October 3, 2017

Arc Flash Study

Prepared for:

ABC

City, State

Prepared by:

John D. Aeiker, PE, CSP

Consultant

CONTENTS

October 3, 2017

ABC–City, State - Five Year Review of DC Arc Flash Study

Jim,
Thank you for the opportunity to perform the five (5) review of the Arc Flash Study for your electrical distribution system and to provide an Arc Flash Study of the direct current (DC) electrical distribution system for the company Center facility near City, SC.

The current version (v7.0) of SKM Power Tools Arc Flash modeling, equipment evaluation, short circuit current analysis and over current device coordination software programs were used to determine Arc Flash incident energy levels for this project. IEEE Standard 1584 modeling software and NFPA 70E 2018 edition was used for verification.

We have documented the results of the calculations and models on one (1) drawing based for the facility direct current (DC) systems. The calculations and analysis have been based on data collected by me during my on-site visit on October 3, 2017.

The results contained in this report are based on the design and information available at the time this report was completed. Any changes made to equipment settings or system configuration will invalidate the results contained in this report and may result in a more hazardous condition thus, necessitating a follow-up review of this arc flash study.

The results of the Five-Year Review of the previous Arc Flash Study and the DC Arc Flash Study are provided below:

Review of AC Arc Flash Study
The Short Circuit, Protective Device Coordination and Arc Flash Hazard Study for Calpine company dated October 2009 (2009 Study) that was completed by Eaton Electrical Services and Systems was reviewed and found to be current with and representative of the site electrical distribution system as found during the on-site inspection and data collection visit on October 3, 2017.

A. The current version (v7.0) of SKM Power Tools was utilized to evaluate various scenarios and these results were compared with the 2009 Study report. No significant differences, variances, or anomalies were identified.
B. The recommended changes in protective device trip settings to improve coordination in the 2009 Study that have been implemented by the site have resulted in the improvements expected.
C. No significant additions or modifications have been made to the electrical distribution system addressed by the 2009 Study.
D. Routine testing and inspection of electrical distribution equipment is performed by the site.
E. The 2009 Study did not evaluate the battery supplied direct current systems utilized on site. A direct current (DC) system arc flash study has been performed as part of this project and the results of it are documented in the “Direct Current (DC) System Arc Flash Study” section of this report.

Direct Current (DC) System Arc Flash Study

The DC Incident Energy Summary Report and Model Drawing provide the detailed results however; the highlights of the DC Arc Flash Study are summarized as follows:

1. **Analysis Methods Utilized**

   For each of the battery systems, three analysis methods were used to determine the worst-case scenario. The three analysis methods were based on three types of ratings provided by the battery manufacturer; the eight (8) hour performance rating, the one (1) minute performance rating, and, the maximum short circuit current rating. Typically, all three of these rating result in similar incident energies for the battery system bus. All three are shown on the model drawing for each battery system. The rating resulting in the worst-case (highest) incident energy level for the battery system bus was then selected for analysis of the DC distribution system fed by the respective battery system bus.

   1. For the CTG-1 and CTG-2 Battery Systems the 8 Hour Rating of 82.5A was used
   2. For the Main Plant Battery System, the 8 Hour Rating of 444A was used
   3. For the Switchyard Battery System, the 1 Minute Rating of 222A was used

2. **System Mis-coordination**

   A few areas of overcurrent device mis-coordination are indicated in the DC Incident Energy Summary Report (see the (*N5) notations). In an industrial power system though, mis-coordination is not an uncommon situation to find and it typically works in your favor relative to arc flash as the speed of the upstream protective device reduces the incident energy exposure. These upstream protective devices function in this manner only in an overload condition. A detailed system analysis could be considered although, it should be noted that this power system device coordination analysis could consume significant engineering and field monitoring cost.

3. **Equipment Labeling**

   The switchboard, motor control center (MCC) sections, and panel boards must be labeled to the actual incident energy levels per the requirements of IEEE 1584 and NFPA 70E for testing, troubleshooting and interacting with the device with exposed energized parts. All disconnects that could require maintenance, testing or troubleshooting will be labeled to the requirements of NFPA 70E 130.5(D); extracted text from provided next.

   NFPA 70E, 2015 Edition (Pg. 28)

   130.5 (D) Equipment Labeling. Electrical equipment such as switchboards, panel boards, industrial control panels, meter socket enclosures, and motor control centers that are in other than dwelling units and that are likely to require examination, adjustment, servicing, or maintenance while energized shall be field-marked with a label containing all the following information:

   (1) Nominal system voltage
   (2) Arc flash boundary
   (3) At least one of the following:

a. Available incident energy and the corresponding working distance, or the arc flash PPE category in Table 130.7(C)(15)(A)(b) or Table 130.7(C)(15)(B)for the equipment, but not both
b. Minimum arc rating of clothing
c. Site-specific level of PPE

Exception: Labels applied prior to September 30, 2011 are acceptable if they contain the available incident energy or required level of PPE.

The method of calculating and the data to support the information for the label shall be documented. Where the review of the arc flash hazard risk assessment identifies a change that renders the label inaccurate, the label shall be updated.

The owner of the electrical equipment shall be responsible for the documentation, installation, and maintenance of the field-marked label.

4. **Operation of Electrical Equipment**

The motor control centers and distribution panels are typical lockout points. The calculated energy levels as indicated on the drawings are often in excess of 1.2 calories/cm2 and as such would require some level of arc rated PPE. The extracted text from NFPA 70E 2015 edition regarding this situation is provided next:

NFPA 70E, 2015 Edition (Pg. 24)
130.2 Electrically Safe Working Conditions
(A) Energized Work

(4) **Normal Operation.** Normal operation of electric equipment shall be permitted where all of the following conditions are satisfied:

(1) The equipment is properly installed.
(2) The equipment is properly maintained.
(3) The equipment doors are closed and secured.
(4) All equipment covers are in place and secured.
(5) There is no evidence of impending failure.

***Informational Note**: The phrase properly installed means that the equipment is installed in accordance with applicable industry codes and standards and the manufacturer's recommendations. The phrase properly maintained means that the equipment has been maintained in accordance with the manufacturer's recommendations and applicable industry codes and standards. The phrase evidence of impending failure means that there is evidence such as arcing, overheating, loose or bound equipment parts, visible damage, or deterioration.*

NFPA 70E, 2015 Edition (Pg. 35)
Table 130.7(C)(15)(A)(a) Arc Flash Hazard Identification for Alternating Current (ac) and Direct Current (dc) Systems

Task	Equipment Condition*	Arc Flash PPE Required
…		
Normal operation of a circuit breaker (CB), switch, contactor, or starter	All of the following: The equipment is properly installed The equipment is properly maintained All equipment doors are closed and secured All equipment covers are in place and secured There is no evidence of impending failure	**No**
	One or more of the following: The equipment is not properly installed the equipment is not properly maintained Equipment doors are open or not secured Equipment covers are off or not secured There is evidence of impending failure	**Yes**

Additionally, while for DC systems, work on energized electrical conductors and circuit parts of series-connected battery cells, including voltage testing requires arc flash PPE, these conditions for Normal Operation apply specifically to voltage testing on individual battery cells or individual multi-cell units and removal of battery inter-cell connector covers as outlined in Table 130.7(C)(15)(A)(a). The calculated energy levels as indicated on the drawings are often in excess of 1.2 calories/cm2 and as such would require some level of arc rated PPE. The extracted text from NFPA 70E 2015 edition regarding this situation is provided next:

NFPA 70E, 2015 Edition (Pg. 35)
Table 130.7(C)(15)(A)(a) Arc Flash Hazard Identification for Alternating Current (ac) and Direct Current (dc) Systems

Task	Equipment Condition*	Arc Flash PPE Required
…		
Voltage testing on individual battery cells or individual multi-cell units or Removal of battery inter-cell connector covers	All of the following: The equipment is properly installed The equipment is properly maintained All equipment covers are in place and secured There is no evidence of impending failure	**No**

	One or more of the following: The equipment is not properly installed the equipment is not properly maintained Equipment doors are open or not secured Equipment covers are off or not secured There is evidence of impending failure	**Yes**

NFPA 70E makes it very clear the determination of this condition can only be made by the responsible person in charge of the facility. If the facility has evidence and documentation as per the requirements of NFPA 70E 205.3, 205.4 and 210.5 that all five conditions are met, then no arc rated PPE would be required to operate disconnects with the doors properly closed and latched. **"In our experience, it is very rare that equipment is maintained to the exact specifications of the manufacturer".** For reference see NFPA extracts listed below.

