



# NFPA 70E: We have our Study, now what?

*Presented by:*  
**Roger Harris**

**HATCH**

*March 7, 2019*

# Agenda

What is:

- Short Circuit Study
- Coordination Study
- Arc Flash Study

Can you have one without the other?

# Agenda

What are some of the things to look for in a good study?

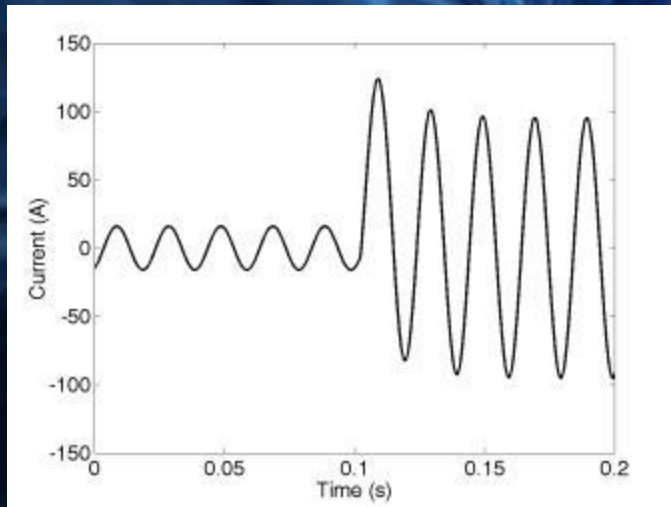
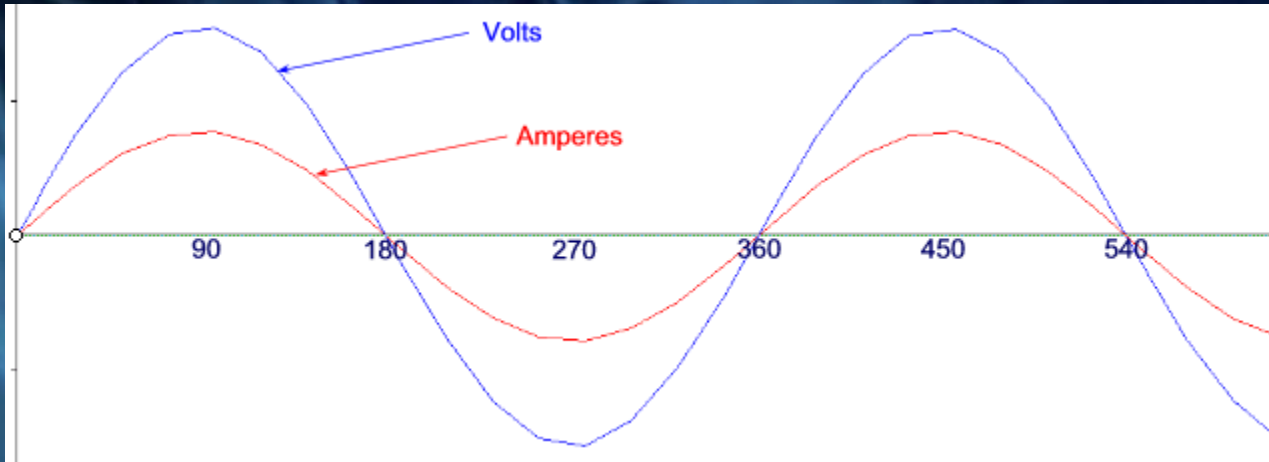
- Correct data
- Utility information
- Transformer information
- Conductor length, type, conduit type
- Fuse types
- Labels, Where does it go, what does it say

# Agenda

I have a “Dangerous” Arc Flash rating, now what do I do?

