Simplified Method for Using the NFPA 70E Tables?

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Learning Objectives

Following this session, participants will be able to:
• Recall which requirements of Article 130 apply when the Hazard/Risk Tables are used to select PPE.
• Discuss the conditions under which energized work shall be permitted.
• Recall the documentation requirements covered
• Explain the components of an arc flash hazard analysis.
• Identify a Hazard/Risk Category and PPE for a task.
Incident Energy Analysis or “HRC Tables”???

130.1. General

• All requirements of this article (Article 130) shall apply whether an incident energy analysis is completed or if Table 130.7(C)(15)(a), Table 130.7(C)(15)(b), and Table 130.7(C)(16) are used in lieu of an incident energy analysis in accordance with 130.5, Exception.

Incident Energy Analysis or “HRC Tables”???

Let’s translate that. This is an important requirement that is often overlooked…

• All requirements of Article 130 apply whether you select PPE via an incident energy analysis or if the Tables are used to select PPE
• The HRC tables are NOT independent of the rest of the provisions of Article 130!
Electrically Safe Work Condition or Energized Work?

130.2(A) Energized Work.

• (1) Greater Hazard. Energized work shall be permitted where the employer can demonstrate that de-energizing introduces additional hazards or increased risk.

• Informational Note No. 1: Examples of additional hazards or increased risk include, but are not limited to, interruption of life-support equipment, deactivation of emergency alarm systems, and shutdown of hazardous location ventilation equipment.

Electrically Safe Work Condition or Energized Work?

130.2(A) Energized Work.

• (2) Infeasibility. Energized work shall be permitted where the employer can demonstrate that the task to be performed is infeasible in a de-energized state due to equipment design or operational limitations.
Electrically Safe Work Condition or Energized Work?

130.2(A) Energized Work.

(2) Infeasibility.

- Informational Note No. 2: Examples of work that might be performed within the limited approach boundary of exposed energized electrical conductors or circuit parts because of infeasibility due to equipment design or operational limitations include performing diagnostics and testing (for example, start-up or troubleshooting) of electric circuits that can only be performed with the circuit energized and work on circuits that form an integral part of a continuous process that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment.

130.2(A) Energized Work.

(3) Less Than 50 Volts.

Energized electrical conductors and circuit parts that operate at less than 50 volts shall not be required to be de-energized where the capacity of the source and any overcurrent protection between the energy source and the worker are considered and it is determined that there will be no increased exposure to electrical burns or to explosion due to electric arcs.
Electrical Safety Program

110.3 Electrical Safety Program

• (A) General. The employer shall implement and document an overall electrical safety program that directs activity appropriate for the electrical hazards, voltage, energy level, and circuit conditions.

Training Requirements

110.2 Training Requirements

• (A) Safety Training. The training requirements contained in this section (1110.2) shall apply to employees who face a risk of electrical hazard that is not reduced to a safe level by the applicable electrical installation requirements.

• Such employees shall be trained to understand the specific hazards associated with electrical energy.
Training Requirements

110.2(A) Safety Training [continued]
• They shall be trained in safety-related work practices and procedural requirements, as necessary, to provide protection from the electrical hazards associated with their respective job or task assignments.
• Employees shall be trained to identify and understand the relationship between electrical hazards and possible injury.

Training Documentation

110.2(E) Training Documentation
• The employer shall document that each employee has received the training required by 110.2(D).
• This documentation shall be made when the employee demonstrates proficiency in the work practices involved and shall be maintained for the duration of the employee’s employment.
• The documentation shall contain the content of the training, each employee’s name, and dates of training.
Energized Electrical Work Permit

• 130.2(B) Energized Electrical Work Permit.

• (1) When Required. When working within the limited approach boundary or the arc flash boundary of exposed energized electrical conductors or circuit parts that are not placed in an electrically safe work condition…, work to be performed shall be considered energized electrical work and shall be performed by written permit only.

Sample Permit from NFPA 70E Annex J
Energized Electrical Work Permit

130.2(B)(3) Exemptions to Work Permit.

- Work performed within the limited approach boundary of energized electrical conductors or circuit parts by qualified persons related to tasks such as testing, troubleshooting, and voltage measuring shall be permitted to be performed without an energized electrical work permit, if appropriate safe work practices and personal protective equipment in accordance with Chapter 1 are provided and used.

