Roadmap to Compliance with NFPA 70E Arc Flash Requirements

aniel Blascovich, P.E. chneider Electric Engineering Services



Continuous, reliable power is critical to hospital operations.

Disruptions or fluctuations in the electrical system ca literally have **life or death implications**.

How do we get to Reliable Power?

- Do things right –
- > Proper design
- > Proper installation
- > Proper maintenance
- > Proper operation
- But, there are constraints like, "don't shut anything down"
- Maintenance: thermographic scanning of live equipment
- A potential safety hazard!

The Need for Electrical Safety

- Electrical accidents 6th among all causes of work-related deaths in the US*
- > More than 300 fatalities annually
- > More than 4,000 serious injuries annually
- Shock / Electrocution from inadvertent contact with energized parts has long been recognized as an issue
- Arc Flash increasingly recognized as a problem in more recent years
- Can produce devastating injuries with severe financial consequences
- based on Electrical Safety Foundation International (ESFI) data)

Electrical Shock Hazard



Arc Flash – a Quick Background

NFPA 70E – *flash hazard* – A dangerous ondition associated with the release of nergy caused by an electric arc.

- Not every electric arc is dangerous
- Not every dangerous electrical arc creates a flash hazard
- Arc flash associated with passage of ubstantial current through air (or through apor of arc terminal material)
- n worst cases, a very violent event
- Significant heat energy released
- Significant pressure wave an explosive event!



/ideo



OSHA and Arc Flash



OSHA – Occupational Safety and Health Administration

listorically, OSHA regulations took a "high level" overview of Arc Flash Hazards
 My words: OSHA requires protection against "recognized" hazards
 OSHA 1910.331 & 1910.335 – applies in general industry; requirements certainly consistent with this general assessment

Senerally, OHSA would require use of Personal Protective Equipment (PPE), but does of provide enough guidance to determine when you need it or how much you need!

NFPA 70E

Standard for Electrical Safety in the Vorkplace

Provides specific details & requirements elated to Electrical Safe Work Practices

Developed as a complementary ocument to the OSHA regulations – fills the details that OSHA does not have

n "Industry Consensus Standard"



Six Steps to Compliance

- 1. Develop an Electrical Safe Work Practices Policy
- 2. Perform an Arc Flash Risk Assessment & Label Equipment
- 3. Provide Appropriate PPE and Insulated Tools
- 4. Develop and Implement an Effective Training Program
- 5. Develop and Implement an Effective Maintenance Program
- 6. Implement Arc Flash Mitigation Solutions

Step 1: Electrical Safe Work Practices (ESWP) Policy

- Written document that defines an overall Electrical Safety Program for the site
- > Emphasizes that de-energization is preferred!
- > Includes appropriate policies, procedures, and controls needed for electrical safety
- > Considers Maintenance of electrical equipment
- Defines the Risk Assessment Procedure
- Defines Training requirements
- Defines responsibilities of Owner vs. Contractors

Policy & Field Work to be periodically audited

Risk Assessment Procedure

- Risk Assessment: to be carried out before work is started in order to:
- > 1. Identify Hazards
- > 2. Assess Associated Risks
- > 3. Implement Risk Control methods
- Consider both the task and equipment condition
- Focus on the two main hazards: shock & arc flash

Norker Training

- Workers should be trained to understand & evaluate hazards specific to electricity
- Includes training specific to the hazard & the equipment to be worked on Includes basic Emergency Response training (contact release, CPR, etc.)
- Training records to be documented and verified annually
- Ultimate Goal -> Qualified Employees
- > Knowledgeable about specific work task/equipment; can identify & avoid associated hazards
- > Understands how to plan the job, perform the Risk Assessment, and select control methods
- > Employer is to document demonstrated proficiency

Host & Contract Employers' Responsibilities

Host Employer must:

- > Inform contractors of known hazards & information needed to perform the Risk Assessments
- > Report observed violations of NFPA 70E to the contract employer

Contract Employer must:

- > Instruct workers on hazards communicated by Host
- > Follow safety requirements in NFPA 70E, as well as additional rules imposed by the Host
- > Advise Host employer of:
 - Unique hazards resulting from the work to be done
 - Hazards identified during the work that were not communicated by the Host
 - Measures to correct violations reported by the Host

Requires documented meeting between Host & Contract employer

Step 2: Arc Flash Risk Assessment

- Risk assessment should answer three basic questions:
- > 1. Am I exposed to a hazard?
- > 2. What is the severity of the hazard?
- > 3. What can I do to mitigate the risk?