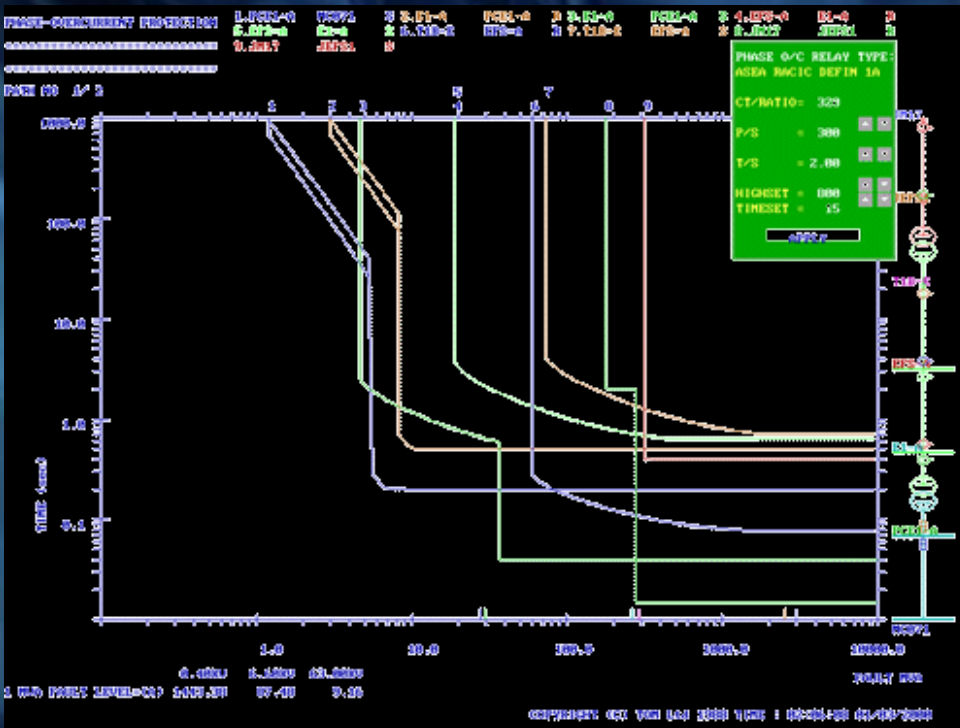
- Importance of data verification
- Mitigation options
  - Run away
  - Identify, isolate
  - Adjust
  - Switch
  - Get Your Safety Team involved
  - Get that darn Engineer involved

# Short Circuit Study



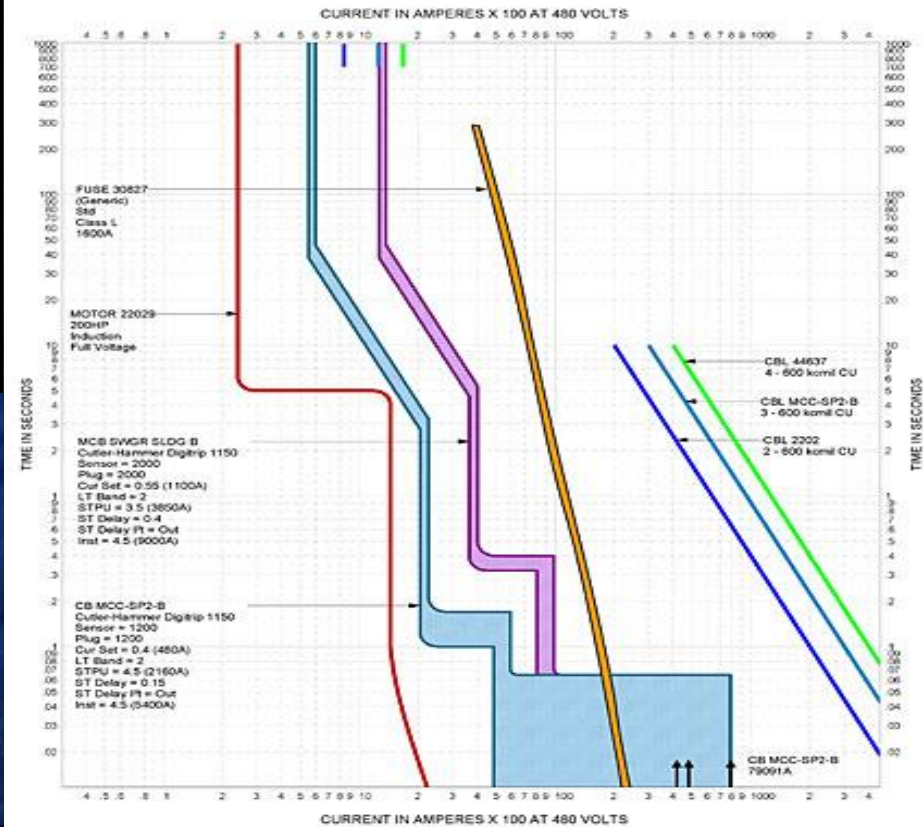
- **Short circuit Study**  
Calculates the maximum current flow in each device at the instant of a fault.

# Coordination Study



- Coordination provides selective breaker operation.

- Closest breaker to the fault trips first!



