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10 Steps to Effective ARC FLASH RISK ASSESSMENT

Developing and implementing an arc flash risk assessment program that meets the requirements of IEEE 1584, NFPA 70E, and OSHA Standard 29 is challenging. Meeting these requirements on a constrained budget and with limited manpower assets requires proper planning and execution.

1 - Acknowledge the Hazard

Become aware of the dangers of arc flash through industry events and resources such as the NFPA, IEEE, trade publications, and **EasyPower's Arc Flash Resource Center**.

www.easypower.com/arcflash

Arcing faults can release dangerous levels of radiant heat energy, plasma, molten metal, and arc blast pressure waves capable of causing severe burns, injuries, and fatalities.

2 - Understand Your Risks and Responsibilities

The OSHA "General Duty" clause makes it clear that the employer is required to protect workers from all known hazards. An effective electrical safety program that includes arc flash hazard assessment is the right thing to do for personnel safety, and can also mitigate the risk of millions of dollars in losses that can arise from a single arc flash incident.

The incurred costs can include:

- Treatment for victims (often $Millions)
- Legal defense fees
- OSHA Fines
- Lost worker productivity
- Workers' compensation premium increases
- Lost facility production/downtime

Arc flash risk management should be a fundamental part of every facility's safety program.

3 - Define the Path Forward

Define specific and measurable goals. Determine the gap between your current electrical safety program and your goals. Develop an action plan, budget, and timeline. Outline the steps necessary to provide tangible safety improvements in your facility that will comply with NFPA and OSHA Safety Standards.

These standards include requirements for:

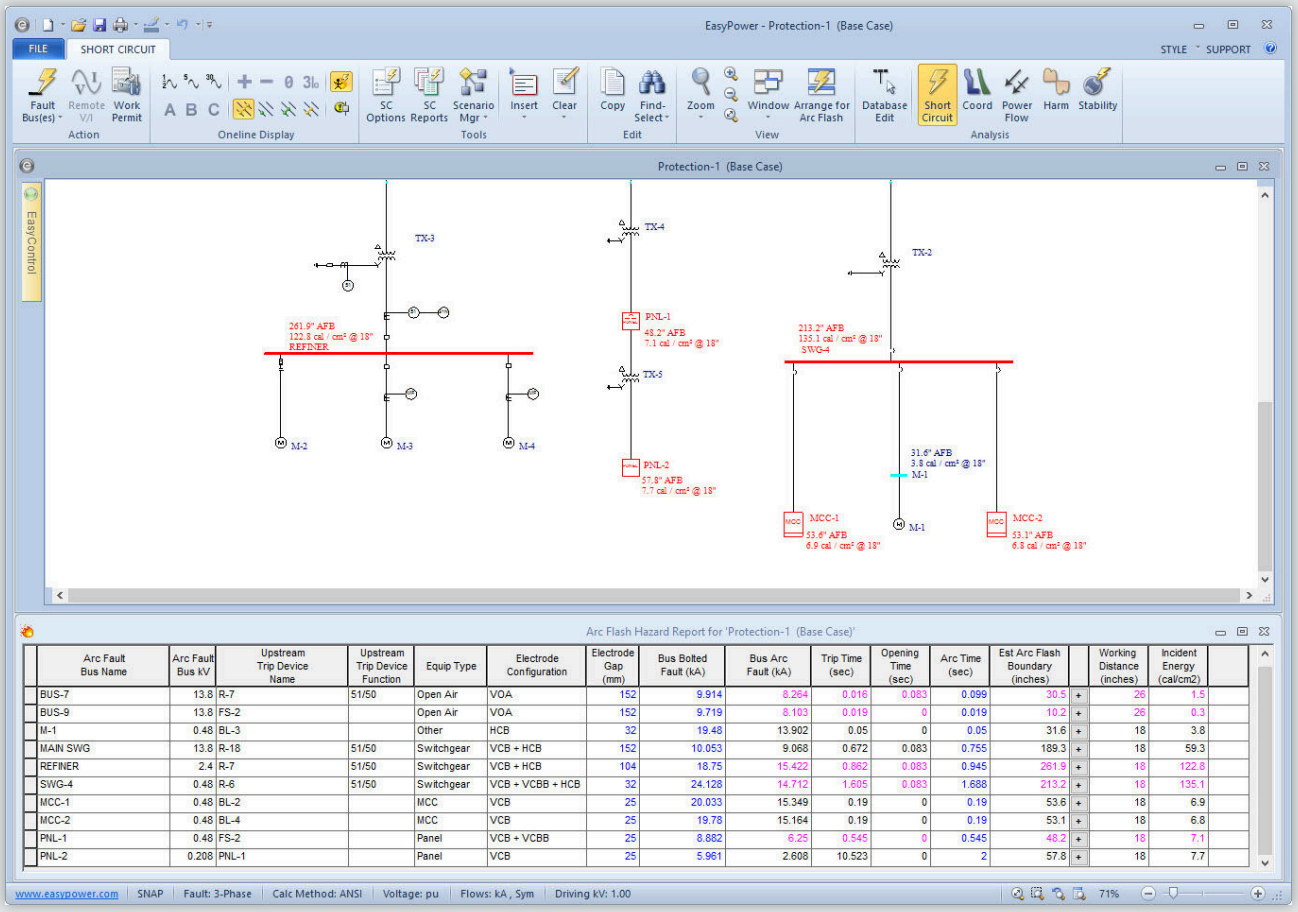
- **Up-to-Date Electrical Drawings**, used for planning work, verifying voltages, alternate sources, capacitor back feeds, etc. *NFPA 70E Article 120.5(1), Annex G3.0*
- **Short Circuit/Equipment Duty Analysis**, required to verify all equipment is properly rated to withstand and interrupt the available short circuit current. Underrated devices may not operate properly during an arc flash incident. *NFPA 70E Article 210.3, 210.5, IEEE 551, 141, 3002.3*

