
Fax: 613-738-6405

From: Massoud Nassar [mailto:Massoud.Nassar@tpsgc-pwgsc.gc.ca]
Sent: November 16, 2012 1:22 PM

To: McGrath, Matthew
Subject: FW: Central Experimental Farm (CEF)

Hi Matthew,
As discussed, the attached file includes the consultant requirements from Hydro Ottawa in order to prepare the Coordination/short circuit study for the CEF Site.

Let me know if you need additional information.

Thanks in advance.

Massoud Nassar, P.Eng
MSS/ PWGSC
Tel: (613) 990-7543, Fax: (613) 998-7714

---

lassoud Nassar
ursday, November 15, 2012 2:04 PM
ızkropp@hydroottawa.com'
Central Experimental Farm (CEF)

Hi Franz,
As per my voice mail, a consultant is preparing a short circuit/coordination study for the CEF Electrical Network (High and low voltage). They are requesting some information on the connection points from Hydro Ottawa, as listed in the attached document.

Can you provide these informations, if not can you let me know who can help in this.

I would appreciate your help.

Thank you

Massoud Nassar, P.Eng
Commissioning - MSS / PWGSC
1010 Somerset St. W, 2nd floor
Tel: (613) 990-7543, Fax: (613) 998-7714
massoud.nassar@pwgsc-tpsgc.gc.ca

Annexe 6 Main substation breaker settings

DESSAU

MICROPROCESSOR OVERCURRENT RELAY

HydroOttawa

MAINTENANCE: Breaker & Relay Maintenance (0110) NOMENCLATURE: CB1 PAGE:

SUBSTATION ADDRESS: EXPERIMENTAL FARM DATE: 12/09/2012

WORK ORDER #: 139000 AMBIENT TEMPERATURE: 25 °F HUMIDITY: 35 %

TEST EQUIPMENT USED: OMICRON 356 TESTED BY: STEVEN PRANSCHKE

TESTED BY: RICHARD STEACY

NAMEPLATE DATA

MANUFACTURER: AREVA TYPE: FEEDER OC MODEL / STYLE NO.: P-123

FIRMWARE: CT RATIO: 400 : 5 RECLOSING: ☐

RELAY SETTINGS

		51 - TAP / TIME DIAL			50 - HS TAP			50-LS - TAP / TIME DELAY ms		
	CURVE	SPECIFIED	AS FOUND	AS LEFT	SPECIFIED	AS FOUND	AS LEFT	SPECIFIED	AS FOUND	AS LEFT
Phase Settings	IEEE EI	5 / 0.2	5 / 0.2	5 / 0.2	60	60	60	NA /	NA /	NA /
Ground Settings	IEEE VI	2 / 0.3	2 / 0.3	2 / 0.3	40	40	40	NA /	NA /	NA /

Note: For testing purposes some settings will need to be disabled, please verify that all proper settings are enabled after testing is completed.

51 TIMING TESTS

PHASE	2 Times Pickup Test						4 Times Pickup Test						6 Times Pickup Test					
	SPECIFIED		AS TESTED		AS LEFT		SPECIFIED		AS TESTED		AS LEFT		SPECIFIED		AS TESTED		AS LEFT	
	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME
A	10	1.908	10	1.921	10	1.921	20	0.400	10	0.415	10	0.415	30	0.185	30	0.202	30	0.202
B	10	1.908	10	1.921	10	1.921	20	0.400	10	0.415	10	0.415	30	0.185	30	0.202	30	0.202
C	10	1.908	10	1.921	10	1.921	20	0.400	10	0.415	10	0.415	30	0.185	30	0.202	30	0.202
G	4	2.11	4	2.116	4	2.116	8	0.540	8	0.539	8	0.539	12	0.31	12	0.332	12	0.332

TRIP INDICATION / FLAGGING VERIFICATION : PASS ☐ FAIL ☐

COMMENTS:

DEFICIENCIES:

50 PICKUP TESTS

PHASE	50-HS INSTANTANEOUS			50-LS INSTANTANEOUS		
	TOLERANCES	AS TESTED		TOLERANCES	AS TESTED	
	AMPS	AMPS	TIME	AMPS	AMPS	TIME
A	57 - 63	60	0.030	-		
B	57 - 63	60	0.030	-		
C	57 - 63	60	0.030	-		
G	38 - 42	40	0.042	-		

50-LS TIME DELAY TESTS

50-LS TIME DELAY	
TOLERANCES	AS TESTED
TIME (ms)	TIME (ms)
-	
-	
-	
-	

TRIP INDICATION / FLAGGING VERIFICATION : PASS ☐ FAIL ☐

COMMENTS:

DEFICIENCIES:

43 L/R OPERATION VERIFICATION: PASS ☐ FAIL ☐ **SCADA OPERATION VERIFICATION:** PASS ☐ FAIL ☐

MICROPROCESSOR OVERCURRENT RELAY

HydroOttawa

MAINTENANCE Breaker & Relay Maintenance (0110) NOMENCLATURE CB1 PAGE

SUBSTATION ADDRESS EXPERIMENTAL FARM DATE 12/09/2012

WORK ORDER # 139000 AMBIENT TEMPERATURE 25 HUMIDITY 35 %

TEST EQUIPMENT USED OMICRON 356 TESTED BY STEVEN PRANSCHKE

TESTED BY RICHARD STEACY

79 CYCLE AND TIME TESTS

	79 OPEN TIME				79 RECLAIM TIME		
	SPECIFIED	TOLERANCES	AS TESTED		SPECIFIED	TOLERANCES	AS TESTED
	TIME (sec.)	TIME (sec.)	TIME (sec.)		TIME (sec.)	TIME (sec.)	TIME (sec.)
PHASE	NA	-			NA	-	
GROUND	NA	-			NA	-	

TO TEST RECLOSE FUNCTIONALLITY, 4 TESTS WILL NEED TO BE PERFORMED FOR PHASE AND GROUND.

PHASE PASS	PHASE FAIL	GROUND PASS	GROUND FAIL		
☐	☐	☐	☐	TEST 1	With the 79 b/e in the enable position, trip the relay on the 50-ls curves and record the open time the breaker should initiate a reclose. The relay was a specified reclaim time this needs to be recorded; after this time has expired, the reclose function will be ready for another cycle.
☐	☐	☐	☐	TEST 2	With the 79 b/e in the enable position, trip the relay on the 50-LS curves, once the breaker closes, wait approximately 30 seconds and then apply a 3x pu fault on the 51 curve. The breaker should trip in the approximate time and stay open with all LED indication.
☐	☐	☐	☐	TEST 3	With the 79 b/e in the enable position trip the breaker on the 50-HS curves the breaker should trip and not reclose. Verify all LED indication.
☐	☐	☐	☐	TEST 4	With the 79 b/e in the block position, trip the relay on the 50-LS curves. The breaker should trip and stay open. Verify all LED indication.

	PASS	FAIL
TRIP INDICATION / FLAGGING OPERATION VERIFICATION	☐	☐

COMMENTS:

DEFICIENCIES:

MICROPROCESSOR OVERCURRENT RELAY

HydroOttawa

MAINTENANCE: Breaker & Relay Maintenance (0110) NOMENCLATURE: CB2 PAGE:

SUBSTATION ADDRESS: EXPERIMENTAL FARM DATE: 12/09/2012

WORK ORDER #: 139000 AMBIENT TEMPERATURE: 25 °F HUMIDITY: 35 %

TESTED BY: STEVEN PRANSCHKE

TEST EQUIPMENT USED: OMICRON 356 TESTED BY: RICHARD STEACY

NAMEPLATE DATA

MANUFACTURER: AREVA TYPE: FEEDER OC MODEL / STYLE NO.: P-123

FIRMWARE: CT RATIO: 400 : 5 RECLOSING: ☐

RELAY SETTINGS

		51 - TAP / TIME DIAL			50 - HS TAP			50-LS - TAP / TIME DELAY ms		
	CURVE	SPECIFIED	AS FOUND	AS LEFT	SPECIFIED	AS FOUND	AS LEFT	SPECIFIED	AS FOUND	AS LEFT
Phase Settings	IEEE EI	5 / 0.2	5 / 0.2	5 / 0.2	60	60	60	NA /	NA /	NA /
Ground Settings	IEEE VI	2 / 0.3	2 / 0.3	2 / 0.3	40	40	40	NA /	NA /	NA /

Note: For testing purposes some settings will need to be disabled, please verify that all proper settings are enabled after testing is completed.

51 TIMING TESTS

PHASE	2 Times Pickup Test						4 Times Pickup Test						6 Times Pickup Test					
	SPECIFIED		AS TESTED		AS LEFT		SPECIFIED		AS TESTED		AS LEFT		SPECIFIED		AS TESTED		AS LEFT	
	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME
A	10	1.908	10	1.932	10	1.932	20	0.400	10	0.419	10	0.419	30	0.185	30	0.204	30	0.204
B	10	1.908	10	1.932	10	1.932	20	0.400	10	0.419	10	0.419	30	0.185	30	0.204	30	0.204
C	10	1.908	10	1.932	10	1.932	20	0.400	10	0.419	10	0.419	30	0.185	30	0.204	30	0.204
G	4	2.11	4	2.116	4	2.116	8	0.540	8	0.534	8	0.534	12	0.31	12	0.334	12	0.334

TRIP INDICATION / FLAGGING VERIFICATION: PASS ☐ FAIL ☐

COMMENTS:

DEFICIENCIES:

50 PICKUP TESTS

PHASE	50-HS INSTANTANEOUS				50-LS INSTANTANEOUS		
	TOLERANCES		AS TESTED		TOLERANCES	AS TESTED	
	AMPS		AMPS	TIME	AMPS	AMPS	TIME
A	57 -	63	60	0.031	-		
B	57 -	63	60	0.031	-		
C	57 -	63	60	0.031	-		
G	38 -	42	40	0.041	-		

50-LS TIME DELAY TESTS

50-LS TIME DELAY	
TOLERANCES	AS TESTED
TIME (ms)	TIME (ms)
-	
-	
-	
-	

TRIP INDICATION / FLAGGING VERIFICATION: PASS ☐ FAIL ☐

COMMENTS:

DEFICIENCIES:

43 L/R OPERATION VERIFICATION: PASS ☐ FAIL ☐ **SCADA OPERATION VERIFICATION:** PASS ☐ FAIL ☐

MICROPROCESSOR OVERCURRENT RELAY

HydroOttawa

MAINTENANCE Breaker & Relay Maintenance (0110) NOMENCLATURE CB2 PAGE

SUBSTATION ADDRESS EXPERIMENTAL FARM DATE 12/09/2012

WORK ORDER # 139000 AMBIENT TEMPERATURE 25 HUMIDITY 35 %

TEST EQUIPMENT USED OMICRON 356 TESTED BY STEVEN PRANSCHKE

TESTED BY RICHARD STEACY

79 CYCLE AND TIME TESTS

	79 OPEN TIME			79 RECLAIM TIME		
	SPECIFIED	TOLERANCES	AS TESTED	SPECIFIED	TOLERANCES	AS TESTED
	TIME (sec.)	TIME (sec.)	TIME (sec.)	TIME (sec.)	TIME (sec.)	TIME (sec.)
PHASE	NA	-		NA	-	
GROUND	NA	-		NA	-	

TO TEST RECLOSE FUNCTIONALLITY, 4 TESTS WILL NEED TO BE PERFORMED FOR PHASE AND GROUND.