# Arc Flash Study

- **Provides calculations for Incident Energy ( $\text{cal}/\text{cm}^2$ ) at “working distance”**
  - $1 \text{ cal}/\text{cm}^2 = \text{Finger over match flame for 1 second}$
- **Protection Boundaries.**
- **Provides an estimated duration of the Arc Event.**
- **Provides the Minimum PPE that must be worn for energized interaction.**

# What to look for in a good Study

ST-5 UTILITY  
SC Contribution 3P 500000.0 Amps  
SC Contribution SLG 250000.0 Amps  
System Nominal Voltage 7200.0 V

ST-5 UTILITY XFMR  
Nominal kVA 500.0 kVA  
Z% 4.9000 %

CBL-0016  
Size 400 AWG/kcmil  
QtyPerPhase 1  
Length 30.0 ft

ST-5 MCC MAIN FS  
Type UNKNOWN  
Sensor/Trip 1000.0 A

ST-5 MCC CB 1B  
Type SE, Spectra RMS

CBL-0017  
Size 12 AWG/kcmil  
QtyPerPhase 1  
Length 85.0 ft

ST-5 SLUICE GATE DSC  
1678.54 Amps 3P  
988.99 Amps SLG

**SC currents too high, JP has 5,000 A and Southerly has 6,600 A**

**Incoming Conductor wrong Transformer = 601FLA  
400kcmil = 400A**

**Incoming fuse is unknown although sized at 1,000A.  
Correct size would be 800 or 600A but must be verified**

**Bus ISC = 14,519, max let through on the  
xfrmr = 12,265**

ST-5 MCC CB 2D  
Type SGLA, Spectra RMS  
Sensor/Trip 400.0 A

CBL-0018  
Size 350 AWG/kcmil  
QtyPerPhase 1  
Length 99.0 ft

ST-5 PUMP 1  
Rated HP 150.0 hp

ST-5 MCC CB 3D  
Type SGLA, Spectra RMS  
Sensor/Trip 400.0 A

CBL-0019  
Size 350 AWG/kcmil  
QtyPerPhase 1  
Length 99.0 ft

ST-5 PUMP 2  
Rated HP 150.0 hp

ST-5 MCC  
14518.95 Amps 3P  
12781.21 Amps SLG  
480.0 Volts RMS

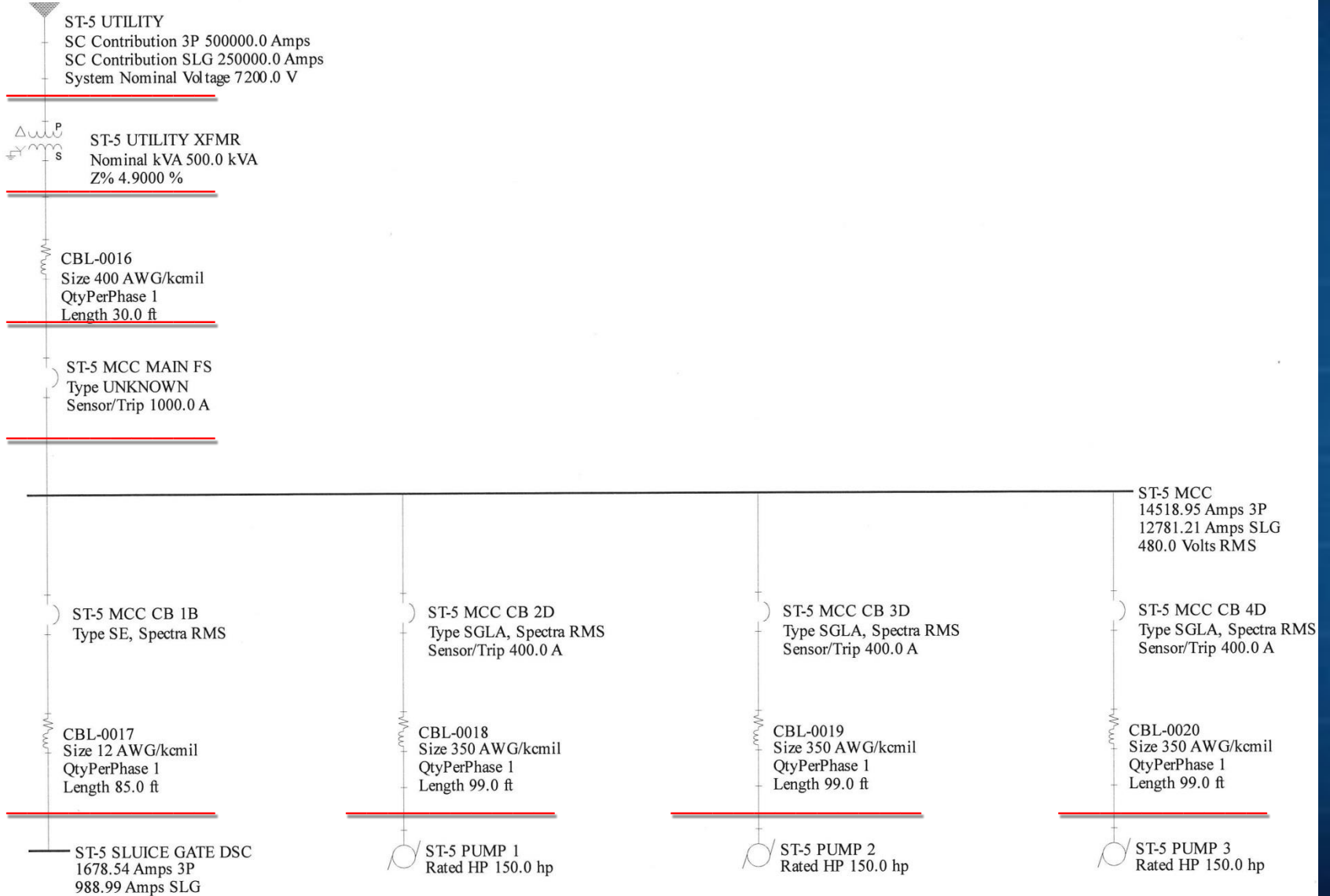
ST-5 MCC CB 4D  
Type SGLA, Spectra RMS  
Sensor/Trip 400.0 A