A safer approach could be taken. Other facilities with similar situations provide an appropriate Arc Rated switchers coat, face shield and leather gloves in each of the MCC rooms and then instruct the task qualified workers when performing the lock out procedure to wear the coat, hard hat, face shield and gloves to interact with the disconnect in question. If this approach is taken, the under-layer clothing shall be 100% natural fiber non-melting clothing per NFPA 70E. After the disconnect switch is operated to the "off" position, then lock out procedures can be performed without any arc rated PPE.

NFPA 70E, 2015 Edition (Pg. 44 & 45)

205.3 General Maintenance Requirements. Electrical equipment shall be maintained in accordance with manufacturers' instructions or industry consensus standards to reduce the risk associated with failure. The equipment owner or the owner's designated representative shall be responsible for maintenance of the electrical equipment and documentation.

Informational Note: *Common industry practice is to apply test or calibration decals to equipment to indicate the test or calibration date and overall condition of equipment that has been tested and maintained in the field. These decals provide the employee immediate indication of last maintenance date and if the tested device or system was found acceptable on the date of test. This local information can assist the employee in the assessment of overall electrical equipment maintenance status.*

205.4 Overcurrent Protective Devices. Overcurrent protective devices shall be maintained in accordance with the manufacturers' instructions or industry consensus standards. Maintenance, tests, and inspections shall be documented.

210.5 Protective Devices. Protective devices shall be maintained to adequately withstand or interrupt available fault current.

Informational Note: Improper or inadequate maintenance can result in increased opening time of the overcurrent protective device, thus increasing the incident energy.

The calculations in this study and resultant incident energy levels are based upon the overcurrent devices (overcurrent relays, circuit breakers, and fused disconnects) operating as designed and being properly

maintained. Maintenance intervals should be based on the manufacturer's recommendations or industry consensus testing standards. This is typically a 3 to 5 year interval based on the conditions of the equipment. The InterNational Electrical Testing Association (NETA) provides guidance documents for adjusting these intervals based on location conditions.

It is important to note that in many cases, changing the trip settings of the equipment in place in the facility is relatively simple to do. Full-function circuit breakers and time overcurrent relay devices often have adjustable long-time, short-time and instantaneous (LSI) trip units that provide the unique ability to modify or change the trip settings with a small screwdriver. As any changes to the equipment settings may have a significant impact on the incident energy levels found in the electrical system, the facility should have a change management process in place to maintain the settings as found for this Arc Flash Study. Any change to the site distribution system or a change to your incoming service fault current could necessitate a review of this arc flash study.

Annex H of NFPA 70E provides guidance for a clothing system to 12 calories/cm2 and as such on all the model drawings anytime there is a PPE Category 3 situation it will be indicated as such with the specific calories/cm2 exposure. This can help you if your clothing supplier is providing 12 calories/cm2 clothing. This needs to be verified to what level of protection your PPE uniform clothing provides. This can be your decision after verification of the ATPV of the clothing supplied, documented and communicated to the affected personnel.

Layering of Arc rated clothing is allowed as long as it has been tested as a system. This information is available on the clothing manufacturers' websites as well as on ArcWear.com. As an example, Westex has tested their Indura Ultrasoft shirt with their T-shirt (typical rental company provided material) and the combination achieves 20 calories/cm2. Tyndale's 9 calories/cm2 shirt has been tested with various other 4 calories/cm2 T-shirts achieving slightly higher overall results when used together.

Any exposures greater than PPE Category 1 (> 4 calories/cm2) requires the use of an arc rated face shield and balaclava or an arc rated face shield hood assembly.

NFPA 70E requires the arc flash study to be reviewed every five years. If nothing has changed relative to your incoming service fault current and you have not changed anything in your distribution system on site, then the review can be a very simple process of noting this fact every 5 years. A verification from the utility of the utility information found on the arc flash study document and also contained on the USB drive is all that would be required.

NFPA 70E requires initial qualified training and re-training every three years for your qualified electrical workers. We typically recommend electrical safety training after the labeling activity as this can provide a customized session for your specific equipment and what the labels require as far as proper work practices. Within the documentation binder for this study are copies of all the associated information; this summary report, the one-line drawings from SKM, the Arc Flash Evaluation reports, and the Equipment Evaluation report. All of the relative files in PDF, native Microsoft Office format and native SKM format are provided on an USB drive for file retention. It is recommended that these files be retained in a secure location within your organization. e-Hazard also retains the files backed up to a "secured cloud service".

I keep an exact duplicate of the documentation binder in my office so if there is ever a question, we can both look at the exact same piece of information at any time in the future. If I should be traveling, I have all the files on my laptop with me.

Please call John Aeiker, 251-581-1492 for any additional clarification relative to this report.
Thank you,

