Objectives

- Explain why electrical contractors should follow the precautions set forth in NFPA 70E
- List the hazards which demonstrate why an arc flash risk assessment is needed.
- Describe the restrictions associated with the boundaries defined in NFPA 70E.
- Identify two methods for determining the appropriate PPE for a given task
- Given a task, select the appropriate Personal Protective Equipment from the proper PPE Categories.
NFPA 70E Standard for Electrical Safety in the Workplace

PPE Compliance/Advice

- OSHA
  - 1910 General Industry Subpart S
  - 1926 Construction Subpart K

- 2015 NFPA 70E

- OSH Act: General Duty Clause 5a(1)

- MSHA, Department of Energy (DOE), Others

NFPA 70E - 2015

Chapter 1 - Safety-Related Work Practices

Chapter 2 - Safety-Related Maintenance Requirements

Chapter 3 - Safety Requirements for Special Equipment.
Calculation Method

- Calculate Incident Energy Level (cal/cm²)

- Select the Hazard / Risk Category using Table H.3(b)
  (Match PPE Arc Thermal Protective Value (ATPV) to incident energy calculation)

- Select Arc Rated clothing and PPE for task

- Determine the need for V-rated gloves and tools
Table Method

- Look up the task to be performed in the NFPA 70E Tables
  o Alternating Current (AC) Table 130.7(C)(15)(A)(b)
  o Direct Current (DC) Table 130.7(C)(15)(B)

- Identify the PPE Category and need for V- rated gloves and tools associated with that task

- Select Arc Rated clothing and PPE associated with that level
HIERARCHY OF SAFETY CONTROLS

1. Elimination
2. Substitution
3. Engineering Controls
4. Awareness
5. Administrative Controls
6. Personal Protective Equipment
MITIGATION

1. Personnel trained in First Aid/Basic Life Support/AED/CPR
2. Emergency Contact Numbers and procedures for summoning help
3. List of Healthcare and Emergency Facilities
4. Secure the area
JOB TASK ANALYSIS

1. Identify job the analysis is needed.
2. Break down the job into steps
3. List hazards for each step.
4. List thee controls used to mitigate hazards.
5. Perform the Job briefing
JOB BRIEFINGS

(share information from Job Task Analysis)

• Energy source controls (e.g., clearances, LOTO)
• PPE required
• Emergency Response measures (alert procedures, First/Aid CPR/AED, rally points after evacuation, etc.)
SHOCK RISK ASSESSMENT

A shock risk assessment shall determine:

• Voltage to which personnel will be exposed
• Boundary requirements
• PPE needed to minimize possible of electric shock
The Body as a Conductor

Current (mA) Reaction
1   Faint tingle
5   Slight shock
6–30   Can’t let go
50–150  Death possible
1,000–4,300 Heart ceases
mA = milliamp = .001 amp
Shock Risk Assessment

Limited (3 ft 6 in)

Restricted (1 ft)

System Voltage = 750 v
Protect Employees

- Working on or Near Live Parts
  • Justification
  • Safe Practices for Working Hot

- Personal Protective Equipment
ARC FLASH RISK ASSESSMENT

An arc flash risk assessment shall determine if an arc hazard exists and if so,

- Appropriate safety-related work practices
- Arc flash boundary
- PPE to be used within the arc flash boundary
Arc Flash Risk Assessment

= Distance at which Incident Energy Equals 1.2 cal/cm²*

*(Fault clearing time slower than 0.1 seconds)
Risk Assessment & PPE Selection

- **Sound Waves** (Sample Test 141 dB at 2 ft)
- **Intense Light**
- **Pressure Waves** (Sample Test 2160 lbs/ft²)
- **Molten Metal**
- **35,000 °F**
Risk assessment:

Involves a determination of the likelihood of occurrence of an incident, resulting from a hazard that could cause injury or damage to health.
The phrase “properly installed”,

as used in the following tables, means that the equipment is installed in accordance with applicable industry codes and standards and the manufacturer’s recommendations.
The phrase “properly maintained”,

as used in the following tables, means that the equipment has been maintained in accordance with the manufacturer’s recommendations and applicable industry codes and standards.
The phrase “evidence of impending failure”,
as used in the following tables, means
that there is evidence of arcing,
overheating, loose or bound equipment
parts, visible damage, deterioration, or
other damage.
## Risk Assessment & PPE Selection

### Tasks that do not require PPE - Excerpts from Table 130.7 (C)(15)(A)(a) Arc Flash Hazard Identification

<table>
<thead>
<tr>
<th>Task</th>
<th>Equipment Condition*</th>
<th>Arc Flash PPE Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading a panel meter while operating a meter switch</td>
<td>Any</td>
<td>No</td>
</tr>
</tbody>
</table>
| Normal Operation of a circuit breaker (CB), switch, contactor or starter | All of the following:  
  - The equipment is properly installed  
  - The equipment is properly maintained  
  - All equipment doors are closed and secured  
  - All equipment covers are in place and secured  
  - There is no evidence of impending failure | No                     |
| Voltage testing on individual battery cells or individual multi-cell units | All of the following:  
  - The equipment is properly installed  
  - The equipment is properly maintained  
  - Covers for all other equipment are in place and secured  
  - There is no evidence of impending failure | No                     |
| Removal or installation of covers for equipment such as wireways, junction boxes, and cable trays that does not expose bare energized electrical conductors and | All of the following:  
  - The equipment is properly installed  
  - The equipment is properly maintained  
  - There is no evidence of impending failure | No                     |
### TASKS THAT ALWAYS REQUIRE PPE
Excerpts from Table 130.7 (C)(15)(A)(a) *Arc Flash Hazard Identification and PPE Shock Protection*

<table>
<thead>
<tr>
<th>Task</th>
<th>Equipment Condition*</th>
<th>Arc Flash PPE Required</th>
</tr>
</thead>
</table>
| Normal operation of a circuit breaker (CB), switch, contactor, or starter | One or more of the following:  
- The equipment is not properly installed  
- The equipment is not properly maintained  
- All equipment doors are open or not secured  
- All equipment covers are off or not and secured  
- There is evidence of impending failure | Yes |
| For ac systems: Work on energized electrical conductors and circuit parts, including voltage testing | Any | Yes |
### Determining Arc Flash Hazard PPE Categories

**Alternating Current**

Excerpts from Table 130.7 (C)(15)(A)(b)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Arc Flash PPE Category</th>
<th>Arc-Flash Boundary</th>
<th>Rubber-Insulated Gloves (Minimum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panelboards or other equipment rated 240 V and below</td>
<td>1</td>
<td>485 mm (19 in.)</td>
<td>Class 00</td>
</tr>
<tr>
<td>Parameters: Maximum of 25 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panelboards or other equipment rated &gt;240 V and up to 600 V</td>
<td>2</td>
<td>900 mm (3 ft.)</td>
<td>Class 00 (&lt;500V) Class 0 (&gt;500V &lt; 1000V)</td>
</tr>
<tr>
<td>Parameters: Maximum of 25 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>600-V class motor control centers (MCCs)</td>
<td>2</td>
<td>1.5 m (5 ft)</td>
<td>Class 00 (&lt;500V) Class 0 (&gt;500V &lt; 1000V)</td>
</tr>
<tr>
<td>Parameters: Maximum of 65 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Risk Assessment & PPE Selection