PHASE PASS	PHASE FAIL	GROUND PASS	GROUND FAIL		
☐	☐	☐	☐	TEST 1	With the 79 b/e in the enable position, trip the relay on the 50-Is curves and record the open time the breaker should initiate a reclose. The relay was a specified reclaim time this needs to be recorded; after this time has expired, the reclose function will be ready for another cycle.
☐	☐	☐	☐	TEST 2	With the 79 b/e in the enable position, trip the relay on the 50-LS curves, once the breaker closes, wait approximately 30 seconds and then apply a 3x pu fault on the 51 curve. The breaker should trip in the approximate time and stay open with all LED indication.
☐	☐	☐	☐	TEST 3	With the 79 b/e in the enable position trip the breaker on the 50-HS curves the breaker should trip and not reclose. Verify all LED indication.
☐	☐	☐	☐	TEST 4	With the 79 b/e in the block position, trip the relay on the 50-LS curves. The breaker should trip and stay open. Verify all LED indication.

	PASS	FAIL
TRIP INDICATION / FLAGGING OPERATION VERIFICATION	☐	☐

COMMENTS:

DEFICIENCIES:

MICROPROCESSOR OVERCURRENT RELAY

HydroOttawa

MAINTENANCE: Breaker & Relay Maintenance (0110) NOMENCLATURE: CB3 PAGE:

SUBSTATION ADDRESS: EXPERIMENTAL FARM DATE: 12/09/2012

WORK ORDER #: 139000 AMBIENT TEMPERATURE: 25 °F HUMIDITY: 35 %

TESTED BY: STEVEN PRANSCHKE

TEST EQUIPMENT USED: OMICRON 356 TESTED BY: RICHARD STEACY

NAMEPLATE DATA

MANUFACTURER: AREVA TYPE: FEEDER OC MODEL / STYLE NO.: P-123

FIRMWARE: CT RATIO: 400 : 5 RECLOSING: ☐

RELAY SETTINGS

		51 - TAP / TIME DIAL			50 - HS TAP			50-LS - TAP / TIME DELAY ms		
	CURVE	SPECIFIED	AS FOUND	AS LEFT	SPECIFIED	AS FOUND	AS LEFT	SPECIFIED	AS FOUND	AS LEFT
Phase Settings	IEEE EI	5 / 0.2	5 / 0.2	5 / 0.2	60	60	60	NA /	NA /	NA /
Ground Settings	IEEE VI	2 / 0.3	2 / 0.3	2 / 0.3	40	40	40	NA /	NA /	NA /

Note: For testing purposes some settings will need to be disabled, please verify that all proper settings are enabled after testing is completed.

51 TIMING TESTS

PHASE	2 Times Pickup Test						4 Times Pickup Test						6 Times Pickup Test					
	SPECIFIED		AS TESTED		AS LEFT		SPECIFIED		AS TESTED		AS LEFT		SPECIFIED		AS TESTED		AS LEFT	
	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME
A	10	1.908	10	1.921	10	1.921	20	0.400	10	0.407	10	0.407	30	0.185	30	0.190	30	0.190
B	10	1.908	10	1.921	10	1.921	20	0.400	10	0.407	10	0.407	30	0.185	30	0.190	30	0.190
C	10	1.908	10	1.921	10	1.921	20	0.400	10	0.407	10	0.407	30	0.185	30	0.190	30	0.190
G	4	2.11	4	2.124	4	2.124	8	0.540	8	0.543	8	0.543	12	0.31	12	0.315	12	0.315

TRIP INDICATION / FLAGGING VERIFICATION: PASS ☐ FAIL ☐

COMMENTS:

DEFICIENCIES:

50 PICKUP TESTS

PHASE	50-HS INSTANTANEOUS			50-LS INSTANTANEOUS		
	TOLERANCES	AS TESTED		TOLERANCES	AS TESTED	
	AMPS	AMPS	TIME	AMPS	AMPS	TIME
A	57 - 63	60	0.030	-		
B	57 - 63	60	0.030	-		
C	57 - 63	60	0.030	-		
G	38 - 42	40	0.040	-		

50-LS TIME DELAY TESTS

50-LS TIME DELAY	
TOLERANCES	AS TESTED
TIME (ms)	TIME (ms)
-	
-	
-	
-	

TRIP INDICATION / FLAGGING VERIFICATION: PASS ☐ FAIL ☐

COMMENTS:

DEFICIENCIES:

43 L/R OPERATION VERIFICATION: PASS ☐ FAIL ☐ **SCADA OPERATION VERIFICATION:** PASS ☐ FAIL ☐

MICROPROCESSOR OVERCURRENT RELAY

HydroOttawa

MAINTENANCE Breaker & Relay Maintenance (0110) NOMENCLATURE CB3 PAGE

SUBSTATION ADDRESS EXPERIMENTAL FARM DATE 12/09/2012

WORK ORDER # 139000 AMBIENT TEMPERATURE 25 HUMIDITY 35 %

TEST EQUIPMENT USED OMICRON 356 TESTED BY STEVEN PRANSCHKE

TESTED BY RICHARD STEACY

79 CYCLE AND TIME TESTS

	79 OPEN TIME			79 RECLAIM TIME		
	SPECIFIED	TOLERANCES	AS TESTED	SPECIFIED	TOLERANCES	AS TESTED
	TIME (sec.)	TIME (sec.)	TIME (sec.)	TIME (sec.)	TIME (sec.)	TIME (sec.)
PHASE	NA	-		NA	-	
GROUND	NA	-		NA	-	

TO TEST RECLOSE FUNCTIONALLITY, 4 TESTS WILL NEED TO BE PERFORMED FOR PHASE AND GROUND.

PHASE PASS	PHASE FAIL	GROUND PASS	GROUND FAIL		
☐	☐	☐	☐	TEST 1	With the 79 b/e in the enable position, trip the relay on the 50-ls curves and record the open time the breaker should initiate a reclose. The relay was a specified reclaim time this needs to be recorded; after this time has expired, the reclose function will be ready for another cycle.
☐	☐	☐	☐	TEST 2	With the 79 b/e in the enable position, trip the relay on the 50-LS curves, once the breaker closes, wait approximately 30 seconds and then apply a 3x pu fault on the 51 curve. The breaker should trip in the approximate time and stay open with all LED indication.
☐	☐	☐	☐	TEST 3	With the 79 b/e in the enable position trip the breaker on the 50-HS curves the breaker should trip and not reclose. Verify all LED indication.
☐	☐	☐	☐	TEST 4	With the 79 b/e in the block position, trip the relay on the 50-LS curves. The breaker should trip and stay open. Verify all LED indication.

	PASS	FAIL
TRIP INDICATION / FLAGGING OPERATION VERIFICATION	☐	☐

COMMENTS:

DEFICIENCIES:

MICROPROCESSOR OVERCURRENT RELAY

HydroOttawa

MAINTENANCE: Breaker & Relay Maintenance (0110) NOMENCLATURE: CB4 PAGE:

SUBSTATION ADDRESS: EXPERIMENTAL FARM DATE: 12/09/2012

WORK ORDER #: 139000 AMBIENT TEMPERATURE: 25 °F HUMIDITY: 35 %

TEST EQUIPMENT USED: OMICRON 356 TESTED BY: STEVEN PRANSCHKE

TESTED BY: RICHARD STEACY

NAMEPLATE DATA

MANUFACTURER: AREVA TYPE: FEEDER OC MODEL / STYLE NO.: P-123

FIRMWARE: CT RATIO: 400 : 5 RECLOSING: ☐

RELAY SETTINGS

		51 - TAP / TIME DIAL			50 - HS TAP			50-LS - TAP / TIME DELAY ms		
	CURVE	SPECIFIED	AS FOUND	AS LEFT	SPECIFIED	AS FOUND	AS LEFT	SPECIFIED	AS FOUND	AS LEFT
Phase Settings	IEEE EI	5 / 0.2	5 / 0.2	5 / 0.2	60	60	60	NA /	NA /	NA /
Ground Settings	IEEE VI	2 / 0.3	2 / 0.3	2 / 0.3	40	40	40	NA /	NA /	NA /

Note: For testing purposes some settings will need to be disabled, please verify that all proper settings are enabled after testing is completed.

51 TIMING TESTS

PHASE	2 Times Pickup Test						4 Times Pickup Test						6 Times Pickup Test					
	SPECIFIED		AS TESTED		AS LEFT		SPECIFIED		AS TESTED		AS LEFT		SPECIFIED		AS TESTED		AS LEFT	
	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME	AMPS	TIME
A	10	1.908	10	1.911	10	1.911	20	0.400	10	0.408	10	0.408	30	0.185	30	0.198	30	0.198
B	10	1.908	10	1.911	10	1.911	20	0.400	10	0.408	10	0.408	30	0.185	30	0.198	30	0.198
C	10	1.908	10	1.911	10	1.911	20	0.400	10	0.408	10	0.408	30	0.185	30	0.198	30	0.198
G	4	2.11	4	2.120	4	2.120	8	0.540	8	0.541	8	0.541	12	0.31	12	0.314	12	0.314

TRIP INDICATION / FLAGGING VERIFICATION: PASS ☐ FAIL ☐

COMMENTS:

DEFICIENCIES:

50 PICKUP TESTS

PHASE	50-HS INSTANTANEOUS			50-LS INSTANTANEOUS		
	TOLERANCES	AS TESTED		TOLERANCES	AS TESTED	
	AMPS	AMPS	TIME	AMPS	AMPS	TIME
A	57 - 63	60	0.030	-		
B	57 - 63	60	0.030	-		
C	57 - 63	60	0.030	-		
G	38 - 42	40	0.040	-		

50-LS TIME DELAY TESTS

50-LS TIME DELAY	
TOLERANCES	AS TESTED
TIME (ms)	TIME (ms)
-	
-	
-	
-	

TRIP INDICATION / FLAGGING VERIFICATION: PASS ☐ FAIL ☐

COMMENTS:

DEFICIENCIES:

43 L/R OPERATION VERIFICATION: PASS ☐ FAIL ☐ **SCADA OPERATION VERIFICATION:** PASS ☐ FAIL ☐

MICROPROCESSOR OVERCURRENT RELAY

HydroOttawa

MAINTENANCE Breaker & Relay Maintenance (0110) NOMENCLATURE CB4 PAGE

SUBSTATION ADDRESS EXPERIMENTAL FARM DATE 12/09/2012

WORK ORDER # 139000 AMBIENT TEMPERATURE 25 HUMIDITY 35 %

TEST EQUIPMENT USED OMICRON 356 TESTED BY STEVEN PRANSCHKE

TESTED BY RICHARD STEACY

79 CYCLE AND TIME TESTS

	79 OPEN TIME				79 RECLAIM TIME		
	SPECIFIED	TOLERANCES	AS TESTED		SPECIFIED	TOLERANCES	AS TESTED
	TIME (sec.)	TIME (sec.)	TIME (sec.)		TIME (sec.)	TIME (sec.)	TIME (sec.)
PHASE	NA	-			NA	-	
GROUND	NA	-			NA	-	

TO TEST RECLOSE FUNCTIONALLITY, 4 TESTS WILL NEED TO BE PERFORMED FOR PHASE AND GROUND.