Thank you,

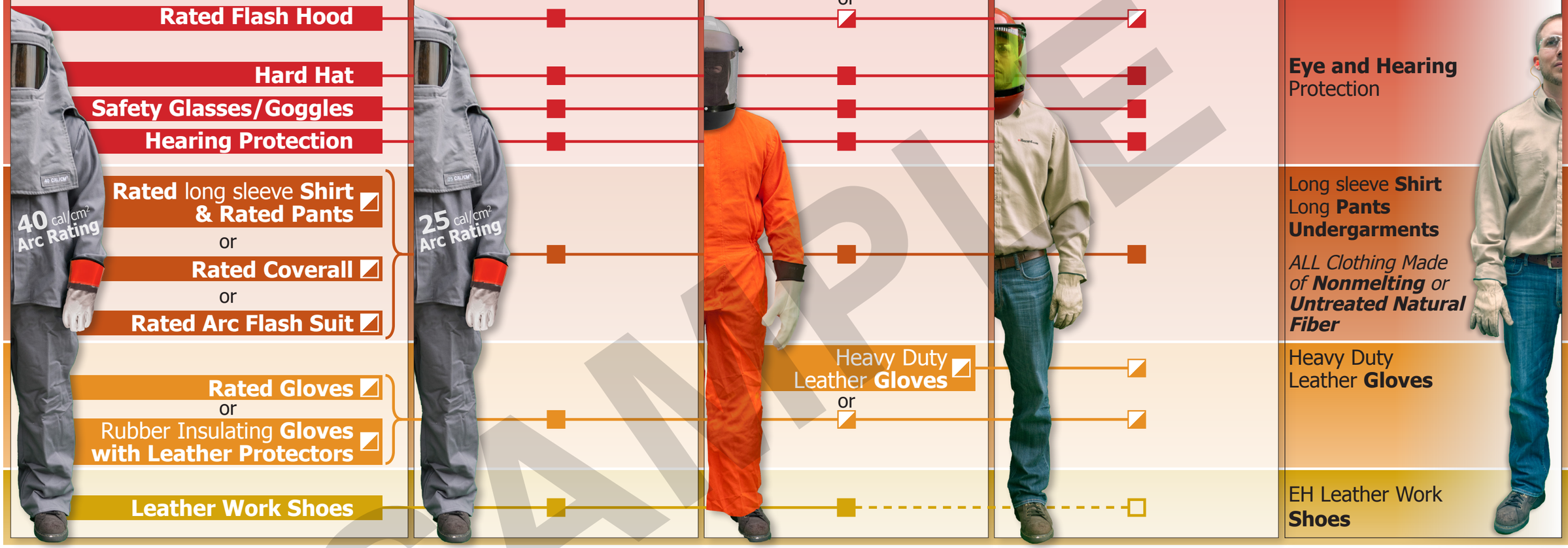
john.aeiker@e-hazard.com

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Bus Name	Protective	Bus	DC Bolted	DC Arcing	Bus	DC Bolted	DC Arcing	Trip/	Breaker	Duration	Multiplier	Working	Arc	Incident	PPE Level
2		Device	kV	Bus	Bus	Equivalent	Prot Dev	Prot Dev	Delay	Opening	of Arc		Distance	Flash	Energy	
3		Name		Fault (kA)	Fault (kA)	Resistance	Fault (kA)	Fault (kA)	Time	Time/Tol	(sec.)		(in)	Boundary	(cal/cm2)	
4						(Ohms)			(sec.)	(sec.)				(in)		
5	600A Main DC Bus @ 1 Minute	MaxTripTime @2.0s	0.125	7.088	3.544	0.0176	0.000	0.000	2.000	0.000	2.000	1.0	18	34	4.2	Level 2 (*N2) (*N9)
6	600A Main DC Bus @ 8 Hour	Emergency Lube Oil Pump CB	0.125	13.495	6.748	0.0093	3.332	1.666	2.000	0.000	2.000	1.0	18	47	8.1	Level 3 (*N2) (*N9)
7	600A Main DC Bus @ 8 Hour	Emergency Seal Oil Pump CB	0.125	13.495	6.748	0.0093	1.773	0.887	2.000	0.000	2.000	1.0	18	47	8.1	Level 3 (*N2) (*N9)
8	600A Main DC Bus @ 8 Hour	MaxTripTime @2.0s	0.125	13.495	6.748	0.0093	8.390	4.195	2.000	0.000	2.000	1.0	18	47	8.1	Level 3 (*N2) (*N9)
9	600A Main DC Bus @ Max SC	MaxTripTime @2.0s	0.125	4.498	2.249	0.0278	0.000	0.000	2.000	0.000	2.000	1.0	18	27	2.7	Level 1 (*N2) (*N9)
10	BOP SWBD 1A Bus	SWBD 1A Main FD	0.125	16.318	8.159	0.0077	16.318	8.159	1.086	0.000	1.086	1.0	18	38	5.3	Level 2
11	BOP SWBD 1B Bus	SWBD 1B Main FD	0.125	16.328	8.164	0.0077	15.640	7.820	1.485	0.000	1.485	1.0	18	44	7.3	Level 2
12	BOP SWBD 1B Bus	SWBD 1B - BOP MCC 1 CB	0.125	16.328	8.164	0.0077	0.689	0.344	2.000	0.000	2.000	1.0	18	45	7.4	Level 2 (*N9)
13	Control Power Cabinet	Control Power CB	0.125	10.420	5.210	0.0120	10.420	5.210	0.020	0.000	0.020	1.0	18	4	0.06	Level 0
14	DC PNLBD Main Bus	Emergency Lube Oil Pump CB	0.125	12.446	6.223	0.0100	3.067	1.534	2.000	0.000	2.000	1.0	18	45	7.4	Level 2 (*N2) (*N9)
15	DC PNLBD Main Bus	Emergency Seal Oil Pump CB	0.125	12.446	6.223	0.0100	1.632	0.816	2.000	0.000	2.000	1.0	18	45	7.4	Level 2 (*N2) (*N9)
16	DC PNLBD Main Bus	MaxTripTime @2.0s	0.125	12.446	6.223	0.0100	7.747	3.874	2.000	0.000	2.000	1.0	18	45	7.4	Level 2 (*N2) (*N9)
17	Emergency Lube Oil Pump FS	Emergency Lube Oil Pump CB	0.125	10.808	5.404	0.0116	6.808	3.404	0.017	0.000	0.017	1.0	18	4	0.05	Level 0 (*N2)
18	Emergency Lube Oil Pump FS	MaxTripTime @2.0s	0.125	10.808	5.404	0.0116	4.000	2.000	2.000	0.000	2.000	1.0	18	26	2.4	Level 1 (*N2) (*N9)
19	Emergency Seal Oil Pump FS	Emergency Seal Oil Pump CB	0.125	8.777	4.389	0.0142	6.777	3.389	0.020	0.000	0.020	1.0	18	4	0.05	Level 0 (*N2)
20	Emergency Seal Oil Pump FS	MaxTripTime @2.0s	0.125	8.777	4.389	0.0142	2.000	1.000	2.000	0.000	2.000	1.0	18	18	1.2	Level 1 (*N2) (*N9)
21	Inverter 1A DC Input Bus	SWBD 1A - Inverter 1A CB (Inverter 1A DC CB)	0.125	16.164	8.082	0.0077	16.164	8.082	0.018	0.000	0.018	1.0	18	5	0.09	Level 0 (*N5)
22	Inverter 1B DC Input Bus	SWBD 1B - Inverter 1B CB (Inverter 1B DC CB)	0.125	16.174	8.087	0.0077	16.174	8.087	0.018	0.000	0.018	1.0	18	5	0.09	Level 0 (*N5)
23	Plant Battery Bus @ 1 Minute	MaxTripTime @2.0s	0.125	14.042	7.021	0.0089	0.000	0.000	2.000	0.000	2.000	1.0	18	48	8.4	Level 3 (*N2) (*N9)
24	Plant Battery Bus @ 8 Hours	SWBD 1B Main FD	0.125	16.443	8.222	0.0076	0.688	0.344	2.000	0.000	2.000	1.0	18	52	9.8	Level 3 (*N2) (*N9)
25	Plant Battery Bus @ 8 Hours	MaxTripTime @2.0s	0.125	16.443	8.222	0.0076	15.755	7.877	2.000	0.000	2.000	1.0	18	52	9.8	Level 3 (*N2) (*N9)
26	Plant Battery Bus @ Max SC	MaxTripTime @2.0s	0.125	13.923	6.962	0.0090	0.000	0.000	2.000	0.000	2.000	1.0	18	47	8.3	Level 3 (*N2) (*N9)
27	SWBD 1A - AX-011A Emergency	SWBD 1B - AX-011A CB	0.125	16.083	8.041	0.0078	16.083	8.041	0.013	0.000	0.013	1.0	18	4	0.06	Level 0
28	SWBD 1A - AX-011A Normal	SWBD 1A - AX-011A CB	0.125	16.194	8.097	0.0077	16.194	8.097	0.014	0.000	0.014	1.0	18	4	0.07	Level 0
29	SWBD 1A - Battery Charger 1A	SWBD 1A - Battery Chgr 1A CB	0.125	16.194	8.097	0.0077	16.194	8.097	0.028	0.000	0.028	1.0	18	6	0.14	Level 0
30	SWBD 1A - Inverter 1A	SWBD 1A - Inverter 1A CB	0.125	16.194	8.097	0.0077	16.194	8.097	0.018	0.000	0.018	1.0	18	5	0.09	Level 0
31	SWBD 1A - Power Panel 21A	SWBD 1A - Power Panel 21A CB	0.125	16.194	8.097	0.0077	16.194	8.097	0.013	0.000	0.013	1.0	18	4	0.06	Level 0
32	SWBD 1B - AX-011B Emergency	SWBD 1A - AX-011B CB	0.125	16.073	8.036	0.0078	16.073	8.036	0.013	0.000	0.013	1.0	18	4	0.06	Level 0
33	SWBD 1B - AX-011B Normal	SWBD 1B - AX-011B CB	0.125	16.205	8.102	0.0077	16.205	8.102	0.013	0.000	0.013	1.0	18	4	0.06	Level 0
34	SWBD 1B - AX-021B Emergency	SWBD 1A - AX-021B CB	0.125	16.073	8.036	0.0078	16.073	8.036	0.013	0.000	0.013	1.0	18	4	0.06	Level 0
35	SWBD 1B - AX-021B Normal	SWBD 1B - AX-021B CB	0.125	16.205	8.102	0.0077	16.205	8.102	0.013	0.000	0.013	1.0	18	4	0.06	Level 0
36	SWBD 1B - Battery Charger 1B	SWBD 1B - Battery Chgr 1B CB	0.125	16.184	8.092	0.0077	16.184	8.092	0.028	0.000	0.028	1.0	18	6	0.14	Level 0
37	SWBD 1B - Battery Charger 2B	SWBD 1B - Battery Chgr 2B CB	0.125	16.205	8.102	0.0077	16.205	8.102	0.028	0.000	0.028	1.0	18	6	0.14	Level 0
38	SWBD 1B - Battery Chgr 1B Lugs	SWBD 1B - Battery Chgr 1B CB	0.125	16.308	8.154	0.0077	16.308	8.154	0.028	0.000	0.028	1.0	18	6	0.14	Level 0
39	SWBD 1B - BOP MCC 1 MLO	SWBD 1B - BOP MCC 1 CB	0.125	16.215	8.108	0.0077	15.526	7.763	0.019	0.000	0.019	1.0	18	5	0.09	Level 0
40	SWBD 1B - BOP MCC 1 MLO	SWBD 1B - BOP MCC 1 Typ CB	0.125	16.215	8.108	0.0077	0.689	0.344	2.000	0.000	2.000	1.0	18	12	0.50	Level 0 (*N9)
41	SWBD 1B - BOP MCC 1 Typ Load	SWBD 1B - BOP MCC 1 Typ CB	0.125	15.940	7.970	0.0078	15.250	7.625	0.014	0.000	0.014	1.0	18	4	0.07	Level 0
42	SWBD 1B - Inverter 1B	SWBD 1B - Inverter 1B CB	0.125	16.205	8.102	0.0077	16.205	8.102	0.018	0.000	0.018	1.0	18	5	0.09	Level 0
43	SWYD 125V DP MLO	SWYD Battery Fused Disconnect	0.125	0.035	0.018	3.5619	0.035	0.018	2.000	0.000	2.000	1.0	18	2	0.02	Level 0 (*N9)
44	SWYD Battery Bus @ 1 Minute	MaxTripTime @2.0s	0.125	0.035	0.018	3.5228	0.000	0.000	2.000	0.000	2.000	1.0	18	2	0.02	Level 0 (*N2) (*N9)
45	SWYD Battery Bus @ 8 Hour	MaxTripTime @2.0s	0.13	0.030	0.015	4.2992	0.000	0.000	2.000	0.000	2.000	1.0	18	2	0.02	Level 0 (*N2) (*N9)
46	SWYD Battery Bus @ Max SC	MaxTripTime @2.0s	0.13	0.023	0.012	5.5513	0.000	0.000	2.000	0.000	2.000	1.0	18	2	0.01	Level 0 (*N2) (*N9)
47	Typ. MCC--1 & MCC-2 15-20A FS	Typ. MCC--1 & MCC-2 15-20A CB	0.125	8.962	4.481	0.0139	8.962	4.481	0.020	0.000	0.020	1.0	18	4	0.05	Level 0
48	Typ. MCC--1 & MCC-2 30A FS	Typ. MCC--1 & MCC-2 30A CB	0.125	8.962	4.481	0.0139	8.962	4.481	0.020	0.000	0.020	1.0	18	4	0.05	Level 0
49	Typical Load on SWYD 125V DP	SWYD 125V DP - Typ. Branch CB	0.125	0.034	0.017	3.6402	0.034	0.017	2.000	0.000	2.000	1.0	18	2	0.02	Level 0 (*N9)
50	Level 0: Nonmelting or Untreated Fiber with Weight >= 4.5 oz/sq yd	0.0 - 1.2 cal/cm^2													#Level 0 = 25	(*N2) < 80% Cleared Fault Threshold
51	Level 1: Arc-rated shirt & pants or arc-rated coverall	1.2 - 4.0 cal/cm^2													#Level 1 = 3	(*N5) - Miscoordinated, Upstream Device Tripped
52	Level 2: Arc-rated shirt & pants or arc-rated coverall	4.0 - 8.0 cal/cm^2													#Level 2 = 4	(*N9) - Max Arcing Duration Reached