Question 1 - Exposure

NFPA 70E, 130.2(A)(4):

- > 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.

This walks you through a simple Risk Assessment

- > Consider the specific task is it "normal operation" or not?
- > Consider equipment conditions five specific conditions to look at

Does Any of This Look Familiar? I Hope Not...



Not properly installed.



Covers not properly secured.



Not properly maintained + Evidence of Impending Failure.

Arc Flash Analysis

- Determining potential severity of exposure requires an analysis
- Method 1: NFPA 70E Tables.
- Method 2: IEEE 1584 Calculations. ("Arc Flash Study")
- On the surface, applying the tables appears to be the simplest option
- To use the tables have to determine that available fault current and fault clearing time are within given parameters. How do you determine this?
- The Arc Flash Study also gives you a way to evaluate Mitigation Options
- Recommendation do the calculations!

Risk Mitigation: Best to Worst

- Elimination / Substitution: is there any way we can do this de-energized?
- Engineering Controls: can I apply some product or design technique to help mitigate the severity of the hazard?
- > Relay / breaker / fuse upgrade?
- > Arc Flash Maintenance Switches
- Warnings / Administrative Controls: what work practices can we employ to minimize risk?
- > LOTO, proper procedures & thorough job planning, etc.

Personal Protective Equipment (PPE)

Arc Flash Labels

- Equipment is supposed to be labeled based on the results of the analysis
- Note some changes in formatting in the 2015 edition of NFPA 70E
- Labeling can be a whole subject in itself...

Arc Flash Information			
PPE LEVEL - Site-Specific		Use this information in accordance with applicable OSHA standards, NFPA 70E- 2015 and other required safe electrical work practices.	
8 cal/cm² 4 ft 9 in.	Max Incident Energy at a Working Distance of 1 ft 6 in. Arc Flash Boundary		
208V 3 ft 6 in. 1 ft 0 in.	Shock hazard when cover is open Limited Approach Restricted Approach		ben
Q2C: 12345678 Date: 12/01/14 Values produced by a Schneider Electric engineering analysis. Any system modification, adjustment of protective device settings, or failure to properly maintain equipment will invalidate this label. For more information. contact Schneider Electric at 1-888-778-273.			
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Meets NFPA 70E Requirements



- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E or CSA Z462.
- This equipment must be installed and serviced only by qualified electrical personnel.
- Turn off all power supplying this equipment before working on or inside equipment.
- Always use a properly rated voltage sensing device to confirm power is off.

• Replace all devices, doors and covers before turning on power to this equipment.

Failure to follow these instructions will result in death or serious injury.

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REV 01

Meets NEC Requirements

Arc Flash Labels – NFPA 70E-2015 Requirements

- Typical practice, up till now: show required PPE Category + available Incident Energy
 70E-2015 specifically prohibits this
- Potential work-around: define Site Specific PPE Levels and include in ESWP



Step 3: PPE & Voltage-Rated Tools

- ESWP should define a process for selecting required PPE
- PPE is to be selected based on the hazard(s) to which one is exposed, as well as the severity of those hazards





Arc & Shock Rated PPE photos courtesy of Oberor

PPE Selection

Arc Rated PPE – select based on results of analysis

- > Vendors sell various levels of PPE based on exposure levels
- > Important select something that actually has an Arc Rating (cal/cm2) not all "FR" clothing can stand up to an Arc Flash event
- > Follow laundering procedures to the letter

Shock PPE (gloves) -

- > Gloves select glove class based on voltage level
- > Leather protectors + rubber insulating gloves
- > Test every 6 months!