EasyPower software empowers you to easily create your one-line diagrams and accurately perform calculations to meet the requirements of OSHA, NFPA 70E, and IEEE 1584.

- **Protective Device Coordination Study**, recommended to verify that equipment and cables are properly protected and the extent of outages is minimized. *IEEE 241, 3004*
- **Arc Flash Risk Assessment**, required to identify arc flash hazards, estimate likelihood and potential severity of injury, and determine protective measures and PPE required. *NFPA 70E, IEEE 1584*

4 - Analyze

Analyze your electrical system to determine predicted maximum incident energy, PPE requirements, arc flash boundary, and the limited and restricted shock boundaries in accordance with the latest requirements of NFPA 70E Art 130.4 and 130.5.



Arc Fault Bus Name	Arc Fault Bus kV	Upstream Trip Device Name	Upstream Trip Device Function	Equip Type	Electrode Configuration	Electrode Gap (mm)	Bus Bolted Fault (kA)	Bus Arc Fault (kA)	Trip Time (sec)	Opening Time (sec)	Arc Time (sec)	Est Arc Flash Boundary (inches)		Working Distance (inches)	Incident Energy (cal/cm2)
BUS-7	13.8	R-7	51/50	Open Air	VOA	152	9.914	8.264	0.016	0.083	0.099	30.5	+	26	1.5
BUS-9	13.8	FS-2		Open Air	VOA	152	9.719	8.103	0.019	0	0.019	10.2	+	26	0.3
M-1	0.48	BL-3		Other	HCB	32	19.48	13.902	0.05	0	0.05	31.6	+	18	3.8
MAIN SWG	13.8	R-18	51/50	Switchgear	VCB + HCB	152	10.053	9.068	0.672	0.083	0.755	189.3	+	18	59.3
REFINER	2.4	R-7	51/50	Switchgear	VCB + HCB	104	18.75	15.422	0.862	0.083	0.945	261.9	+	18	122.8
SWG-4	0.48	R-6	51/50	Switchgear	VCB + VCBB + HCB	32	24.128	14.712	1.605	0.083	1.688	213.2	+	18	135.1
MCC-1	0.48	BL-2		MCC	VCB	25	20.033	15.349	0.19	0	0.19	53.6	+	18	6.9
MCC-2	0.48	BL-4		MCC	VCB	25	19.78	15.164	0.19	0	0.19	53.1	+	18	6.8
PNL-1	0.48	FS-2		Panel	VCB + VCBB	25	8.882	6.25	0.545	0	0.545	48.2	+	18	7.1
PNL-2	0.208	PNL-1		Panel	VCB	25	5.961	2.608	10.523	0	2	57.8	+	18	7.7

Arc flash risk assessment should include the following steps:

A) Field data collection of electrical equipment nameplate parameters. These parameters, in conjunction with the EasyPower® software library provide a comprehensive database of the electrical system used to perform all types of analysis.