- If the purpose of crossing the limited approach boundary is only for visual inspection and the restricted approach boundary will not be crossed, then an energized electrical work permit shall not be required.

Job Briefing

110.3(G) Job Briefing

- (1) General. Before starting each job, the employee in charge shall conduct a job briefing with the employees involved.

- The briefing shall cover such subjects as hazards associated with the job, work procedures involved, special precautions, energy source controls, personal protective equipment requirements, and the information on the energized electrical work permit, if required.

- Additional job briefings shall be held if changes that might affect the safety of employees occur during the course of the work.
130.3(B)(1) Electrical Hazard Analysis.

- If the energized electrical conductors or circuit parts operating at 50 volts or more are not placed in an electrically safe work condition, **other safety-related work practices shall be used** to protect employees who might be exposed to the electrical hazards involved.
- Such work practices shall protect each employee from **arc flash** and from contact with energized electrical conductors or circuit parts operating at 50 volts or more directly with any part of the body or indirectly through some other conductive object.

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130.3(B)(1) Electrical Hazard Analysis.

- Work practices that are used shall be **suitable for the conditions under which the work is to be performed** and for the voltage level of the energized electrical conductors or circuit parts.
- Appropriate safety-related work practices shall be determined before any person is exposed to the electrical hazards involved by using **both shock hazard analysis and arc flash hazard analysis**.
130.4(C)

Approach to Exposed Energized Electrical Conductors or Circuit Parts Operating at 50 Volts or More.

- **No qualified person shall approach** or take any conductive object closer to exposed energized electrical conductors or circuit parts operating at 50 volts or more **than the restricted approach boundary** set forth in Table 130.4(C)(a) and Table 130.4(C)(b), unless…

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**Table 130.4(C)(a), in part**

<table>
<thead>
<tr>
<th>Nominal System Voltage Range, Phase to Phase*</th>
<th>Limited Approach Boundary*</th>
<th>Exposed Movable Conductor*</th>
<th>Exposed Fixed Circuit Part</th>
<th>Restricted Approach Boundary*, Includes Insulator Movement Adder</th>
<th>Prohibited Approach Boundary*</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;50 V</td>
<td>Not specified</td>
<td>Not specified</td>
<td>Not specified</td>
<td>Not specified</td>
<td>Not specified</td>
</tr>
<tr>
<td>50 V–300 V</td>
<td>3 ft (0.91 m)</td>
<td>1 ft (0.30 m)</td>
<td>Avoid contact</td>
<td>Avoid contact</td>
<td></td>
</tr>
<tr>
<td>301 V–750 V</td>
<td>3 ft (0.91 m)</td>
<td>1 ft (0.30 m)</td>
<td>Avoid contact</td>
<td>Avoid contact</td>
<td></td>
</tr>
<tr>
<td>751 V–15 kV</td>
<td>3 ft (0.91 m)</td>
<td>1 ft (0.30 m)</td>
<td>Avoid contact</td>
<td>Avoid contact</td>
<td></td>
</tr>
<tr>
<td>15 kV–36 kV</td>
<td>3 ft (0.91 m)</td>
<td>1 ft (0.30 m)</td>
<td>Avoid contact</td>
<td>Avoid contact</td>
<td></td>
</tr>
<tr>
<td>36 kV–46 kV</td>
<td>3 ft (0.91 m)</td>
<td>2 ft (0.61 m)</td>
<td>Avoid contact</td>
<td>Avoid contact</td>
<td></td>
</tr>
<tr>
<td>46 kV–72.5 kV</td>
<td>3 ft (0.91 m)</td>
<td>2 ft (0.61 m)</td>
<td>Avoid contact</td>
<td>Avoid contact</td>
<td></td>
</tr>
<tr>
<td>72 kV–145 kV</td>
<td>3 ft (0.91 m)</td>
<td>2 ft (0.61 m)</td>
<td>Avoid contact</td>
<td>Avoid contact</td>
<td></td>
</tr>
<tr>
<td>145 kV–230 kV</td>
<td>3 ft (0.91 m)</td>
<td>2 ft (0.61 m)</td>
<td>Avoid contact</td>
<td>Avoid contact</td>
<td></td>
</tr>
</tbody>
</table>
130.4(D)

**Approach by Unqualified Persons**

- Unless permitted by 130.4(D)(2), no unqualified person shall be permitted to approach nearer than the limited approach boundary of energized conductors and circuit parts.