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
53	Level 3: Arc-rated shirt & pants + arc-rated coverall + arc-rated arc flash suit	8.0 - 25.0 cal/cm^2													#Level 3 = 4	
54	Level 4: Arc-rated shirt & pants + arc-rated coverall + arc-rated arc flash suit	25.0 - 40.0 cal/cm^2													#Level 4 = 0	
55	Level Dangerous!: DO NOT WORK ON LIVE!	40.0 - 999.0 cal/cm^2													#Danger = 0	DC Arc Flash (ANSI) Bus Report
56	For additional information refer to NFPA 70 E, Standard for Electrical Safety in the Workplace.															
57	Level 0: Nonmelting or Untreated Fiber with Weight >= 4.5 oz/sq yd, Safety Glasses or Goggles + Ear Canal Inserts, Leather Gloves, Safety glasses, Non-melting or untreated natural fiber (cotton/wool/rayon/silk > 4.5 oz/sq yd), shirt (long-sleeve), pants (long)., > 50V voltage rated tools + Class 0 (minimum) gloves, Dielectric shoes or insulating mat (step and touch potential).															
58	Level 1: Arc-rated shirt & pants or arc-rated coverall , Hardhat + Arc-rated hard hat liner + Safety Glasses or Goggles + Ear Canal Inserts, Leather Gloves, Leather work shoes, Safety glasses, electrically rated hard hat with hood and face shield., 4 cal/sq cm, Arc-rated shirt (long-sleeve) plus Arc-rated pants (long), or Arc-rated coverall, plus arc-rated face shield or arc flash suit hood, Arc-rated rainwear as needed., > 50V voltage rated tools + Class 0 (minimum) gloves and leather protectors (flash) as needed., Leather shoes (flash) as needed. Dielectric shoes or insulating mat (step and touch potential).															
59	Level 2: Arc-rated shirt & pants or arc-rated coverall , Hardhat + Arc-rated hard hat liner + Safety Glasses or Goggles + Ear Canal Inserts, Leather Gloves, Leather work shoes, Safety glasses, electrically rated hard hat with hood and face shield. Hearing protection., 8 cal/sq cm, Arc-rated shirt (long-sleeve) plus Arc-rated pants (long), or Arc-rated coverall, plus arc-rated flash suit hood or arc-rated face shield and arc rated balaclava, Arc-rated rainwear as needed., > 50V voltage rated tools + Class 0 (minimum) gloves and leather protectors (flash)., Leather shoes (flash) as needed. Dielectric shoes or insulating mat (step and touch potential).															
60	Level 3: Arc-rated shirt & pants + arc-rated coverall + arc-rated arc flash suit , Hardhat + Arc-rated hard hat liner + Safety Glasses or Goggles + Ear Canal Inserts, Arc-rated Gloves, Leather work shoes, Safety glasses, electrically rated hard hat with hood and face shield. Hearing protection., 25 cal/sq cm, Arc-rated shirt (long-sleeve) plus Arc-rated pants (long) plus Arc-rated coverall, plus arc rated arc flash suit jacket, pants, & hood, Arc-rated rainwear as needed., > 50V voltage rated tools + Class 0 (minimum) gloves and leather protectors (flash)., Leather shoes (flash) as needed. Dielectric shoes or insulating mat (step and touch potential).															
61	Level 4: Arc-rated shirt & pants + arc-rated coverall + arc-rated arc flash suit , Hardhat + Arc-rated hard hat liner + Safety Glasses or Goggles + Ear Canal Inserts, Arc-rated Gloves, Leather work shoes, Safety glasses, electrically rated hard hat with hood and face shield. Hearing protection., 40 cal/sq cm, Arc-rated shirt (long-sleeve) plus Arc-rated pants (long) plus Arc-rated coverall, plus arc rated arc flash suit jacket, pants, & hood, Arc-rated rainwear as needed., > 50V voltage rated tools + Class 0 (minimum) gloves and leather protectors (flash)., Leather shoes (flash) as needed. Dielectric shoes or insulating mat (step and touch potential).															
62	Level Dangerous!: DO NOT WORK ON LIVE!, DO NOT WORK ON LIVE!, DO NOT WORK ON LIVE!, DO NOT WORK ON LIVE!, DO NOT WORK ON LIVE!, No FR Category Found															