B) Develop accurate one-lines to perform the arc flash calculations. One-lines help workers identify power sources, tie breakers, and other system conditions and equipment that impact hazard calculations. These can also be used for work planning to determine proper switching orders. *NFPA 70E 120.2(C), 205.2*

C) Perform short circuit and equipment duty calculations and verify that all equipment is properly rated to withstand and interrupt the available short circuit current. Improperly rated equipment can result in catastrophic failure, equipment damage, and danger to workers. *NFPA 70E 210.3, 210.5, IEEE 551,141, 3002.3*

D) Review protective device coordination for circuit breakers, fuses, protective relays, etc., to verify that devices will operate properly on the available bolted and arcing short circuit current. Proper protective device selection and coordination (settings) can reduce arc flash hazards and worker exposure, and increase plant reliability. *IEEE-241, 3004, NEC 230.208 et al*

E) Perform arc flash hazard calculations based on IEEE 1584-2018 equations and recommendations. Worst-case calculations should be determined for all equipment. *Article 130.5*

F) Generate arc flash labels with EasyPower to provide Article 130.5(H) compliance and ensure worst-case hazards are posted and visible for all equipment. The labels are to be reviewed and updated at least every 5 years and with any system short circuit or coordination changes. *NFPA 70E 130.5(H)*

EasyPower software allows you to create your one-line diagrams, document electrical system parameters, accurately perform arc flash calculations, and easily evaluate options to reduce hazards and risk to personnel. EasyPower's intuitive and detailed analysis can help prevent the mistakes of over or under protection common to other methods of analysis, allowing you to economically increase system safety and reliability.

5 - Prioritize Hazard Elimination

Proactively address the potential negative influence of human error. Use the "Hierarchy of Risk Control Methods" to establish a system to monitor and continually improve worker safety. *NFPA 70E 110.1(H)*

A) **Eliminate hazards** – physically remove the hazard where possible.

B) **Substitute** - Replace the equipment with a 'hazard-less' solution

C) **Engineering controls** – isolate people from the hazard (remote operation)

D) **Awareness** – Improve training of qualified personnel and operators

E) **Administrative controls** – Document procedures, audit completion

F) **PPE** – Train for proper selection and use

Whereever possible, ensure all electrical work is performed on 'de-energized' parts of the system. This requires a robust, well-documented lockout/tagout procedure. Until a voltage test is performed, equipment must be treated as 'live' and this means the qualified worker must wear the appropriate PPE for the part of the system that must be tested.

6 - Personal Protective Equipment

PPE (personal protective equipment) is your last line of defense should an accident occur; thus, the choice of appropriate PPE for the hazards involved is essential. NFPA 70E outlines PPE requirements for arc flash protection based on available incident energy, which is typically calculated using the study process outlined above.

7 - Energized Work Permits

Energized Work Permits (EWP) are required by NFPA 70E 130.2 for all energized work above 50 V except for diagnostic testing. EWP are a key element of NFPA 70E. The EWP document the work to be done, why energized work is required, and the safe work practices required. They include the shock risk and arc flash risk assessments and require signature by management and the electrician. The electrician must agree that the work can be done safely. The EWP should take into account system operating conditions, specific hazards involved, work procedures, company policies, and site-specific safety rules. EasyPower allows you to create an EWP in just moments, and automatically populates system voltage and arc flash hazard analysis results using an easily edited Word template. When you use EasyPower to create an EWP, the program also stores an electronic record that is easy to reuse, and minimizes the risk of lost documentation.

8 - Safety Program

NFPA 70E encompasses much more than arc flash safety. It covers all aspects of electrical safety and can serve as the model and reference for any organization's electrical safety program. Each facility should develop an Electrical Safe Work Practices standard that includes lockout/tagout, shock risk, testing, tools, inspections, and diagnostics as well as arc flash risk assessment and PPE. OSHA uses NFPA 70E when training their compliance officers, so building a safety program around the requirements of NFPA 70E should satisfy OSHA requirements for electrical safety. The safety program must be periodically reviewed and updated to comply with latest changes to NFPA 70E, which is updated every three years.

9 - Training

All employees working around electrical equipment should receive training based on your Electrical Safe Work Practices document at least every three years. The training should emphasize the major processes in working safely including training workers to be involved, company work procedures and policies, evaluation of system conditions, and making safe decisions. These are key elements in building a safe work culture that prepares workers to handle emergency situations. Additional training should also be considered to cover any hazardous day-to-day activities in your facility. Examples include inserting/removing bus plug-ins, racking circuit breakers in or out, and insertion/removal of MCC buckets. Training should cover how to read and interpret arc flash warning labels as well as proper use and application of PPE.

10 - Equipment Maintenance

Maintenance, including testing, is an essential part of electrical safety, especially arc flash safety. The characteristics of circuit breakers and fuses determine, to a large extent, the arc flash hazard. If these protective devices are not properly maintained they may not operate as expected or may not operate at all. The failure of a circuit breaker to trip per its specified trip curve can cause a massive increase in arc flash energy for someone working downstream. Proper maintenance and testing reduces the risk of equipment failure creating unanticipated arc flash hazards.

Images courtesy of Salisbury by Honeywell

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Practical Solution Guide to Arc Flash Hazards - 3rd Ed

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