PHASE PASS	PHASE FAIL	GROUND PASS	GROUND FAIL		
☐	☐	☐	☐	TEST 1	With the 79 b/e in the enable position, trip the relay on the 50-ls curves and record the open time the breaker should initiate a reclose. The relay was a specified reclaim time this needs to be recorded; after this time has expired, the reclose function will be ready for another cycle.
☐	☐	☐	☐	TEST 2	With the 79 b/e in the enable position, trip the relay on the 50-LS curves, once the breaker closes, wait approximately 30 seconds and then apply a 3x pu fault on the 51 curve. The breaker should trip in the approximate time and stay open with all LED indication.
☐	☐	☐	☐	TEST 3	With the 79 b/e in the enable position trip the breaker on the 50-HS curves the breaker should trip and not reclose. Verify all LED indication.
☐	☐	☐	☐	TEST 4	With the 79 b/e in the block position, trip the relay on the 50-LS curves. The breaker should trip and stay open. Verify all LED indication.

	PASS	FAIL
TRIP INDICATION / FLAGGING OPERATION VERIFICATION	☐	☐

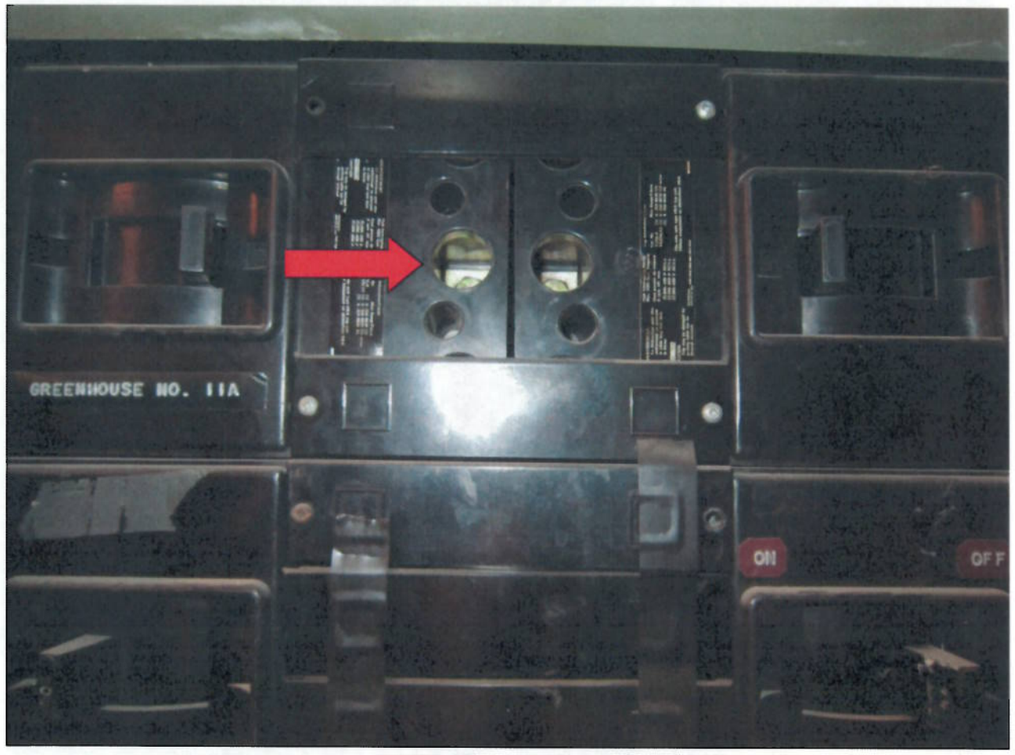
COMMENTS:

DEFICIENCIES:

Annexe 7 Pictures

DESSAU

Greenhouse
Building 142



PA Panel
Building 50

PP Panel
Building 50

Bâtiment 21
Penthouse
Panneau E.R

Panel T-05 "Tower Fan"
Building 50

Bâtiment 143
Sectionneur 05-471-0x

Annexe 8 Carleton Electric LTD. Survey

DESSAU

Agriculture Canada

Central Experimental Farm Medium Voltage Equipment Inventory

07-Mar-13

Equipment ID	Manufacturer	Loop Cable size	Load Cable Size	Fuse Size	Trans. KVA	Primary Volts	Secondary Volts	% Impedance	Notes
PS1	S&C	500 MCM	1/0 AWG	20E					Fuses are SMU 20, Standard Speed
T1	FPE				225	12.8 KV	600Y/347	5.20%	
PS2	S&C	500 MCM	N/A	30E					Fuses are SMU 20, Standard Speed, unable to determine cable size of trans. feeder
T2	FPE				300	12.8 KV	208Y/120	4.40%	
PS3	S&C	500 MCM	N/A	30E					Fuses are SMU 20, Standard Speed, unable to determine cable size of trans. feeder
T3	Carte				500	12.8 KV	600Y/347	4.52%	
PS4	S&C	500 MCM	1/0 AWG	50E					Fuses are SMU20, Standard Speed
T4	FPE				500	12.8 KV	600Y/347	5.60%	
PS5	S&C	500 MCM	1/0 AWG	20E					Fuses are SMU20, Standard Speed, Cable appears to be 1/0 but could not verify.
T5	FPE				225	12.8 KV	600Y/347	5.20%	
PS6	S&C	500 MCM	1/0 AWG	50E					Fuses are SMU20, Standard Speed
T6	FPE				500	12.8 KV	600Y/347	5.60%	
PS7	S&C	500 MCM	1/0 AWG	50E					Fuses are SMU20, Standard Speed, Cable appears to be 1/0 but could not verify.
T7	FPE				500	12.8 KV	600Y/347	5.60%	
PS8	S&C	500 MCM	1/0 AWG	30E					Fuses are SMU20, Standard Speed
T8	FPE				300	12.8 KV	600Y/347	3.80%	
PS9	S&C	500 MCM	1/0 AWG	15E					Fuses are SMU20, Standard Speed, Cable appears to be 1/0 but could not verify.
T9	FPE				150	12.8 KV	208Y/120	3.60%	
PS11	S&C	500 MCM	1/0 AWG	15E					Fuses are SMU20, Standard Speed
T11	FPE				150	12.8 KV	208Y/120	3.90%	
Kiosk #2	Hydro Owned								PT145 is a Hydro Owned Padmounted Transformer
Kiosk #5	Hydro Owned								PT146 is a Hydro Ottawa Panmounted Transformer.
T107	Hydro Owned								We believe T107 is Hydro Owned. Could not get get truck close enough to get info. Pole Mounted

Additional Notes:

Here are the questions I sent Hydro Ottawa.

Protection (relay settings) for cables 302, 305 and 306 and short circuit levels.

Relay settings for F1, F2, F3 and F4 in the main vault at CEF.

Impedance of network.

Also there are three transformers that are Hydro Ottawa's feeding some building there that are not on the loop.

They are PT 145, (feeds bldgs. 59 and 60) PT 146 (feeds bldg. 72) and T107 (feeds bldg.. 144)

Any information for these transformers as above so they can provide an arc flash study for these buildings also.

Annexe 9 One line diagram, ETAP

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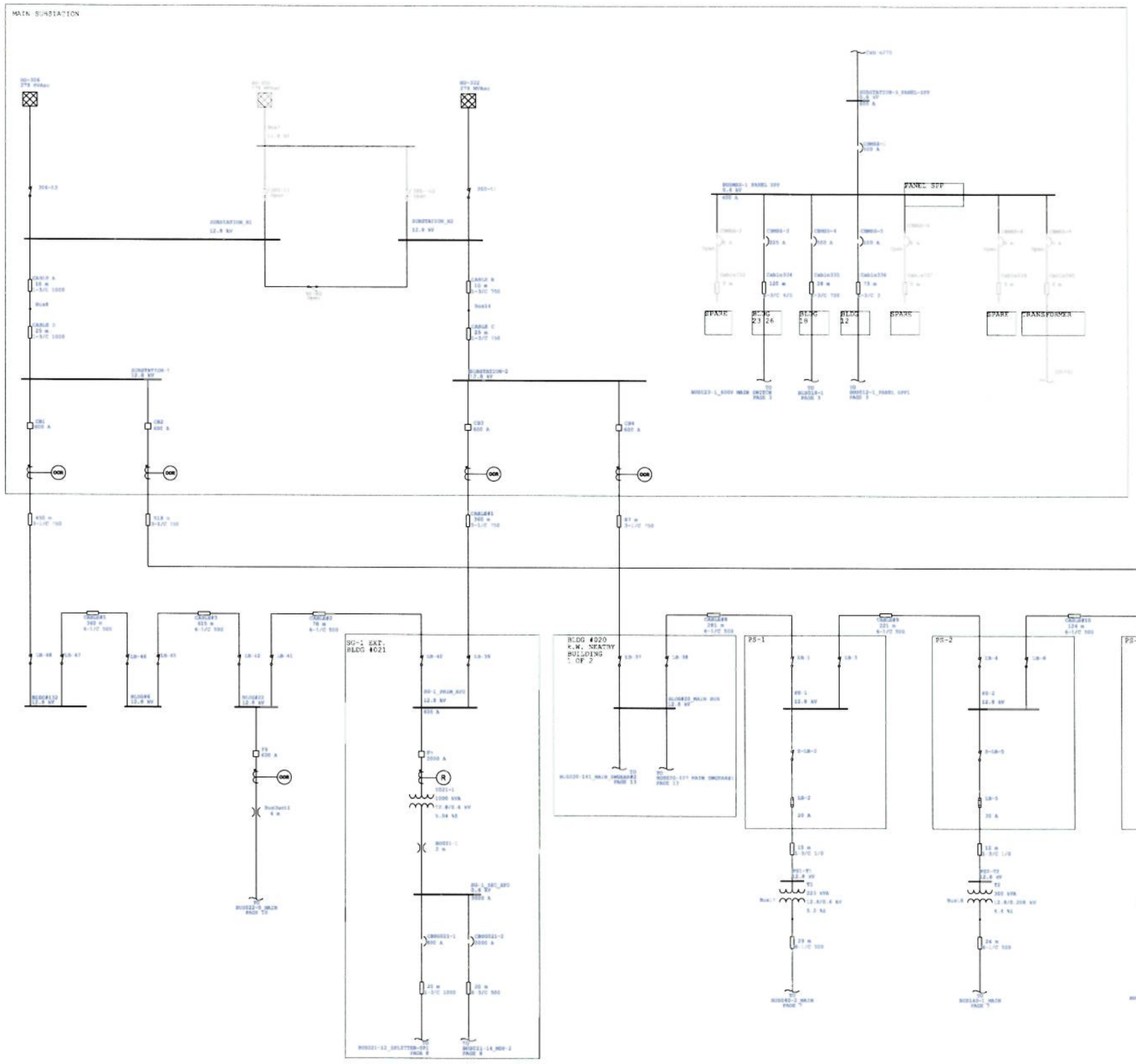

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CENTRAL EXPERIMENTAL FARM

ADRESSE CLIENT

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Projet - Project

ARC FLASH AND SHOCK HAZARD STUDY

Titre - Title

ETAP MODEL

DESSAU

Dessau inc.
1455 rue Champlain
Trois-Rivières (Québec) G9A 5X4
Téléphone : 819 378.7949
Télécopieur : 819 378.2985

Préparé Prepared: J. VEZINA, tech.	Discipline: ÉLECTRIQUE
Dessiné Drawn:	Échelle Scale: IND.
Vérifié Checked: F. ST-ARNAUD, P.Eng.	Date: 2014-05-08
Chargé de projet - Project manager: STYVE VILLENEUVE, tech.	No de séquence - Sequence No: 01 de/of 17