Arc Rated PPE Category

	40 cal/cm² PPE Min. Arc Rating — ARC 4	25 cal/cm² PPE Min. Arc Rating — ARC 3	8 cal/cm² PPE Min. Arc Rating — ARC 2	4 cal/cm² PPE Min. Arc Rating — ARC 1	Best Practices for Exposure up to: 1.2 cal/cm²
Head	Rated Flash Hood Hard Hat Safety Glasses/Goggles Hearing Protection		Rated Face Shield with Rated Balaclava or	Rated Face Shield or	Eye and Hearing Protection
Body	Rated long sleeve Shirt & Rated Pants or Rated Coverall or Rated Arc Flash Suit				Long sleeve Shirt Long Pants Undergarments *ALL Clothing Made of **Nonmelting** or **Untreated Natural Fiber***
Hands	Rated Gloves or Rubber Insulating Gloves with Leather Protectors		Heavy Duty Leather Gloves or		Heavy Duty Leather Gloves
Feet	Leather Work Shoes				EH Leather Work Shoes



Best Practices	
	Rated Undergarments
	DI/EH Work Shoes
	Rated Hard Hat Liner
	Rated Jacket, Parka, or Rainwear

■ **Dielectric Shoes**
- Working under powerlines
- High step-potential risk
- Wet conditions

■ Required by NFPA 70E
☑ Required, Choices Available
☐ As Needed
☐ Recommended Best Practice

Check to be sure you have correct Arc-Rated

Are You Protected?

Personal Protective Equipment for the task

e-Hazard
Taking the Flash Out of Electrical Safety
(502) 716-7073
e-Hazard.com

ABC ENERGY CENTER
Somplace, ST

Main Plant Battery System Alternate Scenarios

Plant Battery @ Max SC
Battery Rating 39630.000 A
Rated Voltage 125.000 V
Battery Size Type MAX_SC
Number of Positive Plates 45
Battery Type LEAD_ACID
Number of Cells 60

dcCBL-0010
Length 10.00 ft

Main Plant Battery DC Bus @ Max SC Rating

Plant Battery Bus @ Max SC
System Nominal DC Voltage 125.0 V
AF_BoltedFault 13.923 kA
AF_TripTime 2.000 s
AF_IncidentEnergy 6.33 Cal/cm^2
AF_PPE Category 3
AF_Boundary 47.41 inches
AF_ArcingFault 6.962 kA

Plant Battery @ 1 Minute
Battery Rating 3245.000 A
Rated Voltage 125.000 V
Battery Size Type ONE_MINUTE
Number of Positive Plates 45
Battery Type LEAD_ACID
Number of Cells 60

dcCBL-0017
Length 10.00 ft

Main Plant Battery DC Bus @ 1 Minute Rating

Plant Battery Bus @ 1 Minute
System Nominal DC Voltage 125.0 V
AF_BoltedFault 14.042 kA
AF_TripTime 2.000 s
AF_IncidentEnergy 6.4 Cal/cm^2
AF_PPE Category 3
AF_Boundary 47.62 inches
AF_ArcingFault 7.021 kA

These are Battery Performance Ratings modeled but not utilized. The model below is based on the worst case performance rating for the battery bank.

Main Plant Battery System

Plant Battery @ 8 Hours
Battery Rating 444.000 A
Rated Voltage 125.000 V
Battery Size Type EIGHT_HOURS
Number of Positive Plates 45
Battery Type LEAD_ACID
Number of Cells 60

dcCBL-0009
Length 10.00 ft

Main Plant Battery DC Bus @ 8 Hour Rating

Plant Battery Bus @ 8 Hours
System Nominal DC Voltage 125.0 V
AF_BoltedFault 16.443 kA
AF_TripTime 2.000 s
AF_IncidentEnergy 9.83 Cal/cm^2
AF_PPE Category 3
AF_Boundary 51.53 inches
AF_ArcingFault 8.222 kA

SWBD 1A - Inverter 1A

Inverter 1A DC CB
GE Model THJK
Voltage 125.0 V
Rated Current 400.0 A
Interrupt Rating 65.0 kA
Trip 400.0 A
Plug 0.0 A
Settings
Thermal Curve (Fixed)
INST (3-10 x Trip) HI (4000A)

dcCBL-0034
Length 5.00 ft

Inverter 1A DC Input Bus
System Nominal DC Voltage 125.0 V
AF_BoltedFault 16.164 kA
AF_TripTime 0.018 s
AF_IncidentEnergy 0.09 Cal/cm^2
AF_PPE Category 0
AF_Boundary 4.9 inches
AF_ArcingFault 8.082 kA

See Drawing E1002 for Continuation to UPS Power Panel 1A and UPS Power Panel 11A

See Drawing CSC-1895, Sheet 3 of 10 for Connection to 010-ELA-MC-011A for 480VAC supply to UPS Power Conditioning Transformer 1A feeding UPS Power Panel 1BA and UPS Power Panel 11A when Inverter 1A is bypassed

SWBD 1A - Inverter 1A
System Nominal DC Voltage 125.0 V
AF_BoltedFault 16.194 kA
AF_TripTime 0.018 s
AF_IncidentEnergy 0.09 Cal/cm^2
AF_PPE Category 0
AF_Boundary 4.8 inches
AF_ArcingFault 8.097 kA

See Drawing CSC-1895, Sheet 3 of 10 for Connection to 010-ELA-MC-011A

SWBD 1A - Battery Charger 1A
System Nominal DC Voltage 125.0 V
AF_BoltedFault 16.194 kA
AF_TripTime 0.028 s
AF_IncidentEnergy 0.14 Cal/cm^2
AF_PPE Category 0
AF_Boundary 6.04 inches
AF_ArcingFault 8.097 kA

dcCBL-0033
Length 20.00 ft

dcCBL-0032
Length 20.00 ft

SWBD 1A- Inverter 1A CB
CUTLER-HAMMER Model HKD
Voltage 125.0 V
Rated Current 400.0 A
Interrupt Rating 22.0 kA
Trip 400.0 A
Plug 0.0 A
Settings
Thermal Curve (Fixed)
INST (5-10 x Trip) 10 (4000A)