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**Table 130.4(C)(a), in part**

<table>
<thead>
<tr>
<th>Nominal System Voltage Range, Phase to Phase</th>
<th>Limited Approach Boundary*</th>
<th>Exposed Movable Conductor*</th>
<th>Exposed Fixed Circuit Part</th>
<th>Restricted Approach Boundary**: Includes Inadvertent Movement Adder</th>
<th>Prohibited Approach Boundary**</th>
</tr>
</thead>
<tbody>
<tr>
<td>301 V–750 V</td>
<td>3.0 m (10 ft 0 in.)</td>
<td>1.0 m (3 ft 6 in.)</td>
<td>0.3 m (1 ft 0 in.)</td>
<td>25 mm (0 ft 1 in.)</td>
<td></td>
</tr>
</tbody>
</table>

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Note: For arc flash boundary, see 130.5(A).

* For single-phase systems, select the range that is equal to the system’s maximum phase-to-ground voltage multiplied by 1.732.

**: Includes Inadvertent Movement Adder

***This term describes a condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.
130.4(D)

Approach by Unqualified Persons

• (1) Working At or Close to the Limited Approach Boundary. Where one or more unqualified persons are working at or close to the limited approach boundary, the designated person in charge of the work space where the electrical hazard exists shall advise the unqualified person(s) of the electrical hazard and warn him or her to stay outside of the limited approach boundary.

• (2) Entering the Limited Approach Boundary. Where there is a need for an unqualified person(s) to cross the limited approach boundary, a qualified person shall advise him or her of the possible hazards and continuously escort the unqualified person(s) while inside the limited approach boundary. Under no circumstance shall the escorted unqualified person(s) be permitted to cross the restricted approach boundary.
130.5

An arc flash hazard analysis shall determine:

• the arc flash boundary,
• the incident energy at the working distance, and
• the personal protective equipment that people within the arc flash boundary shall use.

130.5

• The arc flash hazard analysis shall be updated when a major modification or renovation takes place.
• It shall be reviewed periodically, not to exceed 5 years, to account for changes in the electrical distribution system that could affect the results of the arc flash hazard analysis.
130.5

• The arc flash hazard analysis shall take into consideration the design of the overcurrent protective device and its opening time, including its condition of maintenance.

Exception: The requirements of 130.7(C)(15) and 130.7(C)(16) shall be permitted to be used in lieu of determining the incident energy at the working distance.
Components of an Arc Flash Hazard Analysis

There are three (3) components to an arc flash hazard analysis.

- (A) Arc Flash Boundary
- (B) Protective Clothing and Other Personal Protective Equipment
- (C) Equipment Labeling

Arc Flash Boundary

130.5(A) Arc Flash Boundary

- The arc flash boundary for systems 50 volts and greater shall be **the distance at which the incident energy equals 1.2 cal/cm²**.
Protective Clothing and Other Personal Protective Equipment

130.5(B) Protective Clothing and Other Personal Protective Equipment (PPE) for Application with an Arc Flash Hazard Analysis.

• Where it has been determined that work will be performed within the arc flash boundary, one of the following methods shall be used for the selection of protective clothing and other personal protective equipment (PPE):

130.5(B)(1) Incident Energy Analysis

• The incident energy analysis shall determine, and the employer shall document, the incident energy exposure of the worker (in calories per square centimeter).

• The incident energy exposure level shall be based on the working distance of the employee’s face and chest areas from a prospective arc source for the specific task to be performed.
Protective Clothing and Other Personal Protective Equipment

130.5(B)(1) Incident Energy Analysis

- Arc-rated clothing and other PPE shall be used by the employee based on the incident energy exposure associated with the specific task.
- Recognizing that incident energy increases as the distance from the arc flash decreases, additional PPE shall be used for any parts of the body that are closer than the distance at which the incident energy was determined.