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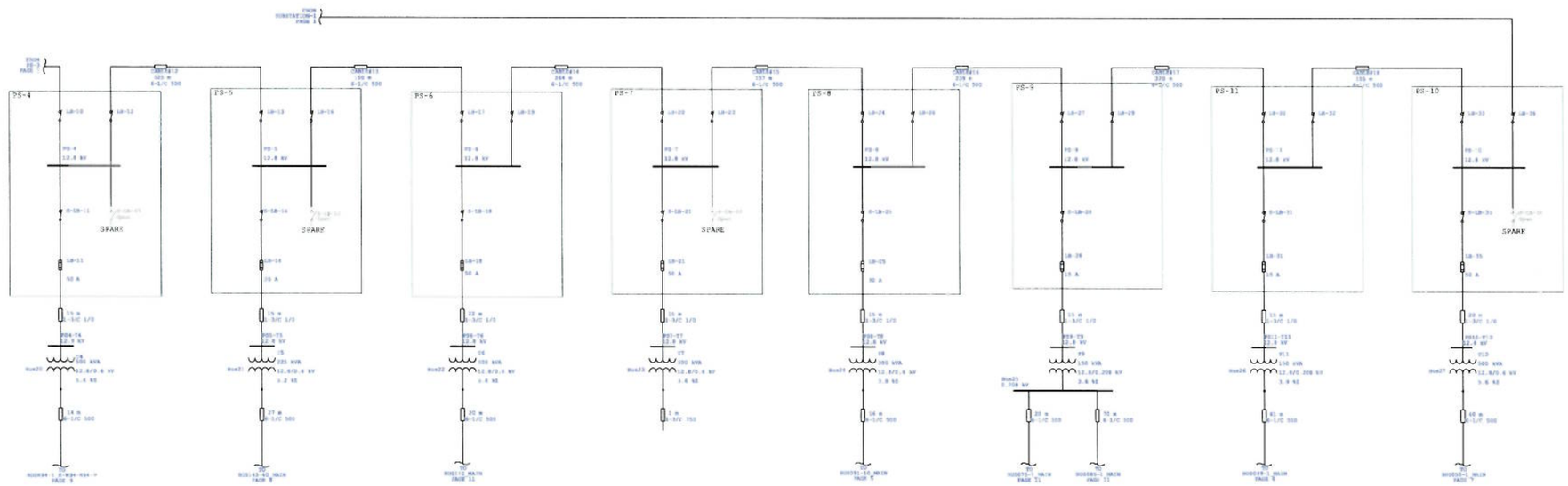

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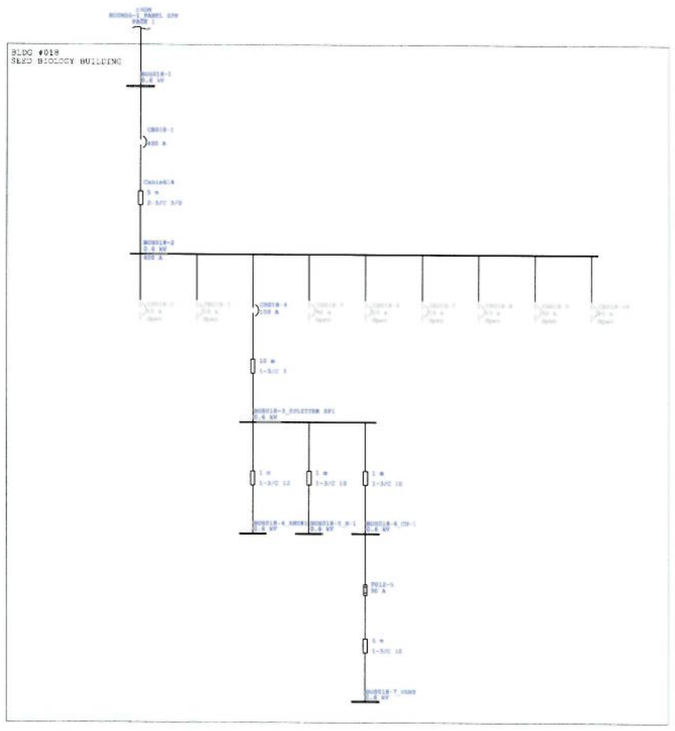

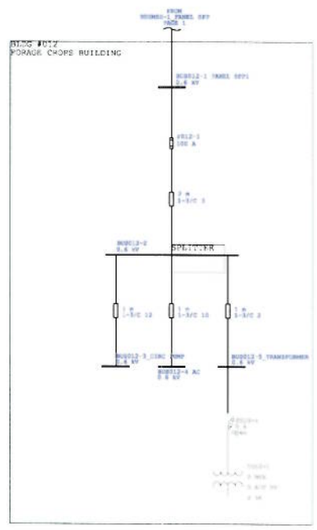

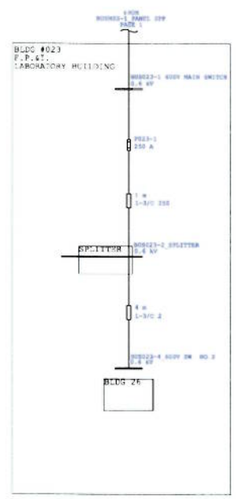

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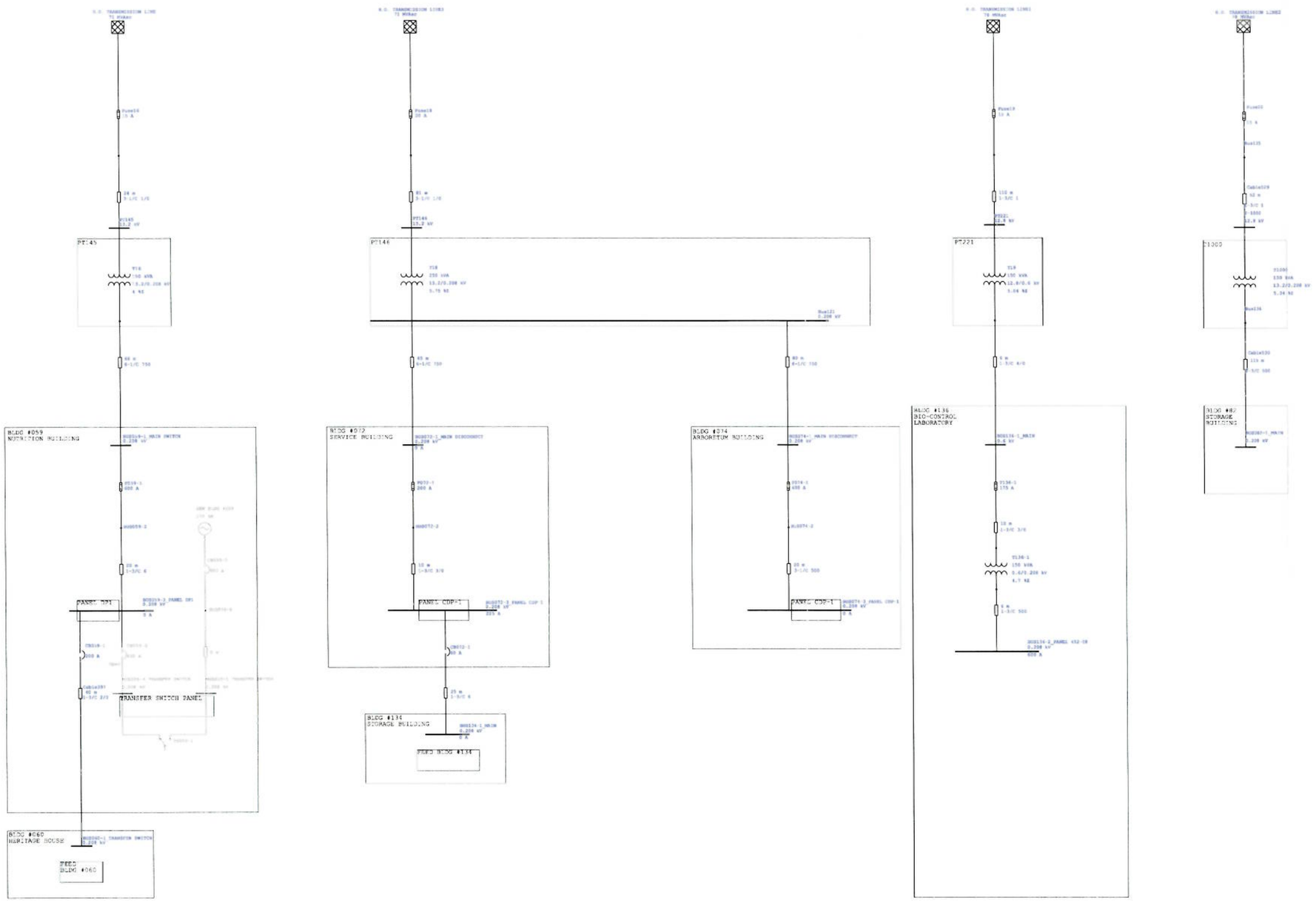

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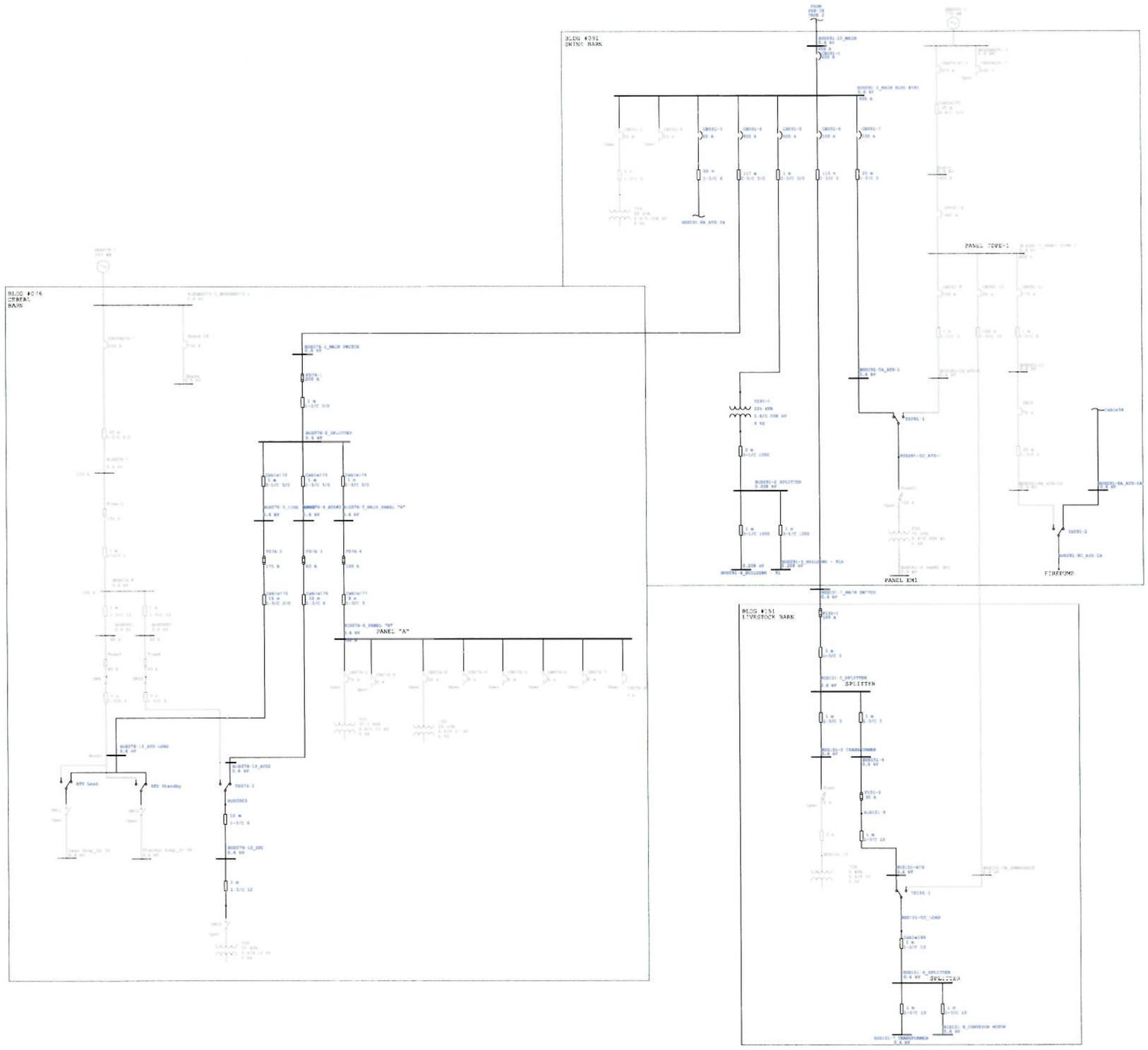