## Determining Arc Flash Hazard PPE Categories

**Direct Current**

Excerpts from Table 130.7 (C)(15)(B)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Arc Flash PPE Category</th>
<th>Arc-Flash Boundary</th>
<th>Rubber-Insulated Gloves (Minimum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage batteries, dc switchboards, and other dc supply sources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 V &gt; Voltage &lt; 250 V Parameters: Voltage: 250 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum arc duration and working distance: 2 sec @ 455 mm (18 in.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short-circuit current &lt; 4 kA</td>
<td>1</td>
<td>900mm (3 ft.)</td>
<td>Class 00*</td>
</tr>
<tr>
<td>4 kA ≤ short-circuit current &lt; 7 kA</td>
<td>2</td>
<td>1.2m (4 ft.)</td>
<td>Class 00*</td>
</tr>
<tr>
<td>7 kA ≤ short-circuit current &lt; 15 kA</td>
<td>3</td>
<td>1.8m (6 ft.)</td>
<td>Class 00*</td>
</tr>
<tr>
<td>Storage batteries, dc switchboards, and other dc supply sources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>250 V &gt; Voltage &lt; 600 V Parameters: Voltage: 600 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum arc duration and working distance: 2 sec @ 455 mm (18 in.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 V ≤ Voltage &lt; 250 V Parameters:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage: 250 V</td>
<td>1</td>
<td>900mm (3 ft.)</td>
<td>Class 00*</td>
</tr>
<tr>
<td>Maximum arc duration and working distance:</td>
<td>2</td>
<td>1.2m (4 ft.)</td>
<td>Class 00*</td>
</tr>
<tr>
<td>2 sec @ 455 mm (18 in.)</td>
<td>3</td>
<td>1.8m (6 ft.)</td>
<td>Class 00*</td>
</tr>
<tr>
<td>7 kA ≤ short-circuit current &lt; 10 kA</td>
<td>4</td>
<td>2.5m (8 ft.)</td>
<td>Class 00*</td>
</tr>
</tbody>
</table>
DETERMINING ARC FLASH HAZARD PPE CATEGORIES DIRECT CURRENT

Excerpts from Table 130.7 (C)(15)(B)

Note: Apparel that can be expected to be exposed to electrolyte must meet both of the following conditions:

• (1) Be evaluated for electrolyte protection in accordance with ASTM F1296, Standard Guide for Evaluating Chemical Protective Clothing

• (2) Be arc-rated in accordance with ASTM F1891, Standard Specification for Arc Rated and Flame Resistant Rainwear, or equivalent
RISK ASSESSMENT & PPE SELECTION

CATEGORY 1 PPE
- Arc-Rated Clothing, Minimum Arc Rating of 4cal/cm² (see Note 1)
- Arc-rated long-sleeve shirt and pants or arc-rated coverall
- Arc-rated face shield (see Note 2) or arc flash suit hood
- Arc rated jacket, parka, rainwear, or hard hat liner (AN)

PROTECTIVE EQUIPMENT
- Hard hat
- Safety glasses or safety goggles (SR)
- Hearing protection (ear canal inserts)
- Heavy duty leather gloves (see Note 3)
- Leather footwear (AN)

AN: as needed (optional)  AR: as required. SR: selection required.

Notes:
(1) Arc rating is defined in Article 100.
(2) Face shields are to have wrap-around guarding to protect not only the face but also the forehead, ears, and neck, or, alternatively, an arc-rated arc flash suit hood is required to be worn.
(3) If rubber insulating gloves with leather protectors are used, additional leather or arc rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement.
**RISK ASSESSMENT & PPE SELECTION**

**CATEGORY 2 PPE**
- Arc-Rated Clothing, Minimum Arc Rating of 8cal/cm² (see Note 1)
- Arc-rated long-sleeve shirt and pants or arc-rated coverall
- Arc-rated flash suit hood or arc-rated face shield (see Note 2) and arc-rated balaclava
- Arc-rated jacket, parka, rainwear, or hard hat liner (AN)

**PROTECTIVE EQUIPMENT**
- Hard hat
- Safety glasses or safety goggles (SR)
- Hearing protection (ear canal inserts)
- Heavy duty leather gloves (see Note 3)
- Leather footwear

AN: as needed (optional). AR: as required. SR: selection required.