130.5(B)(2) Hazard/Risk Categories

- The requirements of 130.7(C)(15) and 130.7(C)(16) shall be permitted to be used for the selection and use of personal and other protective equipment.
Equipment Labeling

130.5(C) Equipment Labeling

- Electrical equipment such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are in other than dwelling units, and are likely to require examination, adjustment, servicing, or maintenance while energized, shall be field marked with a label containing all the following information:

130.5(C) Equipment Labeling

- (1) At least one of the following:
  a. Available incident energy and the corresponding working distance
  b. Minimum arc rating of clothing
  c. Required level of PPE
  d. Highest Hazard/Risk Category (HRC) for the equipment
Equipment Labeling

130.5(C) Equipment Labeling
(2) Nominal system voltage
(3) Arc flash boundary

Exception: Labels applied prior to September 30, 2011, are acceptable if they contain the available incident energy or required level of PPE.

• The method of calculating and data to support the information for the label shall be documented.

Personal and Other Protective Equipment

130.7 Personal and Other Protective Equipment

• (A) General. Employees working in areas where electrical hazards are present shall be provided with, and shall use, protective equipment that is designed and constructed for the specific part of the body to be protected and for the work to be performed.
Personal and Other Protective Equipment

130.7(B) Care of Equipment

• Protective equipment shall be maintained in a safe, reliable condition.
• The protective equipment shall be visually inspected before each use.
• Protective equipment shall be stored in a manner to prevent damage from physically damaging conditions and from moisture, dust, or other deteriorating agents.

Personal Protective Equipment

130.7(C) Personal Protective Equipment

• (1) General. When an employee is working within the restricted approach boundary, the worker shall wear personal protective equipment in accordance with 130.4. (shock protection)
• When an employee is working within the arc flash boundary, he or she shall wear protective clothing and other personal protective equipment in accordance with 130.5. (arc flash protection)
• All parts of the body inside the arc flash boundary shall be protected.
Personal Protective Equipment

130.7(C)(6) Body Protection

• Employees shall wear arc-rated clothing wherever there is possible exposure to an electric arc flash above...1.2 cal/cm²

130.7(C)(9) Factors in Selection of Protective Clothing, in part

• Clothing and equipment that provide worker protection from shock and arc flash hazards shall be used.
• If arc-rated clothing is required, it shall cover associated parts of the body as well as all flammable apparel while allowing movement and visibility.
Personal Protective Equipment

130.7(C)(9) Factors in Selection of Protective Clothing

• (b) Outer Layers. Garments worn as outer layers over arc-rated clothing, such as jackets or rainwear, shall also be made from arc-rated material.

• (c) Underlayers. Meltable fibers such as acetate, nylon, polyester, polypropylene, and spandex shall not be permitted in fabric underlayers (underwear) next to the skin. Exception: An incidental amount of elastic used on nonmelting fabric underwear or socks shall be permitted.

Personal Protective Equipment

130.7(C)(9)(d) Coverage

• Clothing shall cover potentially exposed areas as completely as possible.

• Shirt sleeves shall be fastened at the wrists, and shirts and jackets shall be closed at the neck.
Arc Flash Protective Equipment

130.7(C)(10)(b) Head Protection

- (1) An arc-rated balaclava shall be used with an arc-rated faceshield when the back of the head is within the arc flash boundary.
- An arc-rated hood shall be permitted to be used instead of an arc-rated faceshield and balaclava.
- (2) An arc-rated hood shall be used when the anticipated incident energy exposure exceeds 12 cal/cm².

Arc Flash Protective Equipment

130.7(C)(13) Care and Maintenance of Arc-Rated Clothing and Arc-Rated Arc Flash Suits

- (a) Inspection. Arc-rated apparel shall be inspected before each use.
- Work clothing or arc flash suits that are contaminated, or damaged to the extent that their protective qualities are impaired, shall not be used.
- Protective items that become contaminated with grease, oil, or flammable liquids or combustible materials shall not be used.
Arc Flash Protective Equipment

130.7(C)(13) Care and Maintenance of Arc-Rated Clothing and Arc-Rated Arc Flash Suits

• (b) Manufacturer’s Instructions. The garment manufacturer’s instructions for care and maintenance of arc-rated apparel shall be followed.

• (c) Storage. Arc-rated apparel shall be stored in a manner that prevents physical damage; damage from moisture, dust, or other deteriorating agents; or contamination from flammable or combustible materials.

Arc Flash Protective Equipment

130.7(C)(13)(d) Cleaning, Repairing, and Affixing Items

• When arc-rated clothing is cleaned, manufacturer’s instructions shall be followed to avoid loss of protection.