SWBD 1A - Battery Chgr 1A CB
CUTLER-HAMMER Model HMDL
Voltage 125.0 V
Rated Current 800.0 A
Interrupt Rating 25.0 kA
Trip 800.0 A
Plug 0.0 A
Settings
Thermal Curve (Fixed)
INST (4-6 x Trip) 4 (3200A)

SWBD 1A Main FD
BUSSMANN Model FWH-1600A
Voltage 125.0 V
Rated Current 1600.0 A
Interrupt Rating 200.0 kA
Trip 1600.0 A

dcCBL-0028
Length 20.00 ft

dcCBL-0029
Length 20.00 ft

SWBD 1A - Battery Chgr 1B CB
CUTLER-HAMMER Model HMDL
Voltage 125.0 V
Rated Current 800.0 A
Interrupt Rating 25.0 kA
Trip 800.0 A
Plug 0.0 A
Settings
Thermal Curve (Fixed)
INST (4-6 x Trip) 4 (3200A)

See Drawing E1002 for Continuation to UPS Power Panel 1B and UPS Power Panel 11B

See Drawing CSC-1895, Sheet 6 of 10 for Connection to 010-ELA-MC-012B for 480VAC supply to UPS Power Conditioning Transformer 1B feeding UPS Power Panel 1B and UPS Power Panel 11B when Inverter 1B is bypassed

SWBD 1B - Inverter 1B

Inverter 1B DC CB
GE Model THJK
Voltage 125.0 V
Rated Current 400.0 A
Interrupt Rating 65.0 kA
Trip 400.0 A
Plug 0.0 A
Settings
Thermal Curve (Fixed)
INST (3-10 x Trip) HI (4000A)

dcCBL-0024
Length 5.00 ft

Inverter 1B DC Input Bus
System Nominal DC Voltage 125.0 V
AF_BoltedFault 16.174 kA
AF_TripTime 0.018 s
AF_IncidentEnergy 0.09 Cal/cm^2
AF_PPE Category 0
AF_Boundary 4.9 inches
AF_ArcingFault 8.087 kA

SWBD 1B - Inverter 1B
System Nominal DC Voltage 125.0 V
AF_BoltedFault 16.205 kA
AF_TripTime 0.018 s
AF_IncidentEnergy 0.09 Cal/cm^2
AF_PPE Category 0
AF_Boundary 4.9 inches
AF_ArcingFault 8.102 kA

dcCBL-0023
Length 20.00 ft

SWBD 1B Main FD
BUSSMANN Model FWH-1600A
Voltage 125.0 V
Rated Current 1600.0 A
Interrupt Rating 200.0 kA
Trip 1600.0 A

dcCBL-0026
Length 20.00 ft

See Drawing CSC-1895, Sheet 6 of 10 for Connection to 010-ELA-MC-012B

SWBD 1B - Battery Charger 1B
System Nominal DC Voltage 125.0 V
AF_BoltedFault 16.184 kA
AF_TripTime 0.028 s
AF_IncidentEnergy 0.14 Cal/cm^2
AF_PPE Category 0
AF_Boundary 6.04 inches
AF_ArcingFault 8.092 kA

dcCBL-0021
Length 20.00 ft

SWBD 1B - Battery Chgr 1B Lugs
System Nominal DC Voltage 125.0 V
AF_BoltedFault 16.308 kA
AF_TripTime 0.028 s
AF_IncidentEnergy 0.14 Cal/cm^2
AF_PPE Category 0
AF_Boundary 6.05 inches
AF_ArcingFault 8.154 kA

SWBD 1B - Battery Chgr 1B CB
CUTLER-HAMMER Model HMDL
Voltage 125.0 V
Rated Current 800.0 A
Interrupt Rating 25.0 kA
Trip 800.0 A
Plug 0.0 A
Settings
Thermal Curve (Fixed)
INST (4-6 x Trip) 4 (3200A)

dcCBL-0025
Length 2.00 ft

See Drawing CSC-1895, Sheet 6 of 10 for Connection to 010-ELA-MC-012B

SWBD 1B - Battery Charger 2B
System Nominal DC Voltage 125.0 V
AF_BoltedFault 16.255 kA
AF_TripTime 0.028 s
AF_IncidentEnergy 0.14 Cal/cm^2
AF_PPE Category 0
AF_Boundary 6.04 inches
AF_ArcingFault 8.102 kA

dcCBL-0022
Length 20.00 ft

SWBD 1B - Battery Chgr 2B CB
CUTLER-HAMMER Model HMDL
Voltage 125.0 V
Rated Current 800.0 A
Interrupt Rating 25.0 kA
Trip 800.0 A
Plug 0.0 A
Settings
Thermal Curve (Fixed)
INST (4-6 x Trip) 4 (3200A)

BOP SWBD 1A Bus

BOP SWBD 1A Bus
System Nominal DC Voltage 125.0 V
AF_BoltedFault 16.318 kA
AF_TripTime 1.086 s
AF_IncidentEnergy 5.3 Cal/cm^2
AF_PPE Category 2
AF_Boundary 37.80 inches
AF_ArcingFault 8.159 kA

SWBD 1A - AX-011A CB
CUTLER-HAMMER Model HJD
Voltage 125.0 V
Rated Current 250.0 A
Interrupt Rating 22.0 kA
Trip 250.0 A
Plug 0.0 A
Settings
Thermal Curve (Fixed)
INST (5-10 x Trip) 10 (2500A)

dcCBL-0038
Length 20.00 ft

SWBD 1A - AX-011A Normal
System Nominal DC Voltage 125.0 V
AF_BoltedFault 16.194 kA
AF_TripTime 0.014 s
AF_IncidentEnergy 0.07 Cal/cm^2
AF_PPE Category 0
AF_Boundary 4.23 inches
AF_ArcingFault 8.097 kA

Typical for SWBD 1A equipment:
- Transfer Switch AX-011A
- Power Panel 11A and Branches

SWBD 1A - Power Panel 21A CB
CUTLER-HAMMER Model HKD
Voltage 125.0 V
Rated Current 400.0 A
Interrupt Rating 22.0 kA
Trip 250.0 A
Plug 0.0 A
Settings
Thermal Curve (Fixed)
INST (5-10 x Trip) 10 (2500A)

dcCBL-0039
Length 20.00 ft

SWBD 1A - Power Panel 21A
System Nominal DC Voltage 125.0 V
AF_BoltedFault 16.194 kA
AF_TripTime 0.013 s
AF_IncidentEnergy 0.06 Cal/cm^2
AF_PPE Category 0
AF_Boundary 4.17 inches
AF_ArcingFault 8.097 kA

Typical for SWBD 1A equipment:
- Power Panel 21A and Branches

SWBD 1A - AX-011B CB
CUTLER-HAMMER Model HKD
Voltage 125.0 V
Rated Current 400.0 A
Interrupt Rating 22.0 kA
Trip 250.0 A
Plug 0.0 A
Settings
Thermal Curve (Fixed)
INST (5-10 x Trip) 10 (2500A)

dcCBL-0037
Length 40.00 ft

SWBD 1B - AX-011B Emergency
System Nominal DC Voltage 125.0 V
AF_BoltedFault 16.073 kA
AF_TripTime 0.013 s
AF_IncidentEnergy 0.06 Cal/cm^2
AF_PPE Category 0
AF_Boundary 4.16 inches
AF_ArcingFault 8.036 kA