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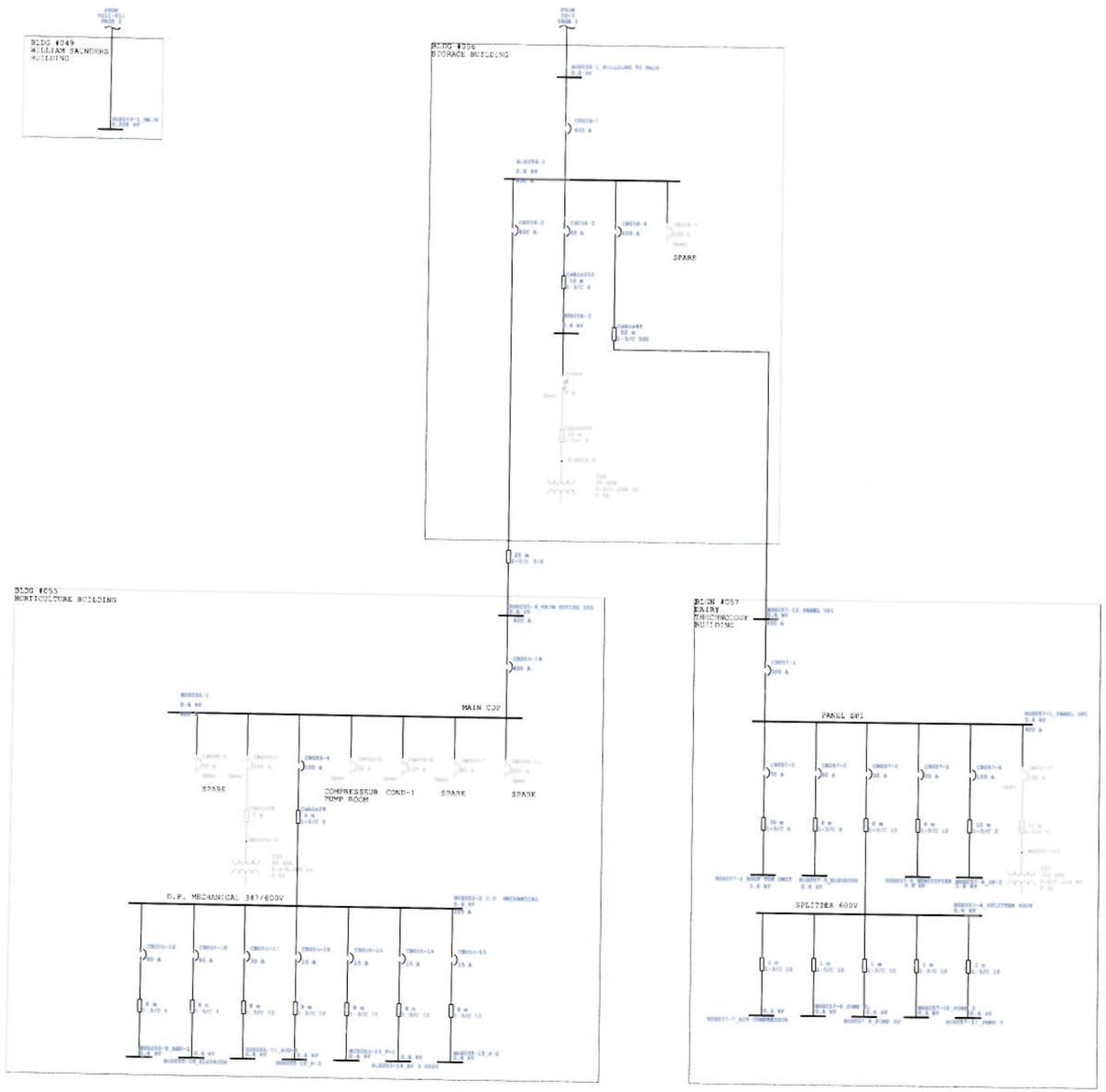

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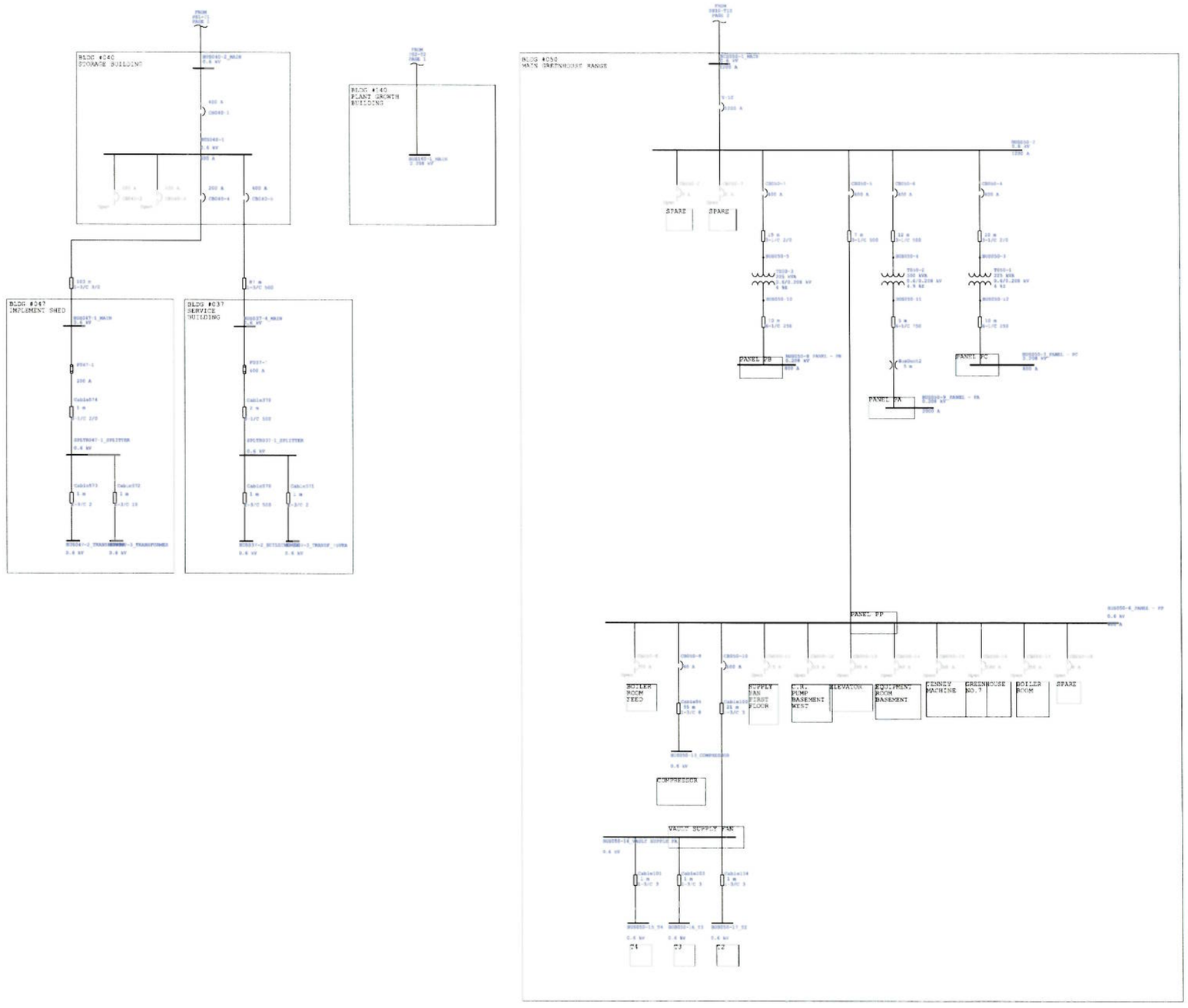

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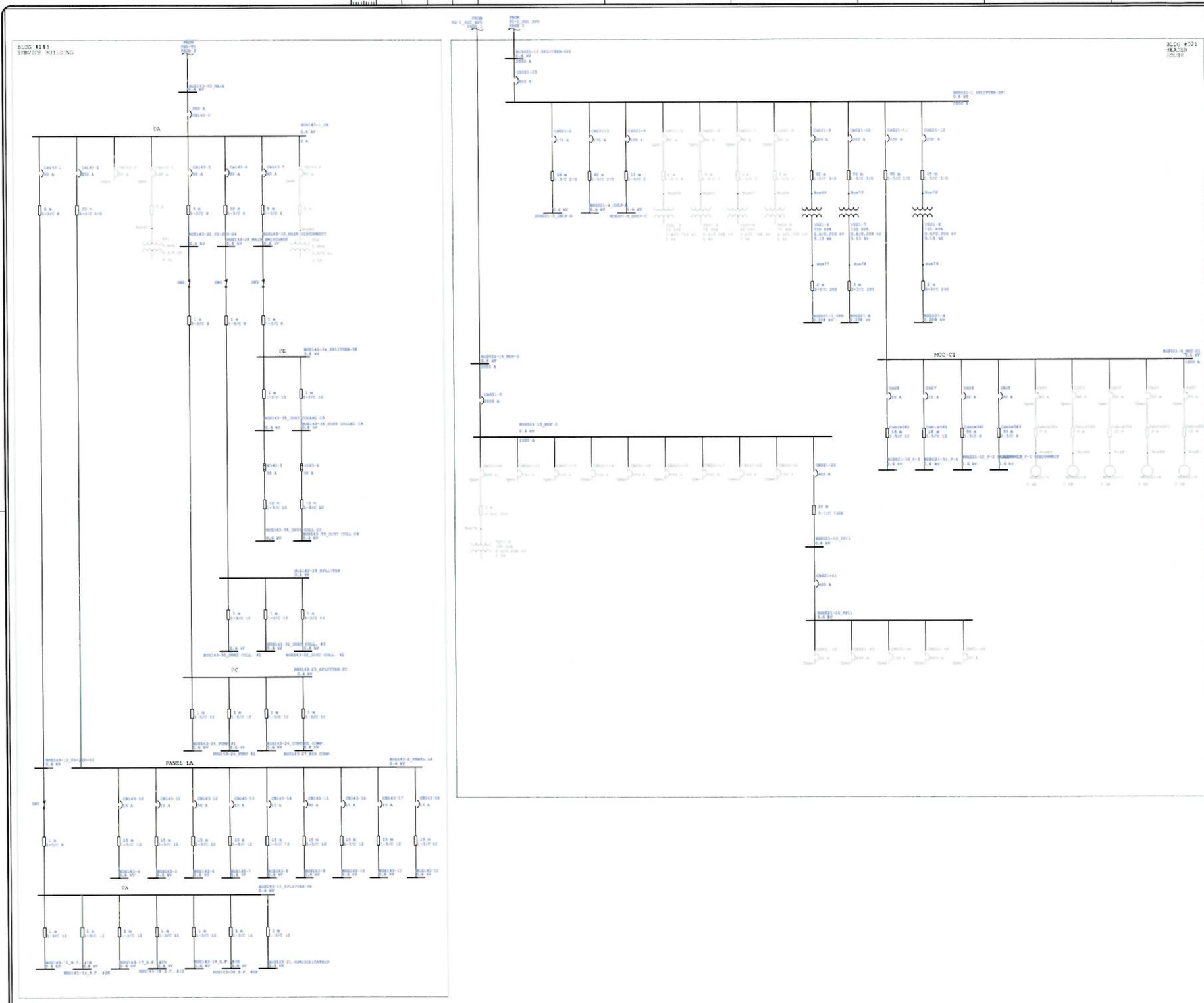