• When arc-rated clothing is repaired, the same arc-rated materials used to manufacture the arc-rated clothing shall be used to provide repairs.

• When trim, name tags, or logos, or any combination thereof, are affixed to arc-rated clothing, guidance in ASTM F 1506 shall be followed.
Standards for Personal Protective Equipment (PPE)

130.7(C)(14) Standards for Personal Protective Equipment (PPE)

• Personal protective equipment (PPE) shall conform to the standards given in Table 130.7(C)(14).

Table 130.7(C)(14), in part

<table>
<thead>
<tr>
<th>Subject</th>
<th>Document Title</th>
<th>Document Number and Revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparel — Arc Rated</td>
<td>Standard Performance Specification for Flame Resistant and Arc Rated Textile</td>
<td>ASTM F 1506-10a</td>
</tr>
<tr>
<td></td>
<td>Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Electric Arc and Related Thermal Hazards</td>
<td></td>
</tr>
<tr>
<td>Eye and Face Protection</td>
<td>General Practice for Occupational and Educational Eye and Face Protection</td>
<td>ANSI/ASSE Z87.1-2003</td>
</tr>
<tr>
<td></td>
<td>Face — Arc Rated</td>
<td>ASTM F 2178-08</td>
</tr>
<tr>
<td></td>
<td>for Face Protective Products</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mittens</td>
<td></td>
</tr>
<tr>
<td>Gloves — Rubber Insulating</td>
<td>Standard Specification for Rubber Insulating Gloves</td>
<td>ASTM D 120@09</td>
</tr>
<tr>
<td>Head Protection — Hard Hat</td>
<td>Personal Protection — Protective Headwear for Industrial Workers</td>
<td>ANSI/ISEA Z89.1-2009</td>
</tr>
<tr>
<td>Rainwear — Arc Rated</td>
<td>Standard Specification for Arc and Flame Resistant Rainwear</td>
<td>ASTM F 1891 - 06</td>
</tr>
</tbody>
</table>
Other Protective Equipment

130.7(D)(1) Insulated Tools and Equipment

• Employees shall use insulated tools or handling equipment, or both, when working inside the limited approach boundary of exposed energized electrical conductors or circuit parts where tools or handling equipment might make accidental contact.

• Table 130.7(C)(15)(a) and Table 130.7(C)(15)(b) provide further information for tasks that require insulated and insulating hand tools.

• Insulated tools shall be protected from damage to the insulating material.

130.7(F) Standards for Other Protective Equipment

• Other protective equipment required in 130.7(D) shall conform to the standards given in Table 130.7(F).
### Table 130.7(F), in part

<table>
<thead>
<tr>
<th>Subject</th>
<th>Document</th>
<th>Document Number and Revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blankets</td>
<td>Standard Specification for Rubber Insulating Blankets</td>
<td>ASTM D1088-05</td>
</tr>
<tr>
<td>Blankets — In-service Care</td>
<td>Standard Specification for In-Service Care of Insulating Blankets</td>
<td>ASTM F 479-06</td>
</tr>
<tr>
<td>Temporary Protective Grounds — Test Specification</td>
<td>Standard Specifications for Temporary Protective Grounds to Be Used on De-energized Electric Power Lines and Equipment</td>
<td>ASTM F 855-09</td>
</tr>
</tbody>
</table>

### 130.7(C)(15)

[see next two slides]
130.7(C)(15)

Selection of Personal Protective Equipment...

• Where selected in lieu of the incident energy analysis..., Table 130.7(C)(15)(a) and Table 130.7(C)(15)(b) shall be used to determine the hazard/risk category and requirements for use of rubber insulating gloves and insulated and insulating hand tools for a task. [1 of 2]

130.7(C)(15)

• The assumed maximum short-circuit current capacities and maximum fault clearing times for various tasks are listed in Table 130.7(C)(15)(a).

