



# 2018 NFPA 70E – The Skinny

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May 2019

# Motivation

1. The DOE updated 10 CFR 851, Worker Safety & Health, establishing the 2017 version of the NEC and the 2015 version of NFPA 70E as requirements for DOE contractors, superseding what was specified in our contract.
2. The 2015 and 2018 versions of 70E are very similar. In the 2018 version, an exception to Article 120.5(7) permits the use of a *permanently mounted absence of voltage tester* in lieu of direct contact with a meter, prompting us to use the 2018 version.

# How does this affect your work?

# Hierarchy of Control

- NFPA 70E now references The National Institutes of Safety and Health's (NIOSH) *Hierarchy of Controls* for the most effective ways to mitigate hazards to workers.

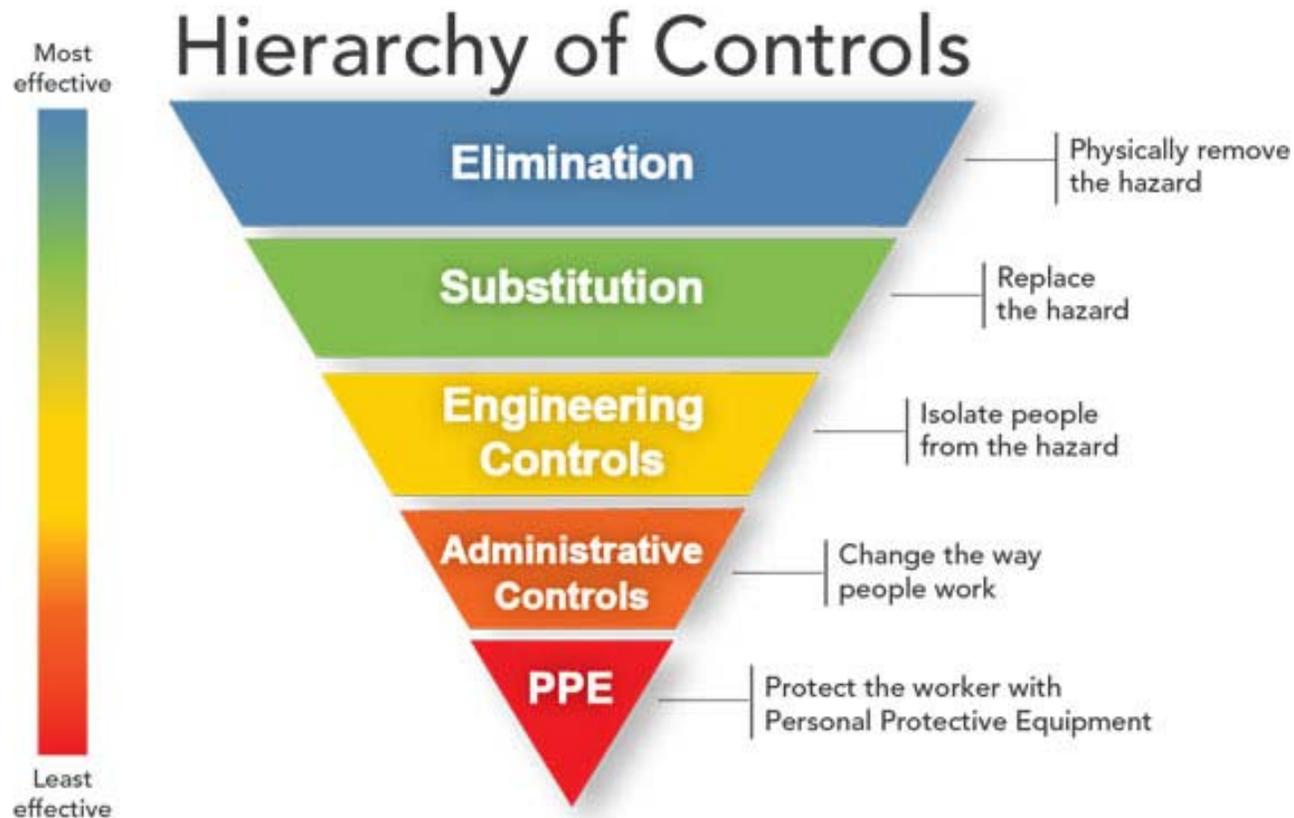


Image courtesy of NIOSH



# Hierarchy of Control

- NFPA 70E prescribes administrative controls to be followed and PPE to be used when it is not feasible to use the higher-level controls to protect us from electrical hazards .