**Notes:**
1. Arc rating is defined in Article 100.
2. Face shields are to have wrap-around guarding to protect not only the face but also the forehead, ears, and neck, or, alternatively, an arc-rated arc flash suit hood is required to be worn.
3. If rubber insulating gloves with leather protectors are used, additional leather or arc rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement.
CATEGORY 3 PPE
Arc-Rated Clothing Selected so That the System Arc Rating
Meets the Required Minimum Arc Rating of 25 cal/cm² (see Note 1)
  • Arc-rated long-sleeve shirt (AR)
  • Arc-rated pants (AR) Arc-rated coverall (AR)
  • Arc-rated arc flash suit jacket (AR)
  • Arc-rated arc flash suit pants (AR)
  • Arc-rated arc flash suit hood
  • Arc-rated gloves (see Note 1)
  • Arc-rated jacket, parka, rainwear, or hard hat liner (AN)

PROTECTIVE EQUIPMENT
  • Hard hat
  • Safety glasses or safety goggles (SR)
  • Hearing protection (ear canal inserts)
  • Leather footwear

AN: as needed (optional). AR: as required. SR: selection required.
RISK ASSESSMENT & PPE SELECTION

CATEGORY 4 PPE
Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm² (see Note 1)
- Arc-rated long-sleeve shirt (AR)
- Arc-rated pants (AR)
- Arc-rated coverall (AR)
- Arc-rated arc flash suit jacket (AR)
- Arc-rated arc flash suit pants (AR)
- Arc-rated arc flash suit hood
- Arc-rated gloves (see Note 1)
- Arc-rated jacket, parka, rainwear, or hard hat liner (AN)

PROTECTIVE EQUIPMENT
- Hard hat
- Safety glasses or safety goggles (SR)
- Hearing protection (ear canal inserts)
- Leather footwear

AN: as needed (optional). AR: as required. SR: selection required.
**GLOVES: RUBBER AND SALCOR® PROTECTIVE EQUIPMENT**

Rubber insulating gloves are available in six ASTM defined voltage classes. Rubber insulating sleeves are available in Class 00 through 4. The chart below identifies the class, proof test voltage and maximum allowable exposure voltage.

<table>
<thead>
<tr>
<th>Class</th>
<th>Color</th>
<th>Proof Test Voltage AC / DC</th>
<th>Max. Use Voltage AC / DC</th>
<th>Rubber Molded Products Label</th>
<th>Insulating Rubber Glove Label</th>
<th>Insulating Rubber Dipped Sleeve Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>Beige</td>
<td>2,500 / 10,000</td>
<td>500 / 750</td>
<td>10</td>
<td>SALISBURY</td>
<td>SBR 9 RUBBER DIPPED SLEEVE 25</td>
</tr>
<tr>
<td>0</td>
<td>Red</td>
<td>5,000 / 20,000</td>
<td>1,000 / 1,500</td>
<td>10</td>
<td>SALISBURY</td>
<td>SBR 9 RUBBER DIPPED SLEEVE 50</td>
</tr>
<tr>
<td>1</td>
<td>White</td>
<td>10,000 / 40,000</td>
<td>7,500 / 11,250</td>
<td>10</td>
<td>SALISBURY</td>
<td>SBR 9 RUBBER DIPPED SLEEVE 125</td>
</tr>
<tr>
<td>2</td>
<td>Yellow</td>
<td>20,000 / 50,000</td>
<td>17,000 / 25,500</td>
<td>10</td>
<td>SALISBURY</td>
<td>SBR 9 RUBBER DIPPED SLEEVE 250</td>
</tr>
<tr>
<td>3</td>
<td>Green</td>
<td>30,000 / 60,000</td>
<td>26,500 / 39,750</td>
<td>10</td>
<td>SALISBURY</td>
<td>SBR 9 RUBBER DIPPED SLEEVE 350</td>
</tr>
<tr>
<td>4</td>
<td>Orange</td>
<td>40,000 / 70,000</td>
<td>35,000 / 54,000</td>
<td>10</td>
<td>SALISBURY</td>
<td>SBR 9 RUBBER DIPPED SLEEVE 450</td>
</tr>
</tbody>
</table>
**Risk Assessment & PPE Selection**

**RISK ASSESSMENT & PPE SELECTION**

**GLOVES:** CLEARANCE TABLE FOR LEATHER PROTECTORS PER ASTM F496

<table>
<thead>
<tr>
<th>Glove Class</th>
<th>Minimum Distance Between Protectors and Rubber Gloves</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in.</td>
</tr>
<tr>
<td>00, 0</td>
<td>1/2</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

**WARNING:** Do not use leather protectors alone for protection against electric shock. Serious injury or death will result. Always use a properly rated insulating glove for the voltage being worked.