• For tasks not listed, or for power systems with greater than the assumed maximum short-circuit current capacity or with longer than the assumed maximum fault clearing times, an incident energy analysis shall be required in accordance with 130.5. [2 of 2]
Table 130.7(C)(15)(a)

Table 130.7(C)(15)(a) Hazard/Risk Category Classifications and Use of Rubber Insulating Gloves and Insulated and Insulating Hand Tools—Alternating Current Equipment (Formerly Table 130.7(C)(b))

<table>
<thead>
<tr>
<th>Tasks Performed on Energized Equipment</th>
<th>Hazard/Risk Category</th>
<th>Rubber Insulating Gloves</th>
<th>Insulated and Insulating Hand Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panelboards or other equipment rated 240 V and below</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parameters:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum of 25 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time; minimum 18 in. working distance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 19 in.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perform infrared thermography and other non-contact inspections outside the restricted approach boundary</td>
<td></td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Circuit breaker (CB) or fused switch operation with covers on</td>
<td></td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>CB or fused switch operation with covers off</td>
<td></td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Work on energized electrical conductors and circuit parts, including voltage testing</td>
<td></td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Remove/install CBs or fused switches</td>
<td></td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Removal of hinged covers (to expose bare, energized electrical conductors and circuit parts)</td>
<td></td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)</td>
<td></td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard</td>
<td></td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>

(5) For power systems up to 600 V the arc flash boundary was determined by using the following information: When 0.03 second trip time was used, that indicated MCC or panelboard equipment protected by a molded-case circuit breaker. Working distance was used: 18 in. (455 mm). Arc gap was used was 32 mm for switchgear and 25 mm for MCC and protective device type 0 for all. When 0.33 or 0.5 second trip time was used, that indicated a LVPCB (drawout circuit breaker) in switchgear. Working distance was 24 in. (610 mm). Arc gap was used was 32 mm and protective device type 0 for all. All numbers were rounded up or down depending on closest multiple of 5.
Selecting Protective Equipment per Table 130.7(C)(15)(a)

Panelboards or other equipment rated 240 V and below

Work on energized electrical conductors and circuit parts, including voltage testing

|   | Y | Y |

Table 130.7(C)(15)(a)
Notes, in part

Y = Yes (required); N: No (not required).

Notes:
(1) Rubber insulating gloves are gloves rated for the maximum line-to-line voltage upon which work will be done.
(2) Insulated and insulating hand tools are tools rated and tested for the maximum line-to-line voltage upon which work will be done, and are manufactured and tested in accordance with ASTM F 1505, Standard Specification for Insulated and Insulating Hand Tools.
(3) The use of “N” does not indicate that rubber insulating gloves and insulated and insulating hand tools are not required in all cases. Rubber insulating gloves and insulated and insulating hand tools may be required by 130.4, 130.8 (C) (7), and 130.8 (D).
Selecting Protective Equipment per Table 130.7(C)(16)

1 Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm² (See Note 3.)
   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)
1 Protective Equipment
   Hard hat
   Safety glasses or safety goggles (SR)
   Hearing protection (ear canal inserts)
   Heavy duty leather gloves (See Note 1.)
   Leather work shoes (AN)

AN: as needed (optional). AR: as required. SR: selection required.
Notes:
(1) If rubber insulating gloves with leather protectors are required by Table 100.7(C)(9), additional leather or arc-rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement.
(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) Arc rating defined in Article 100 and can be either the arc thermal performance value (ATPV) or energy of break open threshold (E50). ATPV is defined in ASTM F 1506, Standard Test Method for Determining the Arc Thermal Performance Value of Materials for Clothing, as the incident energy on a material, or a multilayer system of materials, that results in a 50 percent probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second-degree skin burn injury based on the Soll curve, in cal/cm². E50 is defined in ASTM F 1506 as the incident energy on a material or multilayer system that results in a 50 percent probability of break-open. Arc rating is reported as either ATPV or EBT, whichever is the lower value.
Selecting Protective Equipment Using the Tables

Example 1

- Task is operating a circuit breaker with the cover on in a 240 V panelboard

- 26,000 amps available
- 1 cycle clearing time
- Well-maintained OCPD
Table 130.7(C)(15)(a)

<table>
<thead>
<tr>
<th>Tasks Performed on Energized Equipment</th>
<th>Hazard/Risk Category</th>
<th>Rubber Insulating Gloves</th>
<th>Insulated and Insulating Hand Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panelboards or other equipment rated 240 V and below Parameters:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum of 25 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time; minimum 18 in. working distance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 19 in.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perform infrared thermography and other non-contact inspections outside the restricted approach boundary</td>
<td>0</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Circuit breaker (CB) or fused switch operation with covers on</td>
<td>0</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>CB or fused switch operation with covers off</td>
<td>0</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Work on energized electrical conductors and circuit parts, including voltage testing</td>
<td>1</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Remove/install CBs or fused switches</td>
<td>1</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Removal of hinged covers (to expose bare, energized electrical conductors and circuit parts)</td>
<td>1</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)</td>
<td>0</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard</td>
<td>1</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>

