7 things to look for in an arc flash study

1. Executive summary
2. One-line diagram
3. Short circuit analysis
4. Protective device coordination study
5. Settings table
6. Arc flash incident energy analysis
7. Input data used in the analysis

The threat of arc flash is real, and the consequences of an event can be devastating. The initial step in addressing this risk is to have an arc flash study performed, but beware - not all studies are equal, and an inferior study unnecessarily endangers your employees and your business.

To gauge the quality of a study, first, verify that the study will be performed by experienced engineers. Inquire about their education, licenses and experience.

Then, ask about their ability to offer a turnkey solution after the study. Can they train employees on how to interpret the study, read warning labels, choose the correct PPE and properly maintain electrical equipment? Do they have the ability to help you develop an effective electrical safety program? Can they provide products and services to help reduce high incident energy identified in the study?

Finally, ask for a sample of the final report. What information will be included, and will it provide recommendations to improve safety in your facility? Compare the sample report against the following checklist to ensure you'll get comprehensive and actionable information.

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1. Executive summary

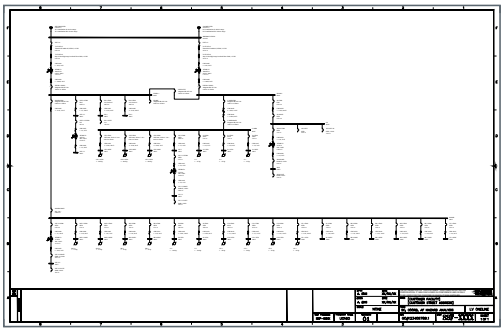
A synopsis of the key findings and recommendations to improve the safety and operation of the power system.

Recommendations may include replacement of over-dutied equipment or methods to reduce incident energy at critical work locations. Use this summary as a roadmap for improvement after the study has been completed.

2. One-line diagram

A model of the entire electrical system which forms the basis for the study.

It shows how the equipment is configured and connected, but many times, a facility one-line diagram doesn't exist or is incomplete. Power systems engineers who perform the arc flash study should first validate, or create, a current one-line diagram. Mark this up if changes are made to your electrical system which then makes it easy to update the study.



3. Short circuit analysis

Calculates available fault current for each piece of electrical distribution equipment in your facility.

This study will determine the first of three factors that are used to calculate incident energy: available fault current. First-rate studies will compare the fault current to the equipment ratings to identify over-dutied equipment, a common occurrence in older facilities with upstream equipment that has been upgraded or modified.

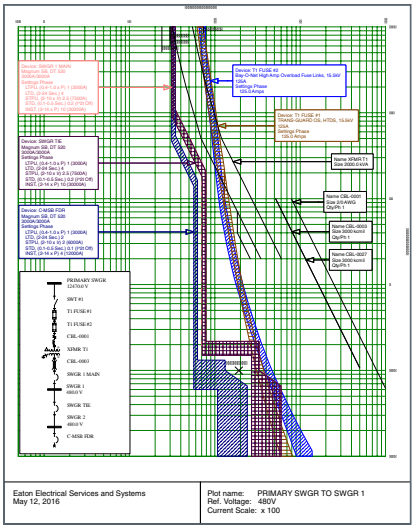
Table 2.1 —Low-Voltage Equipment Evaluation

Bus	Manufacturer	Status	Type	Bus Voltage	Calc Isc kA	Dev Isc kA	Isc Rating%
B 3 DISC	Unknown	Unknown	LV Disconnect	480	2.54	Min. Req'd = 10.00	
BP 1 DISC	Unknown	Unknown	LV Disconnect	480	1.82	Min. Req'd = 10.00	
BP 2 DISC	Unknown	Unknown	LV Disconnect	480	1.62	Min. Req'd = 10.00	
BP 3 DISC	Unknown	Unknown	LV Disconnect	480	1.33	Min. Req'd = 10.00	
BP 4 DISC	Unknown	Unknown	LV Disconnect	480	1.22	Min. Req'd = 10.00	
BP 5 DISC	Unknown	Unknown	LV Disconnect	480	2.56	Min. Req'd = 10.00	
BP 6 DISC	Unknown	Unknown	LV Disconnect	480	2.56	Min. Req'd = 10.00	
CH 1 DISC	Unknown	Unknown	LV Disconnect	480	26.86	Min. Req'd = 35.00	
CH 2 DISC	Unknown	Unknown	LV Disconnect	480	28.09	Min. Req'd = 35.00	
CH 3 DISC	Unknown	Unknown	LV Disconnect	480	28.75	Min. Req'd = 35.00	
CS 1 DISC	Unknown	Unknown	LV Disconnect	480	6.02	Min. Req'd = 10.00	
DCP 1 DISC	Unknown	Unknown	LV Disconnect	480	1.82	Min. Req'd = 10.00	
DCP 2 DISC	Unknown	Unknown	LV Disconnect	480	2.07	Min. Req'd = 10.00	
P 3 DISC	Unknown	Unknown	LV Disconnect	480	10.29	Min. Req'd = 22.00	
1D	Eaton	Pass	LV Panelboard	480	6.72	65.00	10.35
1D1	Eaton	Pass	LV Panelboard	208	0.93 (*N1)	10.00	9.27
NC 2-1	Eaton	Pass	LV Panelboard	208	1.94 (*N1)	10.00	19.41
NC 4	Eaton	Pass	LV Panelboard	480	24.17	65.00	37.18
NW2-1	Square D	Unknown	LV Panelboard	208	1.72	Min. Req'd = 10.00	
NW 2-2	Eaton	Pass	LV Panelboard	208	4.58 (*N1)	10.00	45.57
NW 4-1	Square D	Pass	LV Panelboard	480	11.20	35.00	32.00
SD-1	Square D	Fail	LV Panelboard	480	33.74	25.00	134.96
SD-2	Eaton	Fail	LV Panelboard	480	19.2	14.00	137.16
B-MSB	Eaton	Pass	LV Switchboard	480	37.10	65.00	57.08
C-MSB	Eaton	Pass	LV Switchboard	480	35.14 (*N1)	65.00	54.06
SWGR 1	Eaton	Pass	LV Switchboard	480	43.33 (*N1)	65.00	66.66