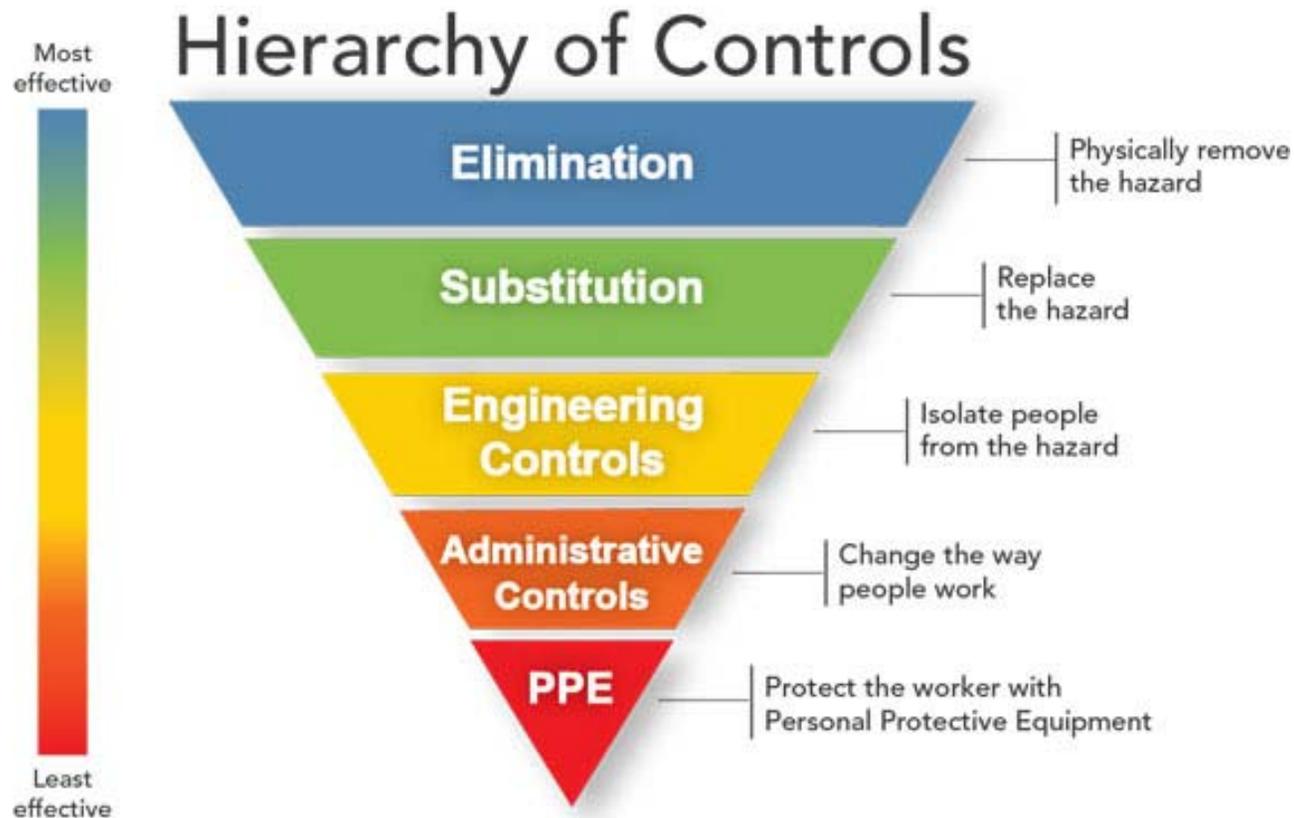


Image courtesy of NIOSH



# Test Before Touch



- Article 120.4(B)(6)(3 & 4).
- “...Test before touching every exposed conductor or circuit part(s) within the defined boundary of the work area.”
- “Retest for absence of voltage when circuit conditions change or when the job location has been left unattended.

## Prohibited Approach Boundary

# GONE

- Entering the Prohibited Approach Boundary (PAB) was considered to be the same as touching the energized part.
- As significant as that seemed, the work practices and PPE used to enter the PAB were the same as those used to enter the restricted approach boundary (RAB).
- Since entering the PAB did not require workers to do anything different than entering the RAB, the PAB is gone.