Emergency connection between SWBD 1A and SWBD 1B Transfer Switch AX-011B and associated Power Panel 11B and its Branches

SWBD 1A - AX-021B CB
CUTLER-HAMMER Model HKD
Voltage 125.0 V
Rated Current 400.0 A
Interrupt Rating 22.0 kA
Trip 250.0 A
Plug 0.0 A
Settings
Thermal Curve (Fixed)
INST (5-10 x Trip) 10 (2500A)

dcCBL-0036
Length 40.00 ft

SWBD 1B - AX-021B Emergency
System Nominal DC Voltage 125.0 V
AF_BoltedFault 16.073 kA
AF_TripTime 0.013 s
AF_IncidentEnergy 0.06 Cal/cm^2
AF_PPE Category 0
AF_Boundary 4.16 inches
AF_ArcingFault 8.036 kA

Emergency connection between SWBD 1A and SWBD 1B Transfer Switch AX-021B and associated Power Panel 21B and its Branches

BOP SWBD 1B Bus

SWBD 1B - AX-011A CB
CUTLER-HAMMER Model HKD
Voltage 125.0 V
Rated Current 400.0 A
Interrupt Rating 22.0 kA
Trip 250.0 A
Plug 0.0 A
Settings
Thermal Curve (Fixed)
INST (5-10 x Trip) 10 (2500A)

dcCBL-0035
Length 40.00 ft

SWBD 1A - AX-011A Emergency
System Nominal DC Voltage 125.0 V
AF_BoltedFault 16.063 kA
AF_TripTime 0.013 s
AF_IncidentEnergy 0.06 Cal/cm^2
AF_PPE Category 0
AF_Boundary 4.16 inches
AF_ArcingFault 8.041 kA

Emergency connection between SWBD 1B and SWBD 1A Transfer Switch AX-011A and associated Power Panel 11A and its Branches

SWBD 1B - AX-011B CB
CUTLER-HAMMER Model HKD
Voltage 125.0 V
Rated Current 400.0 A
Interrupt Rating 22.0 kA
Trip 250.0 A
Plug 0.0 A
Settings
Thermal Curve (Fixed)
INST (5-10 x Trip) 10 (2500A)

dcCBL-0031
Length 20.00 ft

SWBD 1B - AX-011B Normal
System Nominal DC Voltage 125.0 V
AF_BoltedFault 16.205 kA
AF_TripTime 0.013 s
AF_IncidentEnergy 0.06 Cal/cm^2
AF_PPE Category 0
AF_Boundary 4.17 inches
AF_ArcingFault 8.102 kA

Typical for SWBD 1B equipment:
- Transfer Switch AX-011B
- Power Panel 11B and Branches

SWBD 1B - AX-021B CB
CUTLER-HAMMER Model HKD
Voltage 125.0 V
Rated Current 400.0 A
Interrupt Rating 22.0 kA
Trip 250.0 A
Plug 0.0 A
Settings
Thermal Curve (Fixed)
INST (5-10 x Trip) 10 (2500A)

dcCBL-0030
Length 20.00 ft

SWBD 1B - AX-021B Normal
System Nominal DC Voltage 125.0 V
AF_BoltedFault 16.205 kA
AF_TripTime 0.013 s
AF_IncidentEnergy 0.06 Cal/cm^2
AF_PPE Category 0
AF_Boundary 4.17 inches
AF_ArcingFault 8.102 kA

Typical for SWBD 1B equipment:
- Transfer Switch AX-021B
- Power Panel 21B and Branches

SWBD 1B - BOP MCC 1 CB
CUTLER-HAMMER Model HKD
Voltage 125.0 V
Rated Current 400.0 A
Interrupt Rating 22.0 kA
Trip 400.0 A
Plug 0.0 A
Settings
Thermal Curve (Fixed)
INST (5-10 x Trip) 10 (4000A)

dcCBL-0027
Length 20.00 ft

SWBD 1B - BOP MCC 1 MLO
System Nominal DC Voltage 125.0 V
AF_BoltedFault 16.215 kA
AF_TripTime 0.019 s
AF_IncidentEnergy 0.09 Cal/cm^2
AF_PPE Category 0
AF_Boundary 4.88 inches
AF_ArcingFault 8.108 kA

SWBD 1B - BOP MCC 1 Typ CB
CUTLER-HAMMER Model HKD
Voltage 125.0 V
Rated Current 400.0 A
Interrupt Rating 22.0 kA
Trip 250.0 A
Plug 0.0 A
Settings
Thermal Curve (Fixed)
INST (5-10 x Trip) 10 (2500A)

dcCBL-0040
Length 50.00 ft

SWBD 1B - BOP MCC 1 Typ Load
System Nominal DC Voltage 125.0 V
AF_BoltedFault 15.940 kA
AF_TripTime 0.014 s
AF_IncidentEnergy 0.07 Cal/cm^2
AF_PPE Category 0
AF_Boundary 4.2 inches
AF_ArcingFault 7.970 kA

Typical MCC 1 Motor

Typical for motors: Emergency Lube Oil Pump, Turning Gear, Emergency Seal Oil Pump, & Condenser Vacuum Breaker Valve

BOP SWBD 1B Bus
System Nominal DC Voltage 125.0 V
AF_BoltedFault 16.328 kA
AF_TripTime 1.485 s
AF_IncidentEnergy 7.25 Cal/cm^2
AF_PPE Category 2
AF_Boundary 44.25 inches
AF_ArcingFault 8.164 kA

CTG-1 or CTG-2 Battery System Alternate Scenarios

CTG-1 or -2 Battery @ Max SC
Battery Rating 4406.000 A
Rated Voltage 125.000 V
Battery Size Type MAX_SC
Number of Positive Plates 6
Battery Type LEAD_ACID
Number of Cells 60

dcCBL-0018
Length 10.00 ft

600A Main DC Bus @ Max SC Rating

600A Main DC Bus @ Max SC
System Nominal DC Voltage 125.0 V
AF_BoltedFault 4.498 kA
AF_TripTime 2.000 s
AF_IncidentEnergy 2.69 Cal/cm^2
AF_PPE Category 1
AF_Boundary 26.95 inches
AF_ArcingFault 2.249 kA

CTG-1 or -2 Battery @ 1 Minute
Battery Rating 990.000 A
Rated Voltage 125.000 V
Battery Size Type ONE_MINUTE
Number of Positive Plates 6
Battery Type LEAD_ACID
Number of Cells 60

dcCBL-0002
Length 10.00 ft

600A Main DC Bus @ 1 Minute Rating

600A Main DC Bus @ 1 Minute
System Nominal DC Voltage 125.0 V
AF_BoltedFault 5.044 kA
AF_TripTime 2.000 s
AF_IncidentEnergy 4.24 Cal/cm^2
AF_PPE Category 2
AF_Boundary 33.83 inches
AF_ArcingFault 3.544 kA

These are Battery Performance Ratings modeled but not utilized. The model below is based on the worst case performance rating for the battery bank.