4. Protective device coordination study

Modeling each protective device and its recommended set points.

This study will determine the second of three factors that are used to calculate incident energy: clearing time. The clearing time reflects the amount of time it will take for each upstream protective device to clear a potential arcing fault. The report should include time current curves that illustrate the degree of system selectivity that is achieved. This is necessary to verify that only the portion of the power system experiencing a fault is de-energized and nuisance tripping is eliminated.



RESET SAFETY

5. Settings table

A list of recommended settings for circuit breakers and relays.

Reference this table to ensure that equipment is set according to the study recommendations. As some settings may be changed only during an outage, make this table easily accessible for quick reference.

4.0 RECOMMENDED PROTECTIVE DEVICE SETTINGS

The following table shows a comprehensive summary of the recommended settings for the adjustable protective devices. The devices are grouped by system bus name/location. Refer to Section 11 for the system one-line diagram.

Table 4.1 —Recommended and Existing Low-Voltage Protective Device Settings

BUS ID	BREAKER ID	MANUFACTURER & BREAKER MODEL	TRIP UNIT TYPE	CURRENT RATING		LONG DELAY			SHORT DELAY			INST.	GROUND		TCC PAGE NUM
				FRAME	PLUG	PICKUP	TIME		PICKUP	TIME	FI		PICKUP	TIME FI	
SWGR 1	B-MSB FDR	EATON Magnum SB	DT 520 LSI	1600A	1600A	1 (1600A)	2		2 (3200A)	0.1	Out	10 (16000A)	-	-	3-6
	SWGR 1 MAIN	EATON Magnum SB	DT 520 LSIG	3000A	3000A	1 (3000A)	4		2.5 (7500A)	0.2	Out	10 (30000A)	1 (1200A)	0.3 (Out)	3-4, 3-6
	SD-1 FDR	EATON LGH	Thermal Magnetic	600A	600A	-	-		-	-	-	10 (6000A)	-	-	3-7
	SD-2 FDR	EATON LGH	Thermal Magnetic	600A	600A	-	-		-	-	-	10 (6000A)	-	-	3-7
SWGR 1/2	SWGR TIE	EATON Magnum SB	DT 520 LSI	3000A	3000A	1 (3000A)	4		2.5 (7500A)	0.2	Out	10 (30000A)	-	-	3-4
SWGR 2	SWGR 2 MAIN	EATON Magnum SB	DT 520 LSIG	3000A	3000A	1 (3000A)	4		2.5 (7500A)	0.2	Out	10 (30000A)	1 (1200A)	0.3 (Out)	3-5, 3-6
	C-MSB FDR	EATON Magnum SB	DT 520 LSI	3000A	3000A	1 (3000A)	2		2 (6000A)	0.1	Out	4 (12000A)	-	-	3-9
C-MSB	C-MSB MAIN	EATON Magnum SB	DT 520 LSI	3000A	3000A	1 (3000A)	2		2 (6000A)	0.1	Out	10 (30000A)	-	-	3-9
	CH 1 FDR	EATON HMDL	RMS 310+ LSI	800A	800A	1 (800A)	4		5 (4000A)	Inst	-	-	-	-	3-9
	CH 2 FDR	EATON HMDL	RMS 310+ LSI	800A	800A	1 (800A)	4		5 (4000A)	Inst	-	-	-	-	3-9
	CH 3 FDR	EATON HMDL	RMS 310+ LSI	800A	800A	1 (800A)	4		5 (4000A)	Inst	-	-	-	-	3-9
B-MSB	B-MSB MAIN	EATON RGH	RMS 310+ LSI	1600A	-	H (1600A)	2		2 (3200A)	Inst	-	-	-	-	3-6
*SD-1	SD-1 LGST	SQUARE D LA	Thermal Magnetic	400A	350A	-	-		-	-	-	HI (3500A)	-	-	3-7