Other PPE + Insulated Tools

Insulating Aprons + Blankets – reduce chances of contacting energized parts



Voltage-Rated Tools



What does a new hood look like?



hneider Liectric Engineering Services – Jasper



Step 4: Training + Re-Training

- We've already talked a bit about Qualified Employees
- > Get them qualified with combination of classroom + OJT
- Can have task- or equipment-specific qualifications
- > Workers can be qualified for some tasks or equipment & not others
- > Not uncommon to have "specialists" for certain equipment or parts of the system
- Workers have to be re-trained on tasks performed "...less often than once per year"
- Training should include instruction on selecting an appropriate test instrument to verify that equipment is de-energized

Fraining Details

Emergency Response Training

- > Contact release refresher training required annually
- > First Aid, Emergency Response, and CPR/AED again, annual refresher training required
- Employer verification required annually.
- Employer documentation is required
- Employers should audit individual employees "...on at least an annual basis"
- Retraining should be performed at least every three years (Not a coincidence that NFPA 70E is updated on a 3-year cycle), or sooner if special conditions apply

Step 5: Maintenance

- It should be fairly obvious that poorly maintained electrical equipment presents a reliability and safety hazard
- Arc flash safety that is certainly true
- > When there's a fault, we want the devices to actually trip!
- > We'd like them to trip as quickly as possible!
- Poor maintenance practices may mean they just can't
- Recent example: 15kV breaker that took 1 second to open instead of 5 cycles
- Actual quote from hospital chief electrician: "Oh, yeah, we maintain our equipment every 3 years. We're just 5 years late!"

Hospital Maintenance Failures



<u>'DO NOT MESS WITH THIS IT WILL KILL YOU</u>!!"



NFPA 70E & 70B

70E 130.5 – Arc Flash Study – consider OCPD "condition of maintenance"

70E 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."

Mfg's instructions – may give info on the "what" but not generally the "when"

NFPA 70B – Recommended Practice for Electrical Equipment Maintenance

- > Information on workscopes, recommended maintenance intervals, etc.
- > This is the "industry consensus standard" you can refer to for Maintenance of equipment

Maintenance and testing

reventive maintenance keeps the electrical system in peak perating condition and minimizes the risk of power outage ue to equipment failure.



cording to IEEE, the rate electrical component flures is three times higher in cilities that do not perform eventive maintenance on eir electrical systems.



Schneider Electric Services Largest qualified, trained and equipped service organization in USA

The **only** electrical equipment manufacturer Service organization recognized within NFPA 70B, section 31.5 (Functional performance testing on electrical equipment)

Step 6: Arc Flash Mitigation

- PPE should be the last line of defense. Let's "engineer out" the problem.
- General Mitigation Methods:
- > Prevention Barriers/insulation inside equipment. Proper maintenance.
- > Reduction Quickly clear faults to reduce energy levels
- > Containment Arc Resistant switchgear contains/re-directs the energy
- > Avoidance Manage exposure with safe work practices. Remote operation.
- Ideally some combination of the above

Arc Flash Mitigation Solutions

- emoves worker from location or places a barrier
- etween worker and exposed energized parts.
- Infrared (IR) Windows (custom also available)
- Remote Racking System (RRS)
- Wireless Temperature Monitoring System (WTMS)







NEC 240.87 Arc Energy Reduction

here "...the highest continuous current trip setting..." circuit breaker "...is rated or can be adjusted is A or higher...", then one of the following means to ce Clearing Time shall be provided:

- 1. Zone-selective interlocking
- 2. Differential relaying
- 3. Energy-reducing maintenance switching with ocal status indicator
- Energy-reducing active arc flash mitigation system
- 5. An approved equivalent means
- s applies to LV systems
- t applies to <u>any</u> breaker rated/adjusted to 1200A or arger not just the main



NEC 240.87 – introduced into the Code in 2011 Significantly revised in 2014

Arc Flash Mitigation Best Practices

Don't think that just because you used one of the solutions listed in NEC 240.87, you've actually accomplished anything

Best:

- > Define a performance criteria. If you don't like where you are, where do you want to be?
- > Perform a study find the "hot spots"
- > Investigate various mitigation options cost, effectiveness, ease of installation, etc.
- > Validate the solution
- > Implement the solution

Going forward: Design for Safety!





Electrical safety is very important & very achievable

- > OSHA & NFPA 70E provide the guidelines
- > Your ESWP defines the policy & expectations for your site
- > Proper Training makes sure your workers get the message and are equipped with the tools & knowledge to put it into practice
- > Proper Maintenance is part of the "Circle of Safety"
- > Arc Flash Mitigation helps design out the hazard



Recommendations

- If you've started down the road to compliance...keep it going!
- > Audit
- > Re-train
- > Improve!
- If you haven't, where do you start?
- > Policy
- > Training
- > Analysis & evaluation
- > Look for labels
- > Look for settings
- > High Arc flash incident energy >40 cal/cm2

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