(5) For power systems up to 600 V the arc flash boundary was determined by using the following information: When 0.03 second trip time was used, that indicated MCC or panelboard equipment protected by a molded-case circuit breaker. Working distance used was 18 in. (455 mm). Arc gap used was 32 mm for switchgear and 25 mm for MCC and protective device type 0 for all. When 0.33 or 0.5 second trip time was used, that indicated a LVPCB (drawout circuit breaker) in switchgear. Working distance was 24 in. (610 mm). Arc gap used was 32 mm and protective device type 0 for all. All numbers were rounded up or down depending on closest multiple of 5.
Example 2

• Task is operating a circuit breaker with the cover **off** in a 240 V panelboard

• **22,600** amps available
• **6 cycle clearing time**
• Well-maintained OCPD

---

Table 130.7(C)(15)(a)

<table>
<thead>
<tr>
<th>Tasks Performed on Energized Equipment</th>
<th>Hazard/Risk Category</th>
<th>Rubber Insulating Gloves</th>
<th>Insulating and Insulating Hand Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panelboards or other equipment rated 240 V and below</td>
<td>0</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Perform infrared thermography and other non-contact inspections outside the restricted approach boundary</td>
<td>0</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Circuit breaker (CB) or fixed switch operation with covers on</td>
<td>0</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>CB or fixed switch operation with covers off</td>
<td>0</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Work on energized electrical conductors and circuit parts, including voltage testing</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Removal/install CBs or fixed switches</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Removal of hinged covers (to expose bare, energized electrical conductors and circuit parts)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>
Table 130.7(C)(15)(a)

Panelboards or other equipment rated 240 V and below
Parameters: Maximum of 25 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time; minimum 18 in. working distance Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 19 in.

(5) For power systems up to 600 V the arc flash boundary was determined by using the following information: When 0.03 second trip time was used, that indicated MCC or panelboard equipment protected by a molded-case circuit breaker. Working distance used was 18 in. (455 mm). Arc gap used was 32 mm for switchgear and 25 mm for MCC and protective device type 0 for all. When 0.33 or 0.5 second trip time was used, that indicated a LVPCB (drawout circuit breaker) in switchgear. Working distance was 24 in. (610 mm). Arc gap used was 32 mm and protective device type 0 for all. All numbers were rounded up or down depending on closest multiple of 5.

Example 3

• Task is voltage testing in a 240 V panelboard

• 22,600 amps available

• 1 cycle clearing time

• Well-maintained OCPD
Table 130.7(C)(15)(a)

<table>
<thead>
<tr>
<th>Tasks Performed on Energized Equipment</th>
<th>Hazard/Risk Category</th>
<th>Rubber Insulating Gloves</th>
<th>Insulated and Insulating Hand Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panelboards or other equipment rated 240 V and below Parameters:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum of 25 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time; minimum 18 in. working distance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 19 in.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perform infrared thermography and other non-contact inspections outside the restricted approach boundary</td>
<td>0</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Circuit breaker (CB) or fused switch operation with cover off</td>
<td>0</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>CB or fused switch operation with covers on</td>
<td>0</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Work on energized electrical conductors and circuit parts, including voltage testing</td>
<td>1</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Remove/install CBs or fused switches</td>
<td>1</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)</td>
<td>1</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)</td>
<td>0</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard</td>
<td>1</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>

(5) For power systems up to 600 V the arc flash boundary was determined by using the following information: When 0.03 second trip time was used, that indicated MCC or panelboard equipment protected by a molded-case circuit breaker. Working distance used was 18 in (455 mm). Arc gap used was 32 mm for switchgear and 25 mm for MCC and protective device type 0 for all. When 0.33 or 0.5 second trip time was used, that indicated a LVPCB (drawout circuit breaker) in switchgear. Working distance was 24 in. (610 mm). Arc gap used was 32 mm and protective device type 0 for all. All numbers were rounded up or down depending on closest multiple of 5.
Selecting Protective Equipment per Table 130.7(C)(15)(a)