CBL-0020  
Size 350 AWG/kcmil  
QtyPerPhase 1  
Length 99.0 ft

ST-5 PUMP 3  
Rated HP 150.0 hp



# Where do the AF Labels go?



# Who should have access to Arc Flash Study?

- **Plant Managers?**
- **Maintenance Managers?**
- **Engineers?**
- **Safety Staff?**
- **Mechanics?**
- **Electricians?**
- **Anyone who wants to see it?**

# **Great, we have our study...we're good, right?**

**Confirmed that our study is good**

**Electrical Safety Program: Follow NFPA 70E  
Guidelines:**

**Don't work on it ENERGIZED**

**But to turn it off, we need to interact with  
energized equipment**

**Utilize appropriate PPE, or better, as  
designated by the SC/Cord/AF Study  
AND/OR NFPA 70E**

# Great, we have our study...we're good, right?

But I need to work on the equipment energized, now what?

Follow NFPA 70E Guidelines:

Utilize an energized work permit checklist  
Review the work site, perform a complete risk analysis.

Two man rule, qualified employees,  
approval from a supervisor, second set of eyes, let others know what you are doing and where

# Great, we have our study...we're good, right?

**! DANGER**

**NO SAFE PPE EXISTS  
ENERGIZED WORK PROHIBITED**

**295 inches** Flash Hazard Boundary  
**48** cal/cm<sup>2</sup> Flash Hazard at 18 inches

**Dangerous! No FR Category Found**

**480 VAC** Shock Hazard when cover is removed  
**00** Glove Class

**42 inches** Limited Approach

**12 inches** Restricted Approach

**1 inches** Prohibited Approach

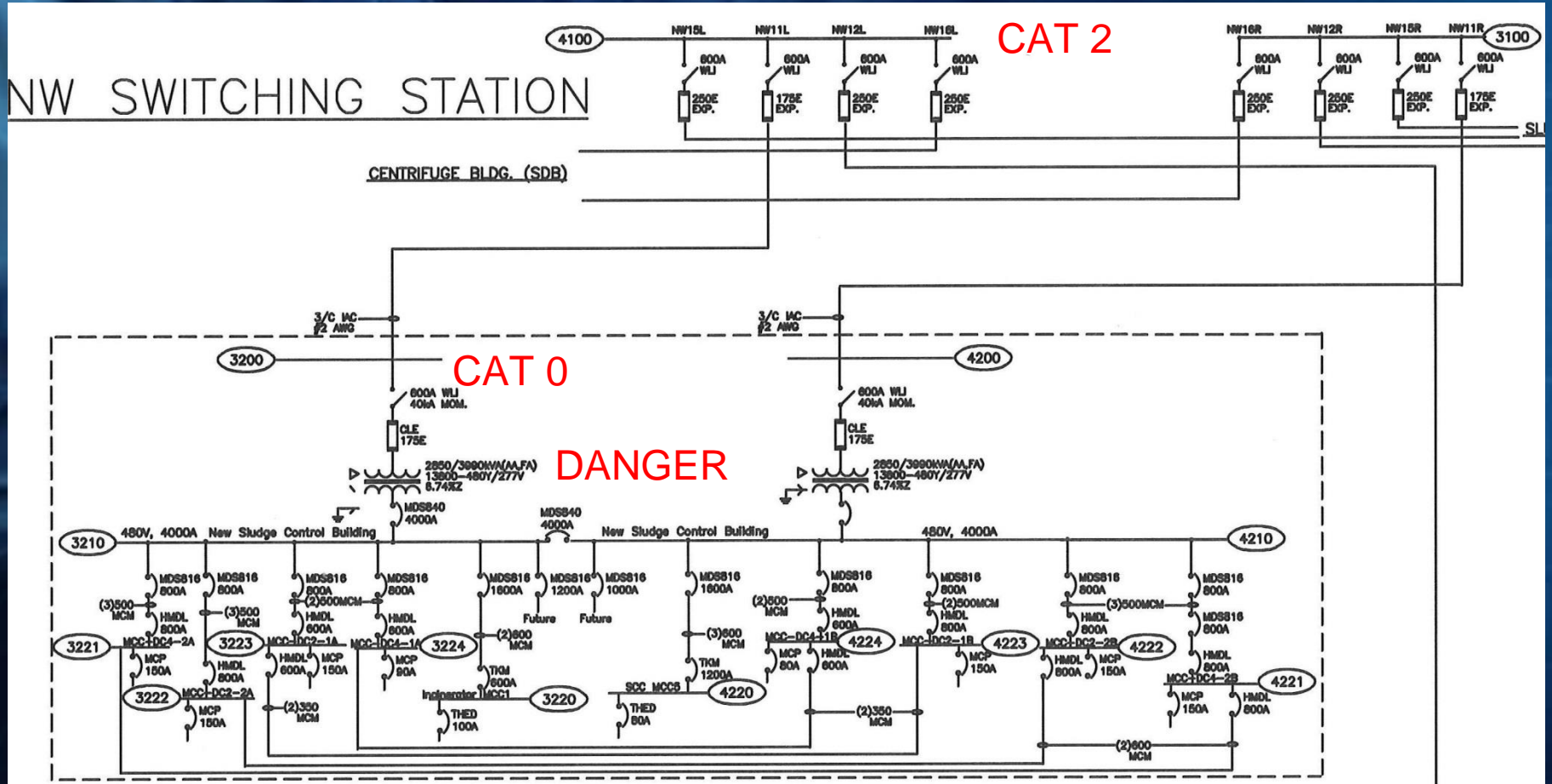
**Bus: 3320 S76R BUS**

**Now what do I do?**

**Mitigation is on a case by case, plant by plant,  
site by site basis. No 1 "fix all" solution.**

# Now what do I do? Mitigation Options

- Review power system, de-energize at a “safe” upstream device.



# Now what do I do? Mitigation Options

- Get Engineering involvement

$$E = \frac{(793 * F * V * t)}{D^2}$$

**E = Incident Energy, Cal/cm<sup>2</sup>**

**F = Bolted Fault Short Circuit Current, kA**

**V = System Phase – Phase Voltage, kV**

**t = Time, Seconds**

**D = Distance from Arc Source, inches**

**(480 V use 18 inches, 14,400 use 36 inches)**

# Now what do I do? Mitigation Options

$$E = \frac{(793 * F * V * t)}{D^2}$$

Review latest SS/Cord/AF Study

Per the study:  $E = \frac{(793 * 6.9 * 0.48 * \mathbf{10})}{18^2} = 81 \text{ cal/cm}^2$

\*\*\*\*\*BUT\*\*\*\*\*

$$E = \frac{(793 * 6.9 * 0.48 * \mathbf{2})}{18^2} = 16 \text{ cal/cm}^2$$



# Example of a Arc Event



# Now what do I do? Mitigation Options

$$E = \frac{(793 * F * V * t)}{D^2}$$

Review latest SS/Cord/AF Study

Per the study:  $E = \frac{(793 * 6.9 * 0.48 * \underline{10})}{18^2} = 81 \text{ cal/cm}^2$