**GLOVES:** MINIMUM DISTANCE FROM PROTECTOR AND RUBBER GLOVE

<table>
<thead>
<tr>
<th>Glove Class</th>
<th>Leather Protector Cuff</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/2 &quot; from cuff</td>
</tr>
<tr>
<td>1</td>
<td>1 &quot; from cuff</td>
</tr>
<tr>
<td>2</td>
<td>2 &quot; from cuff</td>
</tr>
<tr>
<td>3</td>
<td>3 &quot; from cuff</td>
</tr>
<tr>
<td>4</td>
<td>4 &quot; from cuff</td>
</tr>
</tbody>
</table>
Ancillary Protective Equipment

- Tools
- Temporary grounds
- Rubber insulating equipment
- Barriers
- Inspection and maintenance
NFPA 70E Requirements

- Qualified Person
- Complete Energized Electrical Work Permit
- Perform Risk Assessment
- Select PPE
Exceptions to Work Permit by Qualified Person

- Testing
- Troubleshooting
- Voltage Measuring
PPE

- Required within the Arc Flash Boundary

- Based on Arc Flash Risk Assessment as well as other hazards

- Includes head to toe protection
1. A prudent course of action for electrical contractors is to observe the PPE requirements in NFPA 70E because:

   a. NFPA 70E is the equivalent of an OSHA standard

   b. NFPA 70E serves as an industry guideline for safe practices and may be referenced by OSHA

   c. NFPA 70E should not be used
2. List at least three hazards which demonstrate why an Arc Flash Risk Assessment is needed:

- Electric Shock Hazard
- Extreme Temperatures
- Molten Metal Debris
- Intense Light
- Sound waves
- Pressure
3. A distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists is:

   a. Arc Flash Boundary

   b. Limited Protection Boundary

   c. Restricted Approach Boundary
4. The only method for determining the appropriate PPE is to perform a Arc Flash Risk Assessment and Incident Energy Level calculation using appropriate formulas.

True

False
5. Which of the following would you expect to need for a Personal Protective Equipment Category 1?

   a. Arc-rated face shield or arc flash suit hood
   
   b. Hearing Protection
   
   c. Heavy Duty Leather Gloves
5. Which of the following would you expect to need for a Personal Protective Equipment Category 1?

a. Arc-rated face shield or arc flash suit hood
b. Hearing Protection
c. Heavy Duty Leather Gloves
SAFETY PROFESSIONALS CONFERENCE 2015

NECA
NFPA 70E®
PERSONAL PROTECTIVE EQUIPMENT (PPE) SELECTOR
Welcome to eSafetyLine

This software has been developed to provide you with a comprehensive tool to establish and maintain your safety program. The resources available here can be used to walk you through the development of a complete program. Items can also be selected on an as-needed basis to compliment an existing program. All materials can be edited to fit your company’s unique operations. The ability of the application to maintain your safety records is most important.

Helpful Tips

Will you have more than 10 employees at any time during a calendar year? Then you must maintain an OSHA 300 Log. Follow the Access Records link to enter incidents and maintain an up-to-date OSHA 300 Log.

- Use the Safety Calendar to view talks that will keep your safety ideas fresh and on the top of employees minds.
- Access Safety Topics for lessons plans with talks, activities and tests to address compliance training.
- Enter your employee training in the Access Records link to print employee safety wallet cards identifying qualifications/training received.

View our disclaimer and the licensing agreement.

www.esafetyline.net/neca
Personal Protective Equipment (PPE)

Selection for Electrical Workers

An NFPA 70E – 2015 Perspective