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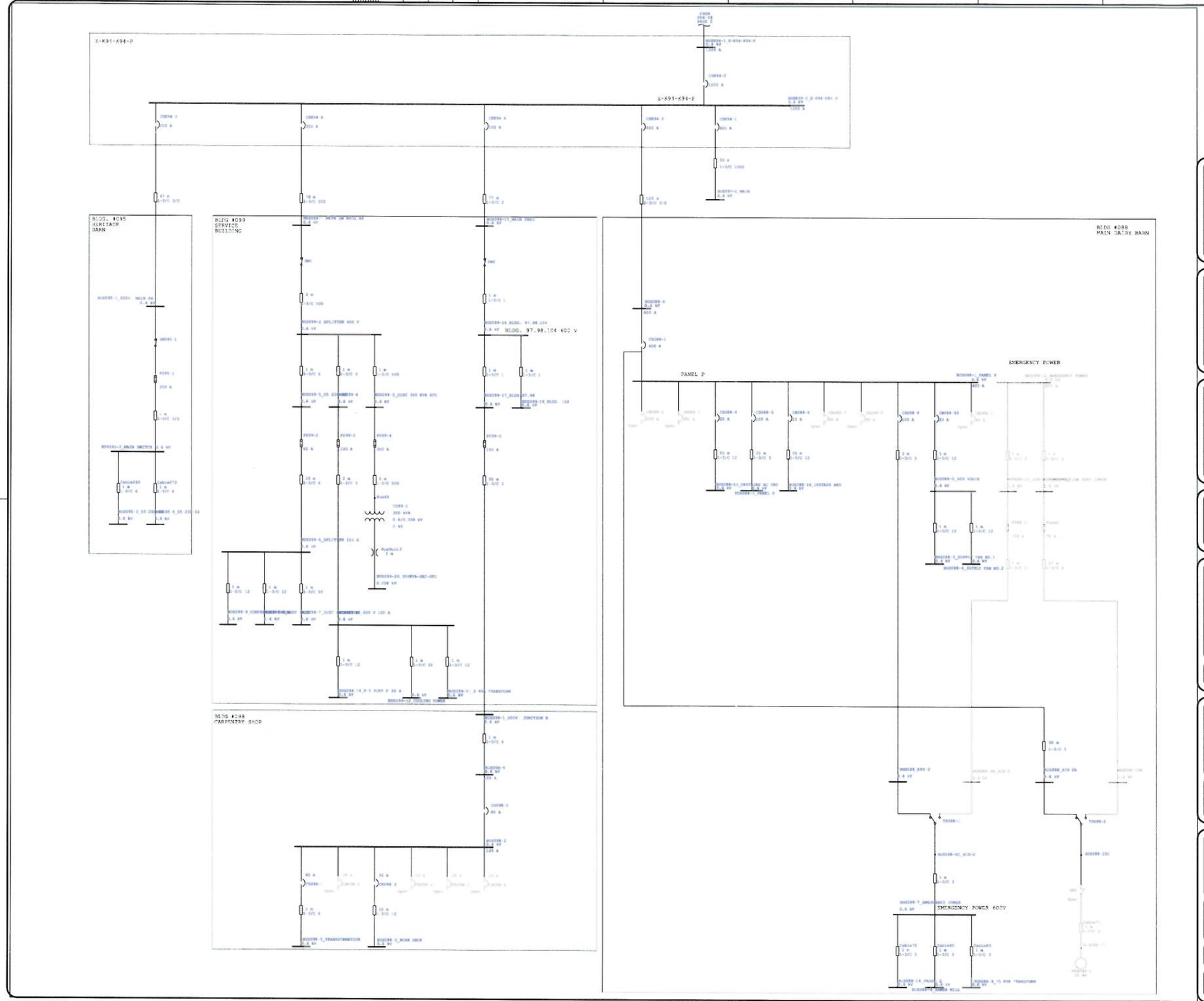

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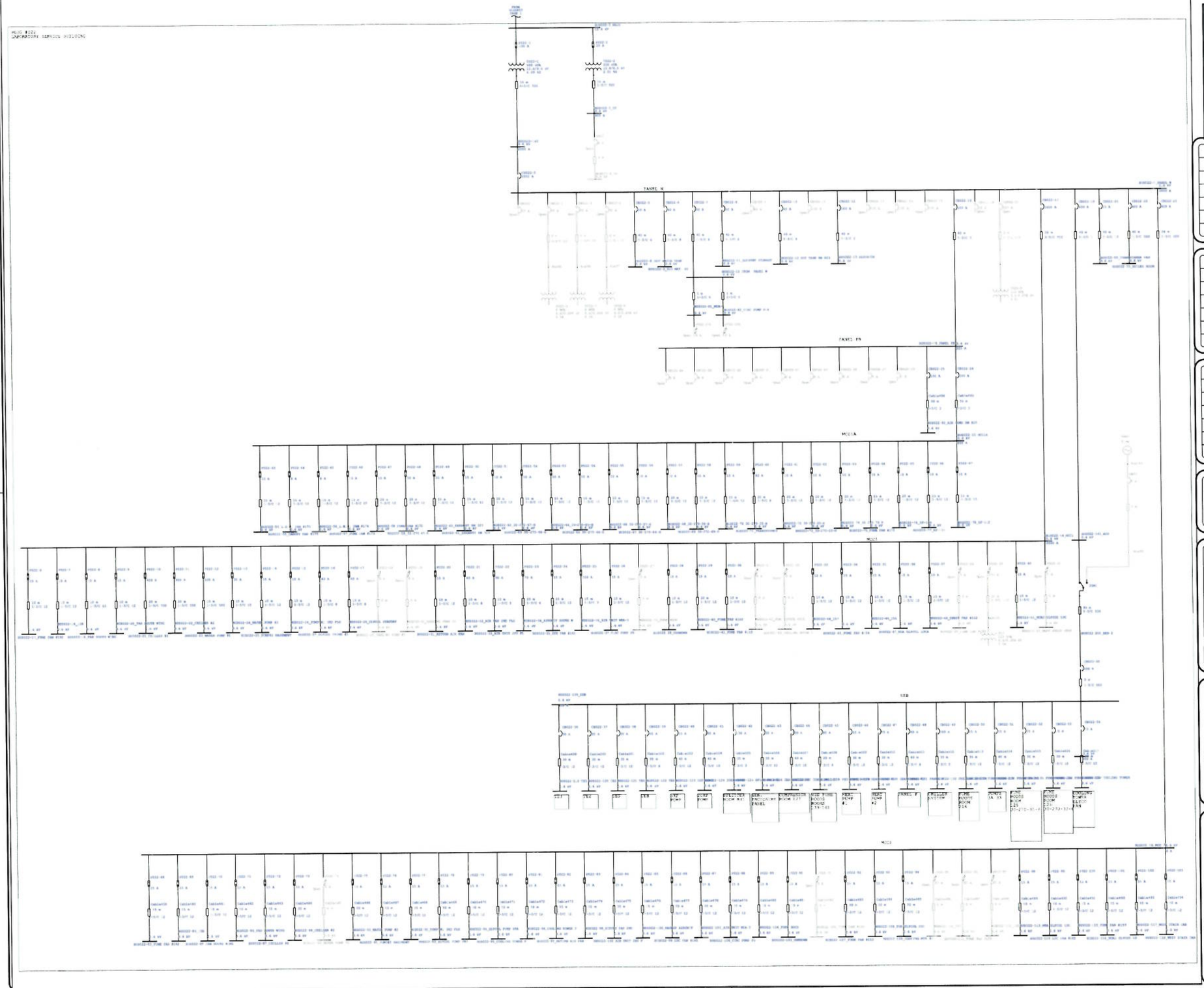

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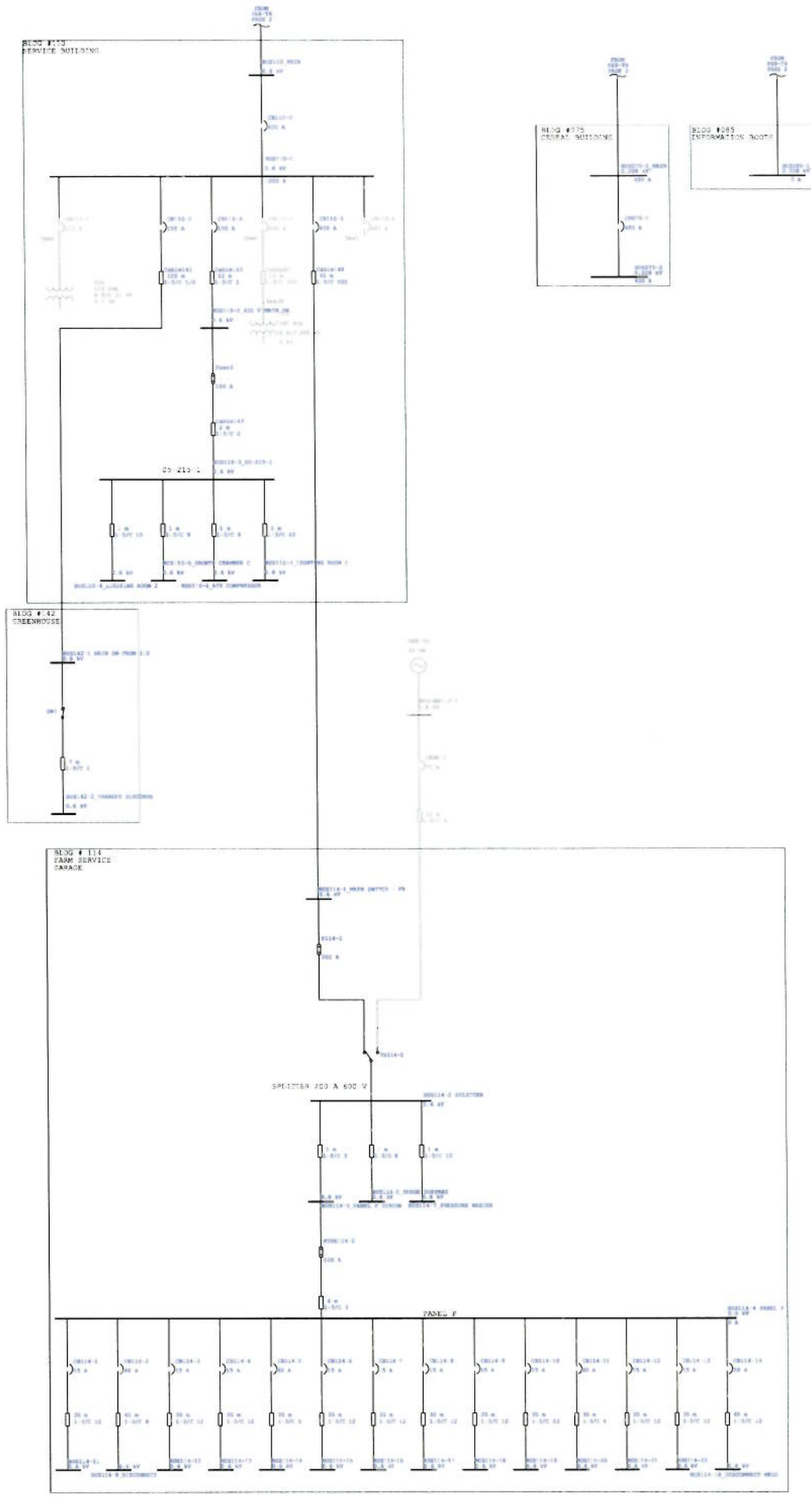