\*\*\*\*\*BUT\*\*\*\*\*

$$E = \frac{(793 * 6.9 * 0.48 * \underline{10})}{36^2} = 20 \text{ cal/cm}^2$$

# Now what do I do? Mitigation Options

- Adjust

$$E = \frac{(793 * F * V * t)}{D^2}$$

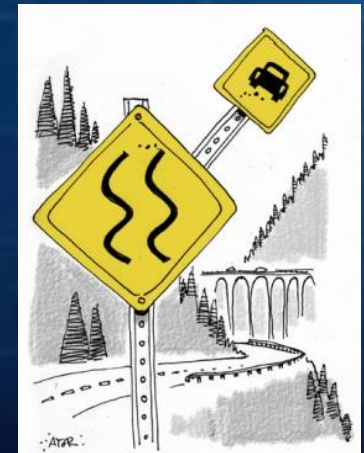
**! DANGER**

**NO SAFE PPE EXISTS**

**ENERGIZED WORK PROHIBITED**

<b>292 inches</b>	<b>Flash Hazard Boundary</b>
<b>115.9</b>	<b>cal/cm<sup>2</sup> Flash Hazard at 18 inches</b>
	<b>Dangerous! No FR Category Found</b>
<b>480 VAC</b>	<b>Shock Hazard when cover is removed</b>
<b>00</b>	<b>Glove Class</b>
<b>42 inches</b>	<b>Limited Approach</b>
<b>12 inches</b>	<b>Restricted Approach</b>
<b>1 inches</b>	<b>Prohibited Approach</b>