Panelboards or other equipment rated 240 V and below

Work on energized electrical conductors and circuit parts, including voltage testing

|   | Y | Y |

Selecting Protective Equipment per Table 130.7(C)(16)

1. Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm² (See Note 3.)
   - 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)

1. Protective Equipment
   - Hard hat
   - Safety glasses or safety goggles (SR)
   - Hearing protection (ear canal inserts)
   - Heavy duty leather gloves (See Note 1.)
   - Leather work shoes (AN)
Example 4

• Task is voltage testing in a 480 V panelboard

• 22,600 amps available
• 2 cycle clearing time
• Well-maintained OCPD

Table 130.7(C)(15)(a)

Panelboards or other equipment rated > 240 V and up to 600 V
Parameters:
Maximum of 25 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time; minimum 18 in. working distance
Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 30 in.

Work on energized electrical conductors and circuit parts, including voltage testing

| 2 | Y | Y |
Table 130.7(C)(15)(a)
Notes, in part

Y = Yes (required). N: No (not required).

Notes:
1. Rubber insulating gloves are gloves rated for the maximum line-to-line voltage upon which work will be done.
2. Insulated and insulating hand tools are tools rated and tested for the maximum line-to-line voltage upon which work will be done, and are manufactured and tested in accordance with ASTM F 1505, Standard Specification for Insulated and Insulating Hand Tools.
3. The use of “N” does not indicate that rubber insulating gloves and insulated and insulating hand tools are not required in all cases. Rubber insulating gloves and insulated and insulating hand tools may be required by 130.4, 130.8(C) (7), and 130.8(D).

Selecting Protective Equipment per Table 130.7(C)(16)

2. Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm² (See Note 3.)
   - 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 cordura hat liner (AN)

Protective Equipment
- Hard hat
- Safety glasses or safety goggles (SR)
- Hearing protection (ear canal inserts)
- Heavy duty leather gloves (See Note 1.)
- Leather work shoes
Example 5

- Task is inserting a bucket into a MCC
- 36,000 amps available
- 10 cycle clearing time
- Well-maintained OCPD

Table 130.7(C)(15)(a)

600 V class motor control centers (MCCs)
Parameters:
  Maximum of 42 kA short circuit current available; maximum of 0.33 sec (20 cycle) fault clearing time; minimum 18 in. working distance
Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 165 in.

Insertion or removal of individual starter “buckets” from MCC

Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)

<table>
<thead>
<tr>
<th></th>
<th>Y</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>
Selecting Protective Equipment per Table 130.7(C)(16)

<table>
<thead>
<tr>
<th>Hazard/Risk Category</th>
<th>Protective Clothing and PPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm² (See Note 3)</td>
</tr>
<tr>
<td></td>
<td>Arc-rated long-sleeve shirt (AR)</td>
</tr>
<tr>
<td></td>
<td>Arc-rated pants (AR)</td>
</tr>
<tr>
<td></td>
<td>Arc-rated coverall (AR)</td>
</tr>
<tr>
<td></td>
<td>Arc-rated arc flash suit jacket (AR)</td>
</tr>
<tr>
<td></td>
<td>Arc-rated arc flash suit pants (AR)</td>
</tr>
<tr>
<td></td>
<td>Arc-rated arc flash suit hood</td>
</tr>
<tr>
<td></td>
<td>Arc-rated gloves (See Note 1)</td>
</tr>
<tr>
<td></td>
<td>Arc-rated jacket, parka, rainwear, or hard hat liner (AN)</td>
</tr>
<tr>
<td></td>
<td>Protective Equipment</td>
</tr>
<tr>
<td></td>
<td>Hard hat</td>
</tr>
<tr>
<td></td>
<td>Safety glasses or safety goggles (SR)</td>
</tr>
<tr>
<td></td>
<td>Hearing protection (ear canal inserts)</td>
</tr>
<tr>
<td></td>
<td>Leather work shoes</td>
</tr>
</tbody>
</table>

Summary

- Recall which requirements of Article 130 apply when the Hazard/Risk Tables are used to select PPE.
- Discuss the conditions under which energized work shall be permitted.
- Recall the documentation requirements covered.
- Explain the components of an arc flash hazard analysis.
- Identify a Hazard/Risk Category and PPE for a task.
Questions

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