Note: Circuit breaker SD-1 LGST is an existing breaker. The adjustable settings could not be verified and a worst case scenario of instantaneous set at HI (3500A) was assumed for purposes of coordination.

6. Arc flash incident energy analysis

Used to generate arc flash warning labels showing nominal system voltage and arc flash boundaries, as well as available incident energy and/or PPE category.

In a comprehensive study, this section features the results in tabular format, including the available fault current, clearing time and working distance used to calculate the incident energy at each equipment location. It should include a discussion of the operating scenarios considered, including normal utility operation and alternative sources of power such as diesel standby generators. Refer to this section to learn how to interpret the results based on the most current version of NFPA 70E.

Table 5.1 —Arc Flash Incident Energy Analysis Summary Table

Bus Name	Device Name	Bus kV	Bus Bolted Fault kA	Device Bolted Fault kA	Device Arcing Fault kA	Trip Time sec.	Bkr. Opening sec.	Ground	Equip	Gap mm	AF Boundary	Working Distance	Incident Energy cal/cm2
1D	1D FDR	0.48	6.83	6.83	4.74	0.019	0.000	Yes	PNL	25	7"	1' 6"	0.3
B 3 DISC	B 3 FDR	0.48	2.54	2.54	2.04	0.018	0.000	Yes	PNL	25	4"	1' 6"	0.1
B-MSB	B-MSB FDR	0.48	32.77	29.98	16.54	0.132	0.000	Yes	PNL	25	4' 10"	1' 6"	8.0
BP 1 DISC	BP 1 FDR	0.48	1.82	1.82	1.53	0.02	0.000	Yes	PNL	25	4"	1' 6"	0.1
BP 2 DISC	BP 2 FDR	0.48	1.61	1.61	1.17	0.026	0.000	Yes	PNL	25	4"	1' 6"	0.1
BP 3 DISC	BP 3 FDR	0.48	1.32	1.32	0.99	0.147	0.000	Yes	PNL	25	9"	1' 6"	0.4
BP 4 DISC	BP 4 FDR	0.48	1.21	1.21	0.92	0.2	0.000	Yes	PNL	25	11"	1' 6"	0.5
BP 5 DISC	BP 5 FDR	0.48	2.58	2.54	2.03	0.018	0.000	Yes	PNL	25	4"	1' 6"	0.1
BP 6 DISC	BP 6 FDR	0.48	2.58	2.54	2.03	0.019	0.000	Yes	PNL	25	4"	1' 6"	0.1
CH 1 DISC	CH 1 FDR	0.48	29.18	26.41	14.81	0.001	0.000	Yes	PNL	25	3"	1' 6"	0.1
CH 2 DISC	CH 2 FDR	0.48	30.66	27.83	15.51	0.001	0.000	Yes	PNL	25	3"	1' 6"	0.1
CH 3 DISC	CH 3 FDR	0.48	31.38	28.60	15.88	0.001	0.000	Yes	PNL	25	3"	1' 6"	0.1
C-MSB	C-MSB FDR	0.48	36.69	27.91	12.87	0.132	0.000	Yes	PNL	25	4' 5"	1' 6"	7.1
CP 1 VFD	CP 1 FDR	0.48	11.67	11.41	7.32	0.014	0.000	Yes	PNL	25	8"	1' 6"	0.4
CP 2 VFD	CP 2 FDR	0.48	12.34	12.08	7.68	0.014	0.000	Yes	PNL	25	9"	1' 6"	0.4
CP 3 VFD	CP 3 FDR	0.48	11.69	11.49	7.37	0.015	0.000	Yes	PNL	25	9"	1' 6"	0.4
CP 4 VFD	CP 4 FDR	0.48	13.01	12.81	8.08	0.014	0.000	Yes	PNL	25	9"	1' 6"	0.4

7. Input data used in the analysis

A reference to the data upon which the study was based.

This data includes things such as cable, utility, motor and generator information. Reference this data when updating the study in the future.

If the study you're considering doesn't provide all of the information detailed above, you may be compromising arc flash safety by not having all of the relevant data available to you.

Eaton has one of the largest engineering services organization in the U.S., can provide a turnkey arc flash safety solution. We would welcome the opportunity to review your existing study or talk with you about a new one.

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