# AC Restricted Approach Boundary change

- Was (2004 / 2009 / 2012):
  - 50 to 300 volts: Avoid contact
  - 301 to 750 volts: 1 foot
- Is (2015 / 2018):
  - 50 to **150** volts: Avoid contact
  - **151** to 750 volts: 1 foot

## DC shock hazards are different

- Article 350: Research & Development Laboratories (that's us!)
- Article 350.9: Energy thresholds:
  - AC: 50 volts & 5 milliamps (same as it ever was)
  - **DC: 100 volts and 40 milliamps** (changed in 2012 based on new research data)
  - The DC thresholds were set back to 50 volts & 5 milliamps for everyone but R & D Laboratories in the 2018 edition due to the consensus standard process, not on any empirical data.
  - Fermilab is staying at **100 volts and 40 milliamps for DC**

# DC shock hazards are different

- Capacitive systems:
  - The energy a capacitor can store is based on the formula
  - $\text{Joules} = \frac{1}{2} * C \text{ (in Farads)} * V^2 \text{ (in peak volts)}$
- Based on the maximum peak voltage, hazards exist:
  - Less than 100 volts: 100 Joules of stored energy
  - 100 volts to <400 volts: 1.0 Joules of stored energy
  - 400 or more volts: 0.25 Joules of stored energy

## DC shock hazards are different

- There are now separate shock hazard tables for AC and DC
  - Except for the RAB change for 150 to 300, AC hasn't changed
  - DC table was new in 2012
  - DC table in 2012 and 2015 required shock PPE starting at 100 Volts
  - The ESS simplified table for DC shock hazards follows Article 350.9(2).

# Normal Operating Condition

- “Normal Operating Condition” is a new term that helps define where and when an arc-flash hazard exists.
- Article 130.2(A)(4) defines “Normal Operating Condition” as:
  1. The equipment is properly installed
  2. The equipment is properly maintained
  3. The equipment is used in accordance with instructions included in the listing and labeling and in accordance with the manufacturer’s instructions
  4. The equipment doors are closed and secured
  5. All equipment covers are in place and secured
  6. There is no evidence of impending failure

# Normal Operating Condition

- There is a lot of discussion in the electrical safety profession about how useful “Normal Operating Condition” is, especially when one of its requirements is a very qualitative condition like “There is no evidence of impending failure.”
- This is what sometimes happens when a consensus standard like NFPA 70E is developed. Things that all parties can agree on but might not be the best possible get put into the standard.
- Like everywhere else, you get to decide whether “There is no evidence of impending failure.” Please be conservative in your evaluation. Request help from your supervision or SME

# Arc-Flash Likelihood of Occurrence

- Certain electrical equipment operations present negligible hazard of an arc-flash occurring.
- These operations are listed in NFPA 70E Article 130.5(B & C), Table 130.5(C).
- The next slide lists the operations that have a negligible likelihood of an arc-flash occurring, regardless of equipment being in a “Normal Operating Condition.”
- The following slide lists the operations that ONLY have a negligible likelihood of an arc-flash occurring, IF the equipment is in a “Normal Operating Condition.”
- Use of arc-flash PPE in these situations is at the discretion of the employee and supervisor. The worker and her or his supervisor must agree to waive PPE requirements

# Arc-Flash Likelihood of Occurrence

- Use of arc-flash PPE is at the discretion of the employee and supervisor:
- Equipment condition: Any
  - Reading a panel meter, including meter switch operation
  - Performing infrared thermography while outside of the RAB (does not cover work to remove doors or covers)
  - Work on exposed control circuits at or below 125 V AC or DC not involving exposure to adjacent circuits exceeding these limits
  - Examining insulated cables without manipulating them
  - Maintaining, inserting or removing single cells or battery units in an open rack

# Arc-Flash Likelihood of Occurrence

- Use of arc-flash PPE is at the discretion of the employee and supervisor
- Equipment condition: Normal
  - Operating a circuit breaker, switch, contactor, or starter
  - Voltage testing on single cells or battery units
  - Removing and installing electrical enclosure covers that does not expose bare, (not proven to be de-) energized electrical conductors or circuit parts
  - Opening a hinged panelboard door or cover to access dead-front overcurrent devices
  - Removal of battery non-conductive intercell connector covers

# Arc-Flash PPE Categories

- These next slides show how the 2009 HRC categories for arc-flash PPE changed into 2018 arc-flash PPE categories.
- The term “Arc-Flash PPE Category” replaces “Hazard-Risk Category” (HRC). Actual PPE doesn’t change.
- The 2004 / 2009 Version categories were:
  - 0
  - 1
  - 2
  - 2\*
  - 3
  - 4