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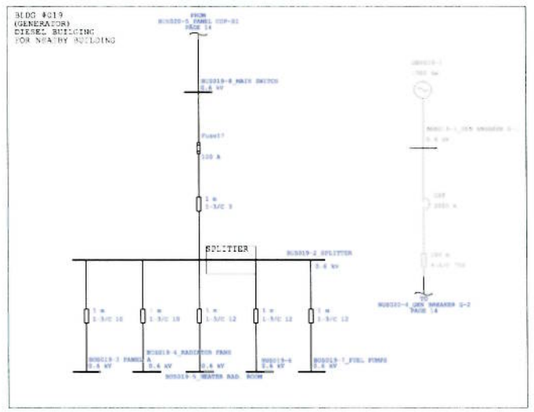

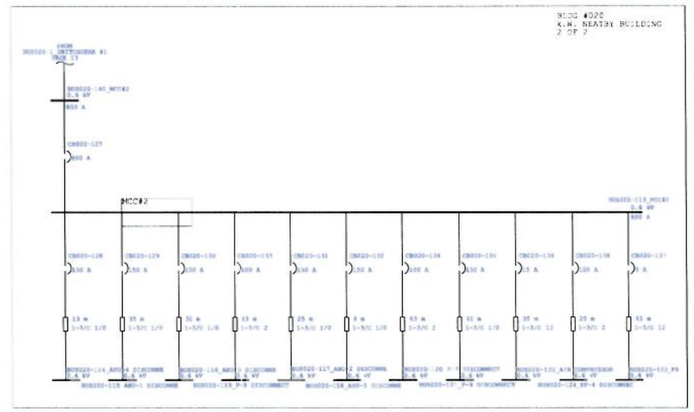

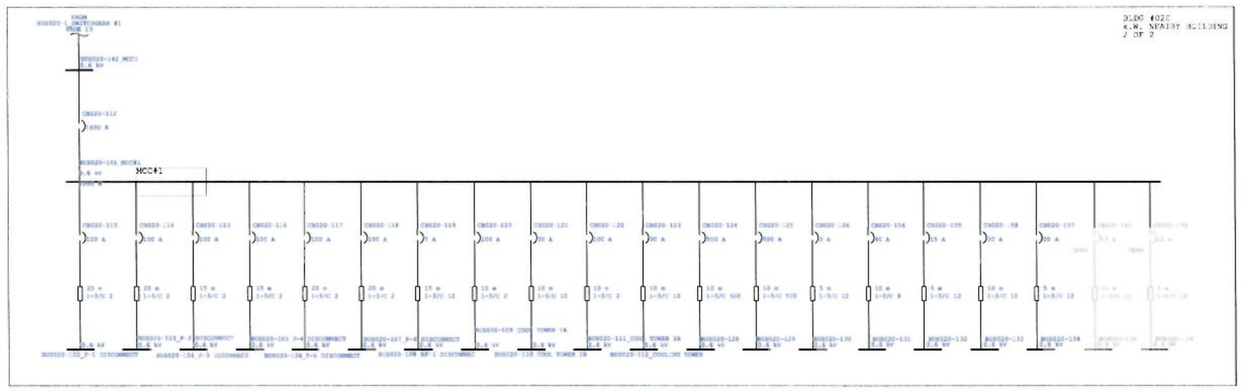

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ARC FLASH AND SHOCK HAZARD STUDY

Titre - Title

ETAP MODEL

DESSAU

Dessau inc.
1455 rue Champlain
Trois-Rivières (Québec) G9A 5X4
Téléphone : 819.378.7949
Télécopieur : 819.378.2985

Préparé Prepared: J. VEZINA, tech.
Dessiné Drawn:
Vérifié Checked: F. ST-ARNAUD, P.Eng.

Discipline: ÉLECTRIQUE
Échelle Scale: IND.
Date: 2014-05-08

Chargé de projet - Project manager: STYVE VILLENEUVE, tech.

No de séquence - Sequence No: 12 de/of 17

Serv.	Projet/Project	Otp/Lot	Disc.	Type	Seq. no	Rev.
063	B-0000430	9100	EL	D	0001	01

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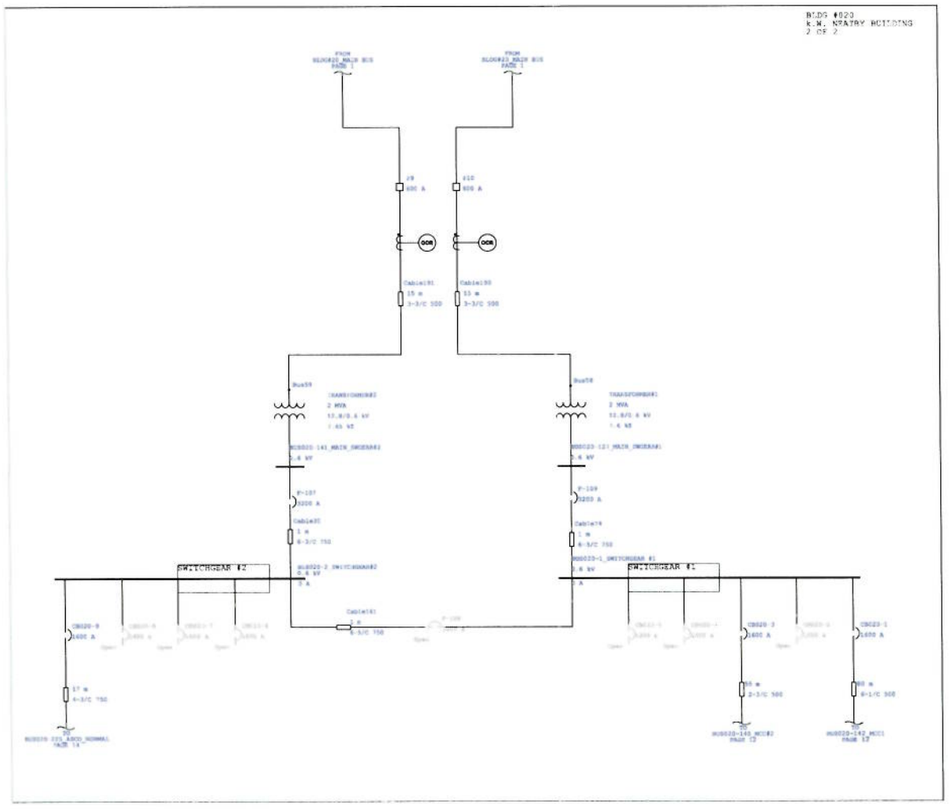

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MAY 8 2014

NUMÉRO - NUMBER	TITRE - TITLE

DESSINS DE RÉFÉRENCE - REFERENCE DRAWINGS

REV	AA-MM-JJ DATE	DESCRIPTION	VER

RÉVISION - REVISIONS

NO	AA-MM-JJ DATE	DESCRIPTION	REV	VER
01	14-02-03	FINAL	JV	FSA

ÉMISSIONS - ISSUES

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CENTRAL EXPERIMENTAL FARM

ADRESSE CLIENT

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Vérifié Checked: F. ST-ARNAUD, P.Eng.	Date: 2014-05-08
Chargé de projet - Project manager: STYVE VILLENEUVE, tech.	No de séquence - Sequence No: 13 de/of 17

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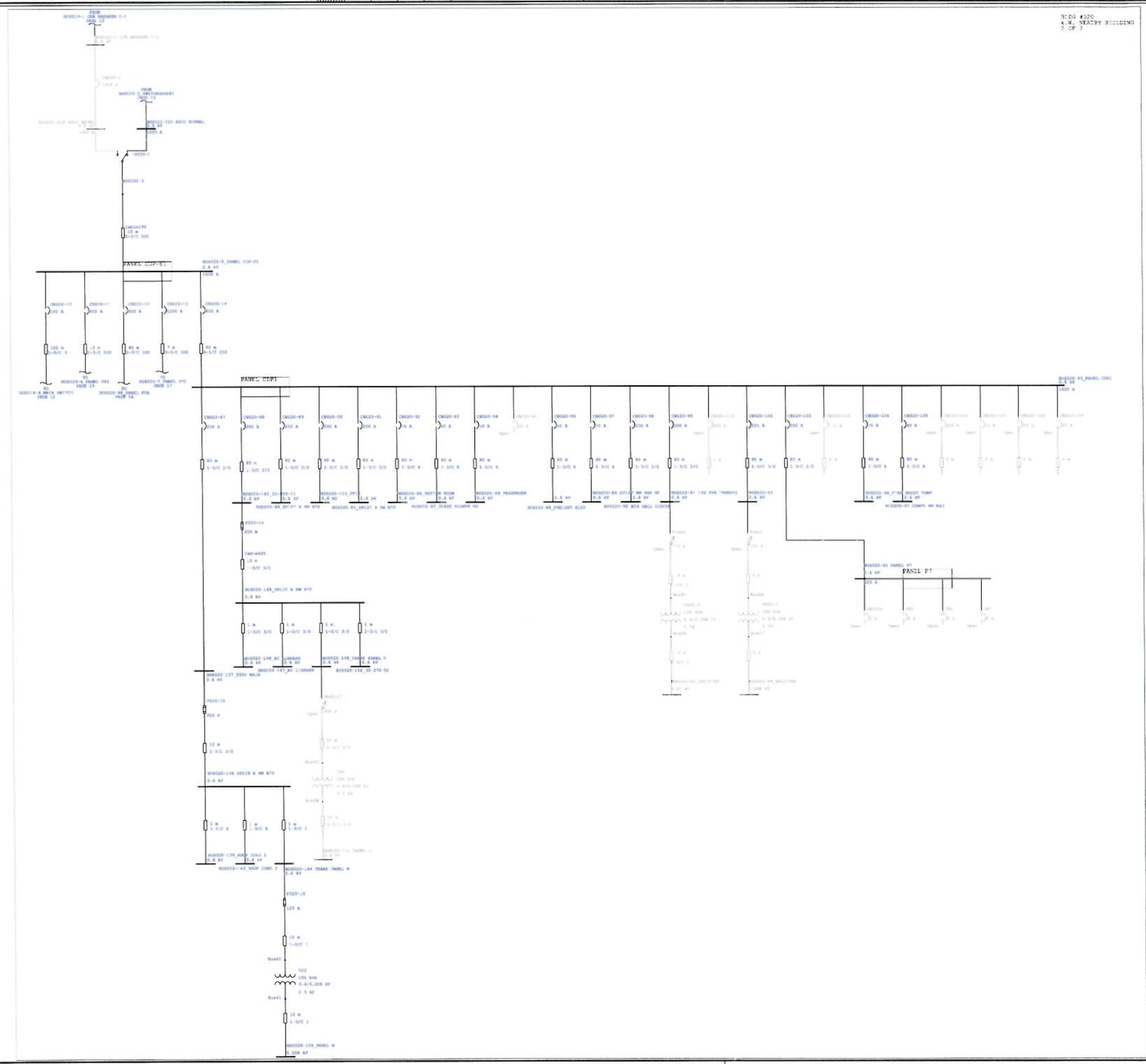