CTG-1 or CTG-2 Battery System

CTG-1 or -2 Battery @ 8 Hour
Battery Rating 82.500 A
Rated Voltage 125.000 V
Battery Size Type EIGHT_HOURS
Number of Positive Plates 6
Battery Type LEAD_ACID
Number of Cells 60

dcCBL-0001
Length 10.00 ft

600A Main DC Bus @ 8 Hour Rating

600A Main DC Bus @ 8 Hour
System Nominal DC Voltage 125.0 V
AF_BoltedFault 13.495 kA
AF_TripTime 2.000 s
AF_IncidentEnergy 8.07 Cal/cm^2
AF_PPE Category 3
AF_Boundary 46.68 inches
AF_ArcingFault 6.748 kA

Emergency Lube Oil Pump CB
SQUARE D Model KA
Voltage 125.0 V
Rated Current 250.0 A
Interrupt Rating 10.0 kA
Trip 225.0 A
Plug 0.0 A
Settings
Thermal Curve (Fixed)
INST (5-10 x Trip) 5.0 (1125A)

dcCBL-0003
Length 100.00 ft

Emergency Lube Oil Pump FS
System Nominal DC Voltage 125.0 V
AF_BoltedFault 10.668 kA
AF_TripTime 2.000 s
AF_IncidentEnergy 2.43 Cal/cm^2
AF_PPE Category 1
AF_Boundary 25.6 inches
AF_ArcingFault 5.404 kA

20 HP Motor

Emergency Seal Oil Pump CB
GE Model TEYL
Voltage 125.0 V
Rated Current 100.0 A
Interrupt Rating 35.0 kA
Trip 100.0 A
Plug 0.0 A
Settings
Fixed

dcCBL-0005
Length 100.00 ft

Emergency Seal Oil Pump FS
System Nominal DC Voltage 125.0 V
AF_BoltedFault 8.777 kA
AF_TripTime 2.000 s
AF_IncidentEnergy 1.24 Cal/cm^2
AF_PPE Category 1
AF_Boundary 18.27 inches
AF_ArcingFault 4.389 kA

10 HP Motor

dcCBL-0004
Length 10.00 ft

MCC1-DC PNLBD or MCC2-DC PNLBD Main Bus

DC PNLBD Main Bus
System Nominal DC Voltage 125.0 V
AF_BoltedFault 12.446 kA
AF_TripTime 2.000 s
AF_IncidentEnergy 7.44 Cal/cm^2
AF_PPE Category 2
AF_Boundary 44.83 inches
AF_ArcingFault 6.223 kA

Control Power CB
GE Model TEYL
Voltage 125.0 V
Rated Current 50.0 A
Interrupt Rating 42.0 kA
Trip 50.0 A
Plug 0.0 A
Settings
Fixed

dcCBL-0006
Length 25.00 ft

Control Power Cabinet
System Nominal DC Voltage 125.0 V
AF_BoltedFault 10.420 kA
AF_TripTime 0.020 s
AF_IncidentEnergy 0.06 Cal/cm^2
AF_PPE Category 0
AF_Boundary 4.1 inches
AF_ArcingFault 5.210 kA

Typ. MCC--1 & MCC-2 30A CB
GE Model TEYL
Voltage 125.0 V
Rated Current 30.0 A
Interrupt Rating 42.0 kA
Trip 30.0 A
Plug 0.0 A
Settings
Fixed

dcCBL-0007
Length 50.00 ft

Typ. MCC--1 & MCC-2 30A FS
System Nominal DC Voltage 125.0 V
AF_BoltedFault 8.962 kA
AF_TripTime 0.020 s
AF_IncidentEnergy 0.00 Cal/cm^2
AF_PPE Category 0
AF_Boundary 3.8 inches
AF_ArcingFault 4.481 kA

Typ. MCC--1 & MCC-2 15-20A CB
GE Model TEYL
Voltage 125.0 V
Rated Current 20.0 A
Interrupt Rating 42.0 kA
Trip 20.0 A
Plug 0.0 A
Settings
Fixed

dcCBL-0008
Length 50.00 ft

Typ. MCC--1 & MCC-2 15-20A FS
System Nominal DC Voltage 125.0 V
AF_BoltedFault 8.962 kA
AF_TripTime 0.020 s
AF_IncidentEnergy 0.00 Cal/cm^2
AF_PPE Category 0
AF_Boundary 3.8 inches
AF_ArcingFault 4.481 kA

Switchyard Battery System

Switchyard Battery @ 1 Minute
Battery Rating 222.000 A
Rated Voltage 125.000 V
Battery Size Type ONE_MINUTE
Number of Positive Plates 7
Battery Type LEAD_ACID
Number of Cells 60

dcCBL-0016
Length 10.00 ft

Switchyard Battery DC Bus @ 1 Minute Rating

SWYD Battery Bus @ 1 Minute
System Nominal DC Voltage 125.0 V
AF_BoltedFault 0.035 kA
AF_TripTime 2.000 s
AF_IncidentEnergy 0.02 Cal/cm^2
AF_PPE Category 0
AF_Boundary 2.39 inches
AF_ArcingFault 0.018 kA

SWYD Battery Fused Disconnect
BUSSMANN Model FRN-R
Voltage 125.0 V
Rated Current 200.0 A
Interrupt Rating 200.0 kA
Trip 200.0 A
Settings
200.0 Amps

dcCBL-0019
Length 10.00 ft

SWYD 125V DP MLO
System Nominal DC Voltage 125.0 V
AF_BoltedFault 0.035 kA
AF_TripTime 2.000 s
AF_IncidentEnergy 0.02 Cal/cm^2
AF_PPE Category 0
AF_Boundary 2.36 inches
AF_ArcingFault 0.018 kA

SWYD 125V DP - Typ. Branch CB
CUTLER-HAMMER Model FD
Voltage 125.0 V
Rated Current 30.0 A
Interrupt Rating 10.0 kA
Trip 30.0 A
Plug 0.0 A
Settings
Fixed

dcCBL-0020
Length 20.00 ft

Typical Load on SWYD 125V DP
System Nominal DC Voltage 125.0 V
AF_BoltedFault 0.034 kA
AF_TripTime 2.000 s
AF_IncidentEnergy 0.02 Cal/cm^2
AF_PPE Category 0
AF_Boundary 2.35 inches
AF_ArcingFault 0.017 kA

Switchyard Battery System Alternate Scenarios

Switchyard Battery @ Max SC
Battery Rating 1557.000 A
Rated Voltage 132.000 V
Battery Size Type MAX_SC
Number of Positive Plates 7
Battery Type LEAD_ACID
Number of Cells 60

dcCBL-0014
Length 10.00 ft

Switchyard Battery DC Bus @ Max SC Rating

SWYD Battery Bus @ Max SC
System Nominal DC Voltage 130.0 V
AF_BoltedFault 0.053 kA
AF_TripTime 2.000 s
AF_IncidentEnergy 0.01 Cal/cm^2
AF_PPE Category 0
AF_Boundary 1.98 inches
AF_ArcingFault 0.012 kA

Switchyard Battery @ 8 Hour
Battery Rating 18.800 A
Rated Voltage 132.000 V
Battery Size Type EIGHT_HOURS
Number of Positive Plates 7
Battery Type LEAD_ACID
Number of Cells 60

dcCBL-0015
Length 10.00 ft

Switchyard Battery DC Bus @ 8 Hour Rating

SWYD Battery Bus @ 8 Hour
System Nominal DC Voltage 130.0 V
AF_BoltedFault 0.030 kA
AF_TripTime 2.000 s
AF_IncidentEnergy 0.00 Cal/cm^2
AF_PPE Category 0
AF_Boundary 1.25 inches
AF_ArcingFault 0.015 kA

These are Battery Performance Ratings modeled but not utilized. The model below is based on the worst case performance rating for the battery bank.

company
Arc Flash Study - Model Drawing - DC
Systems e-Hazard - Louisville, KY
J. D. Aeiker October 3, 2017 Rev. 0