# Arc-Flash PPE Categories

- In the 2012 NFPA 70E, it was no longer permitted to use a face shield without a balaclava (arc-rated ski mask) for incident energies over 4 cal/cm<sup>2</sup> but 8 or less cal/cm<sup>2</sup>.
- 2012 Version categories:
  - 0
  - 1
  - ~~2~~ ← No more face shield alone at category 2.
  - 2\*
  - 3
  - 4

# Arc-Flash PPE Categories

- So the list started to look like this:
- 2012 Version categories:
  - 0
  - 1
  - 2\*
  - 3
  - 4

# Arc-Flash PPE Categories

- But since “2\*” made little sense without a plain “2,” the entirely rational decision was made to get rid of “2\*.”
- 2012 Version categories:
  - 0
  - 1
  - 2 ← Old 2\* renamed
  - 3
  - 4

# Arc-Flash PPE Categories

- In 2015, category 0 was dropped because now that the term is “Arc-Flash PPE Category,” because none of the required PPE is actually arc-flash rated.
- 2015 / 2018 Version categories:
  - ~~0~~
  - 1
  - 2
  - 3
  - 4

# Arc-Flash PPE Categories

- However, the ESS has decided to retain “Category 0” as a reminder to not wear meltable clothing and to protect your eyes.
- 2015 / 2018 Version categories:
  - 0 ← Fermilab will retain to address need for non-melting clothing and safety glasses
  - 1
  - 2
  - 3
  - 4

## Arc-Flash Categories for tasks

- The arc-flash PPE tables in the 2004 / 2009 versions defined both shock and arc-flash protection needed for several different tasks on each type of equipment.
- The 2015 / 2018 tables no longer list shock protection, simplifying the tables.
- The 2015 / 2018 tables no longer list different tasks, just types of equipment. So arc-flash PPE is determined by equipment type alone. (Just like the ESS tables!)
- Some tasks are potentially exempted from PPE requirements based on a negligible likelihood of occurrence

## Arc-Flash Categories for tasks

- The 2015 / 2018 tables include very conservative arc-flash boundaries. The 4-foot default arc-flash boundary (AFB) for equipment between 50 and 600 V is gone found in the 2009 NFPA 70E Article 130.3(A)(1) disappeared in 2012.
- However, the arc-flash calculations based on our limited selection of 13 800 – 480 V and 480 – 208 V transformers are still valid. Maximum calculated AFB is 2.4 feet.
- Fermilab will continue to use the 4-foot default boundary for AC power system work between 50 and 600 V for equipment that does not have a sticker with a calculated arc-flash boundary.
- If equipment has a sticker showing a calculated AFB, use that AFB, even if it is less than the 4-foot default boundary.

# Training changes

- NFPA 70E training (FN000385) revisions are complete, requalification will remain on a 3-year interval.
- CPR/AED training is still required, recertification is now required on the training provider's recommended interval, which is currently a 2-year cycle.
- Contact Release training is required on an annual basis. This is computer-based and relatively short and painless. Last year EFCOG Electrical Safety Task Group (ESTG) developed a core course for use across DOE complex.
- Basic Electrical Training will be required on 3-year cycle. This may be broken down into modules to be selected based on individual's job responsibilities. EFCOG Electrical Safety Task Group should finish a core course this year.

## EHAWP changes

- Page 1: Added line to identify “person performing switching.” Needed for compliance, doubt we will ever use it.
- Page 1: Manipulative work justification requires a written risk assessment
- Page 1: Hazard Mitigation loses the HRC selection text. Moves to page 2.
- Page 2: Revisions to shock hazard boundaries, PPE, and NFPA 70E references.
- Page 2: You must enter AFB and Arc-flash PPE Categories when using tables and default values
- Page 2: Revised to match new arc-flash PPE Categories
- Page 3: No changes.

## Other changes

- There are other minor changes to the Electrical Safety Program many of which were already in NFPA 70E training but not explicitly stated in the FESHM 9000 series chapters.
- There are some new requirements for which practical implementation is still being worked out by the industry.
  - Example: “130.7(E)(4): When conductors are de-energized to cut, remove, or relocate and the terminations are not within sight of the work area, **take additional steps** to identify the conductors and verify absence of voltage prior to [doing the work].”
- You can look forward to more updates as practical implementations of new requirements are worked out by the industry.

# Questions?

Please send to [mertz@fnal.gov](mailto:mertz@fnal.gov) or call x 6322.