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No de séquence - Sequence No: 14 de/of 17

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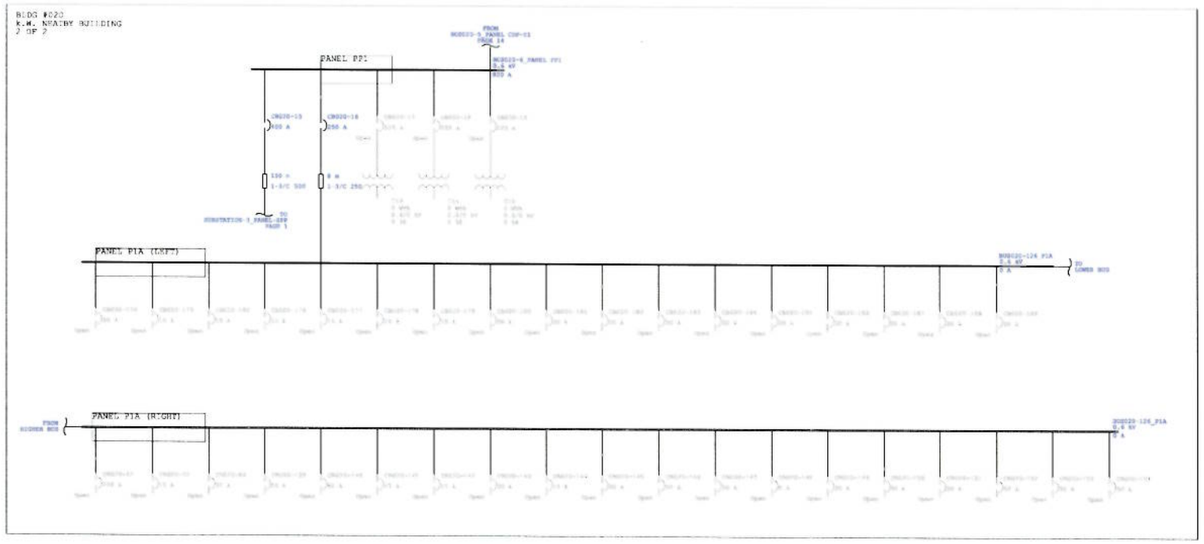

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Chargé de projet - Project manager: STYVE VILLENEUVE, tech.

No de séquence - Sequence No: 15 de/of 17

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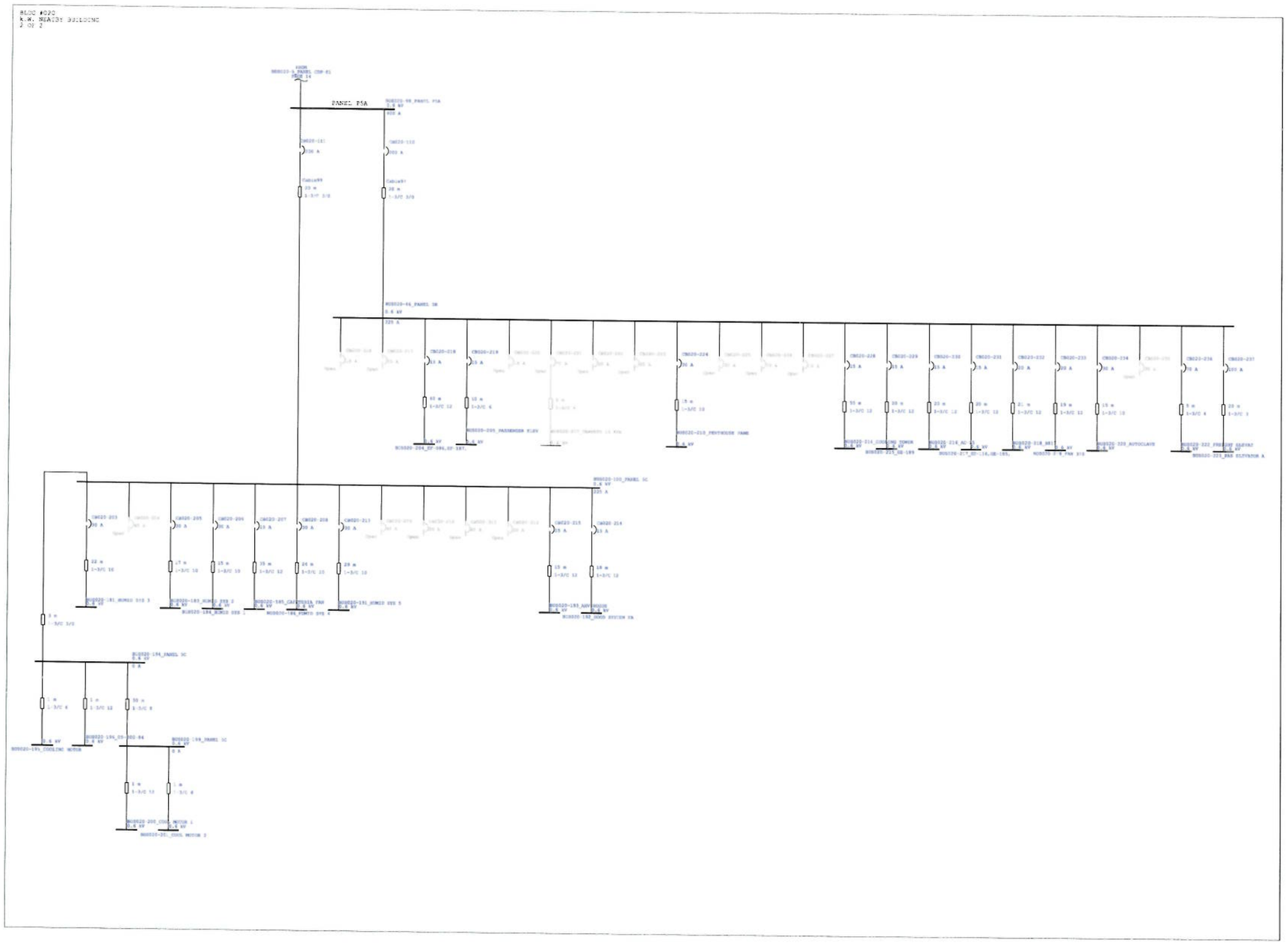

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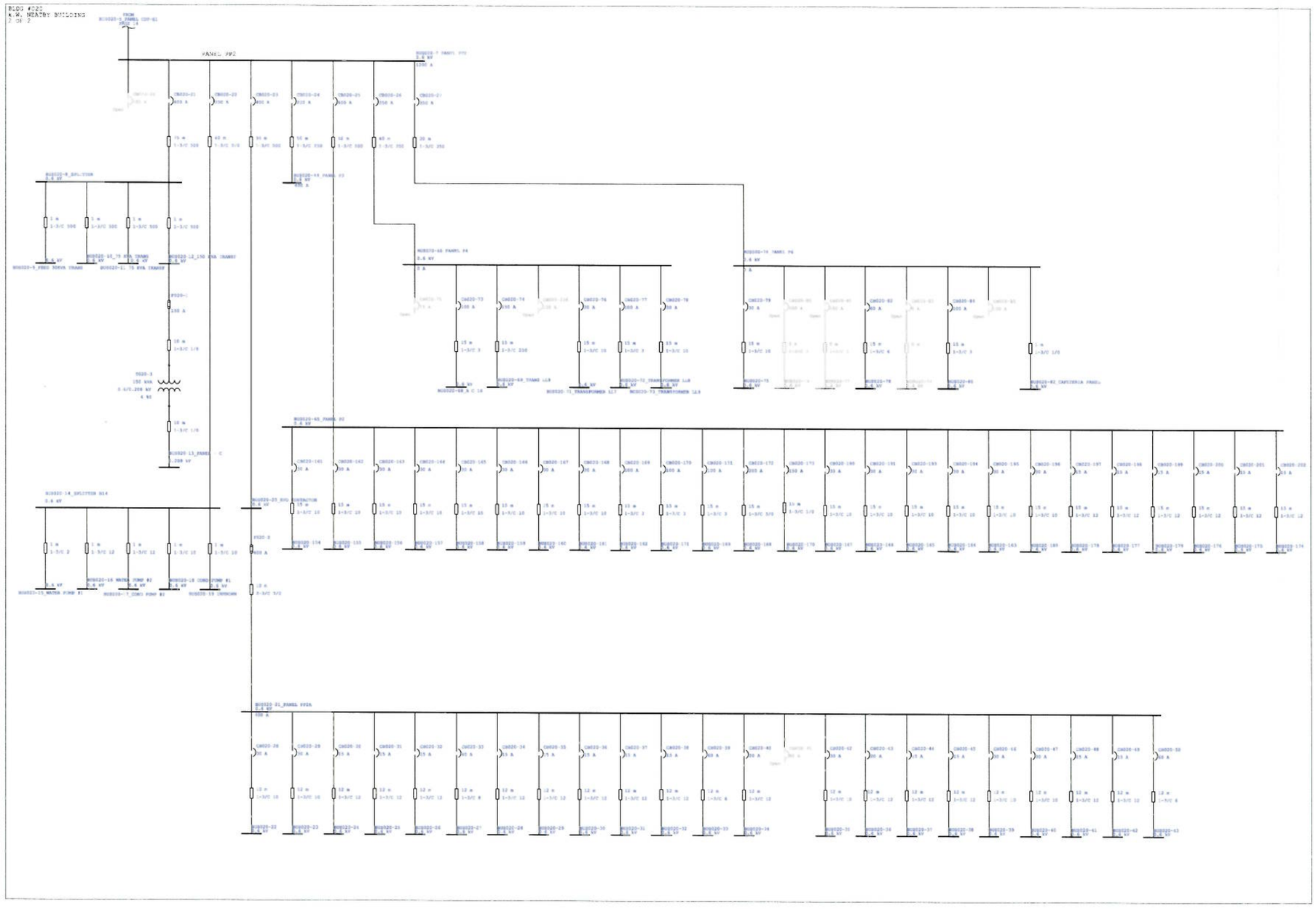

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