**Bus: 1230 MCC M**

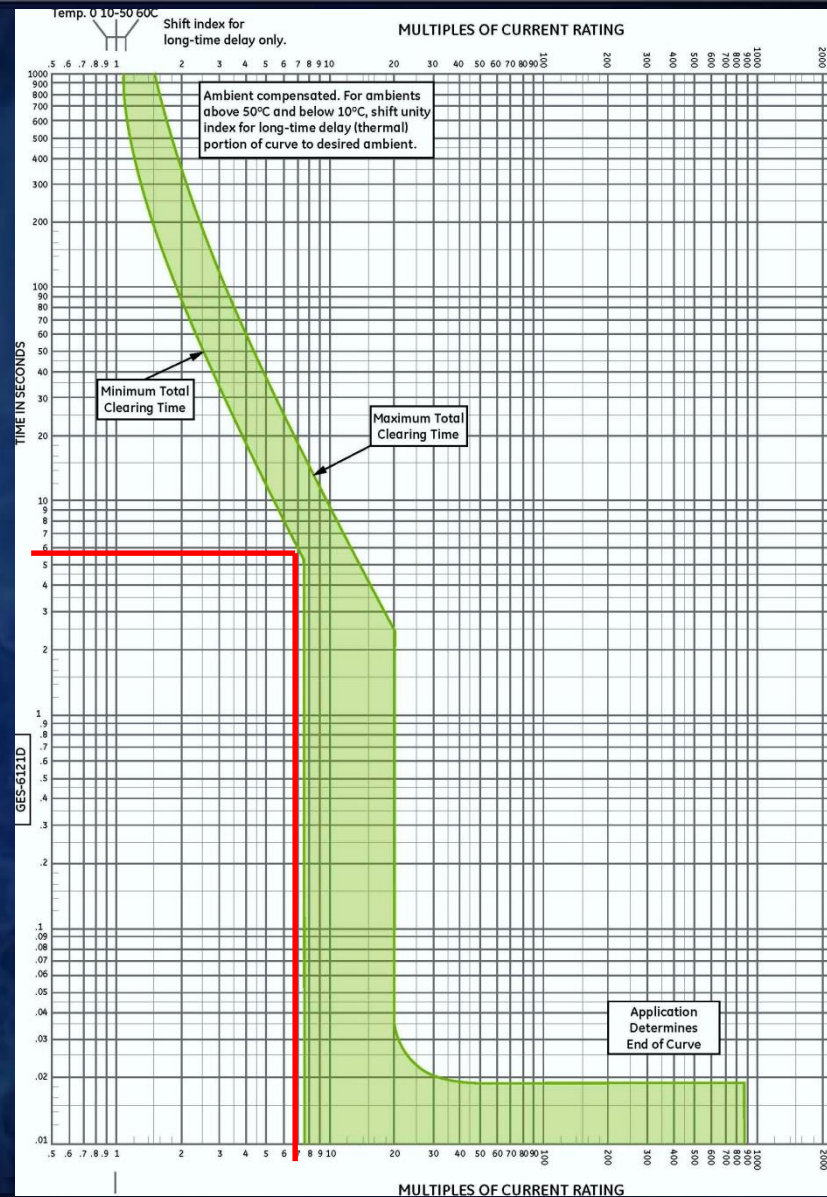


# Now what do I do? Mitigation Options

- Adjust

$$E = \frac{(793 * F * V * t)}{D^2}$$

Bus 1230 F = 7.167kA



# Now what do I do? Mitigation Options

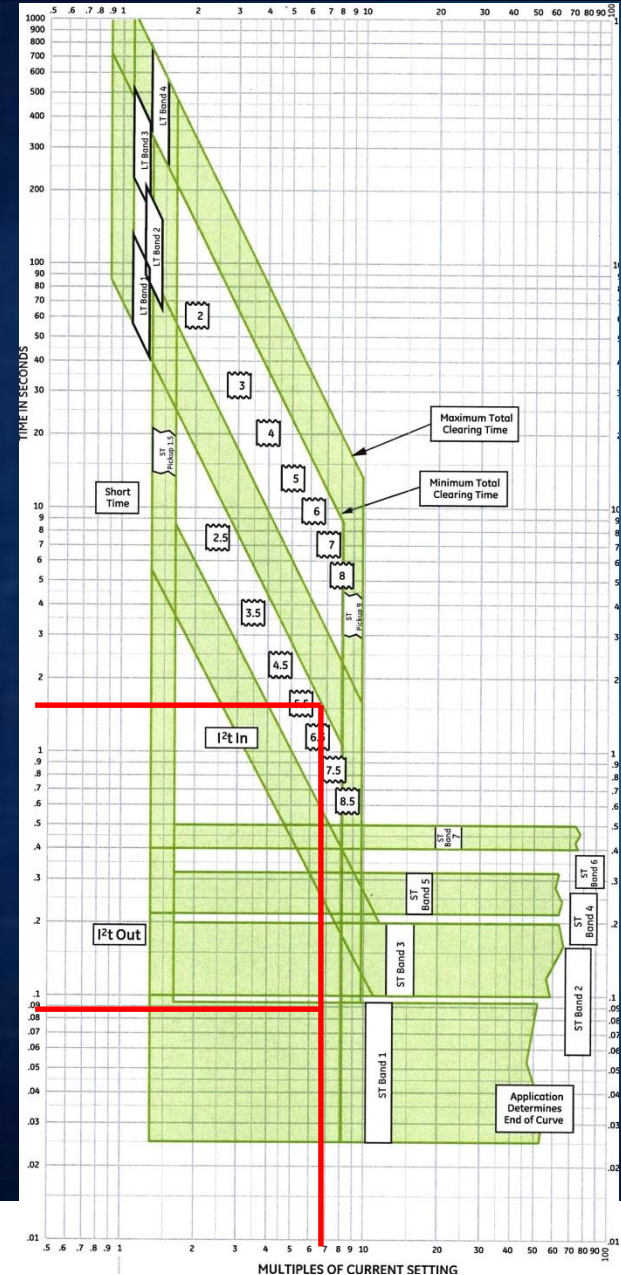
- Adjust

$$E = \frac{(793 * F * V * t)}{D^2}$$

Bus 1230 F = 7.167kA

$$E = \frac{(793 * 7.16 * 0.48 * 0.9)}{18^2}$$

$$E = 7.57 \text{ cal/cm}^2$$



# Now how do I implement?

- Have AF report contain mitigation options
  - Electricians adjust breakers in the field
    - Prior to work
    - Return to “normal” settings when work is complete
  - AF Mitigation or Safety “switch”
    - Automatically adjusts breakers to minimum settings
    - Simple
    - Can be monitored

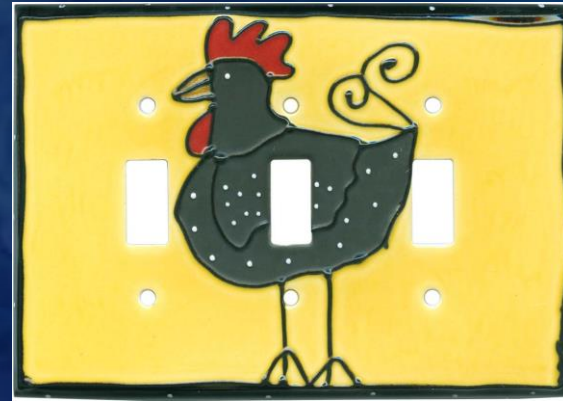
# Now how do I implement?

- AF Mitigation or Safety “switch”



# Are there other options?

- Minimize electrician interaction
- Utilize
  - Remote Switching



- Remote sensing

**⚠ DANGER VOLTAGE IF FLASHING**  
SAFETY PROCEDURES STILL APPLY.  
TEST BEFORE TOUCHING.



**⚠ DANGER VOLTAGE** VOLTAGE PRE-TEST POINTS


L1 L2 L3

Manufacturers' Non-Contact Voltage Detector (NCVD) and Voltage Indicator (VI) Procedures Apply.

**Procedure:**

- 1.) Verify proper operation of VI.
- 2.) Verify NCVD to known voltage source.
- 3.) Open isolator.
- 4.) Verify NO flashing LEDs on VI.
- 5.) Insert NCVD into bottom of recess & test ALL points.
- 6.) Re-Verify NCVD to known voltage source.
- 7.) Upon completion of work, close isolator and verify proper operation of VI.

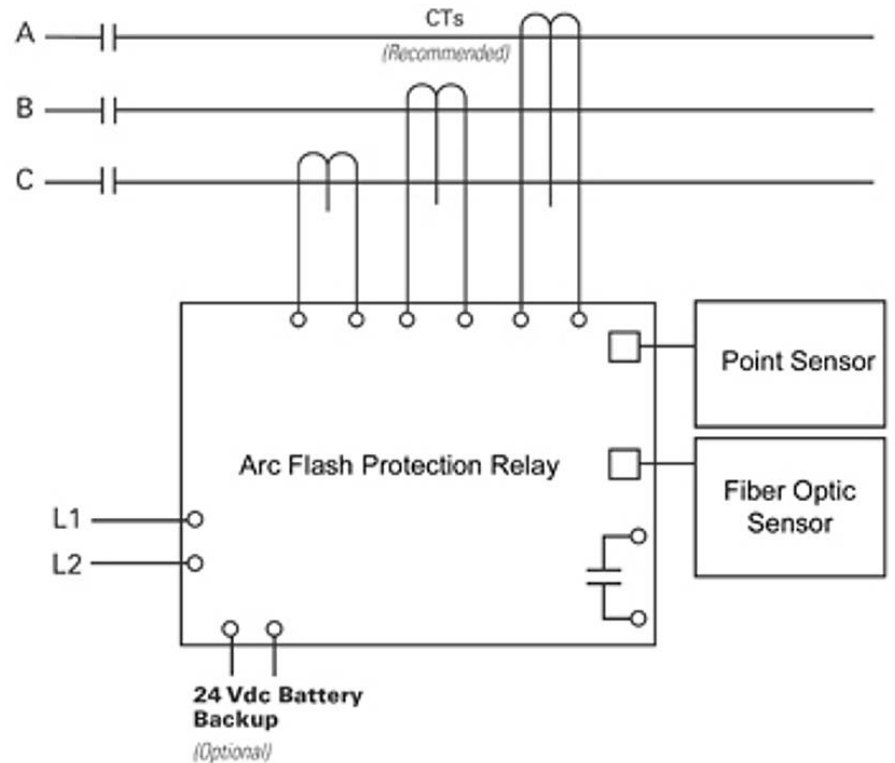
**WARNING!**  
Follow Safety Procedures  
Read instructions before installing





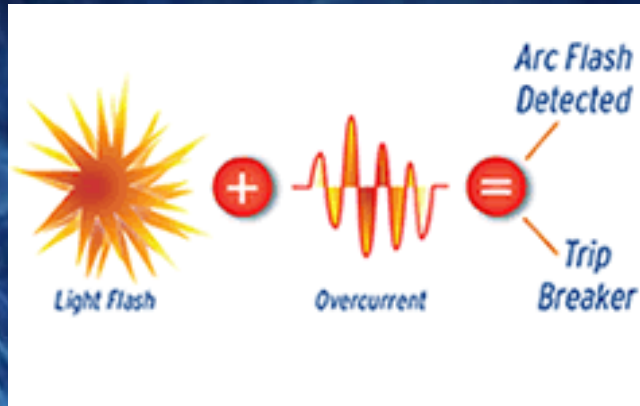
# The one "Fix All"

- Arc Flash Relay
- Must be an Engineered System
- Must be installed by a Factory Trained Rep



# The one "Fix All"

- Arc Flash Relay
- Each installation is not the same



# Recap

- **Verify that you have a quality: Short Circuit/Coordination/Arc Flash Study**
  - **Have a second reviewer (QA/QC)**
  - **Confirm settings and spot check**
- **Review your study for any and all Dangerous locations**
- **Meet with your maintenance team to decide how you are going to address**
  - **Request Engineer performing study provide Dangerous mitigation settings**

# Recap

- **Get Engineering involved**
  - **Design a safety system**
    - **Mitigate interaction**
      - **Remote switching**
      - **Remote sensing**
      - **IR Windows**
    - **Safety Switch maximize breaker operation to minimum opening time**
    - **Arc Flash Sensing Relay(s)**

**Thank you!**

**Questions & Discussion**

**HATCH**

**Roger Harris, PE**

**Roger.harris@hatch.com**

**614-224-4419**