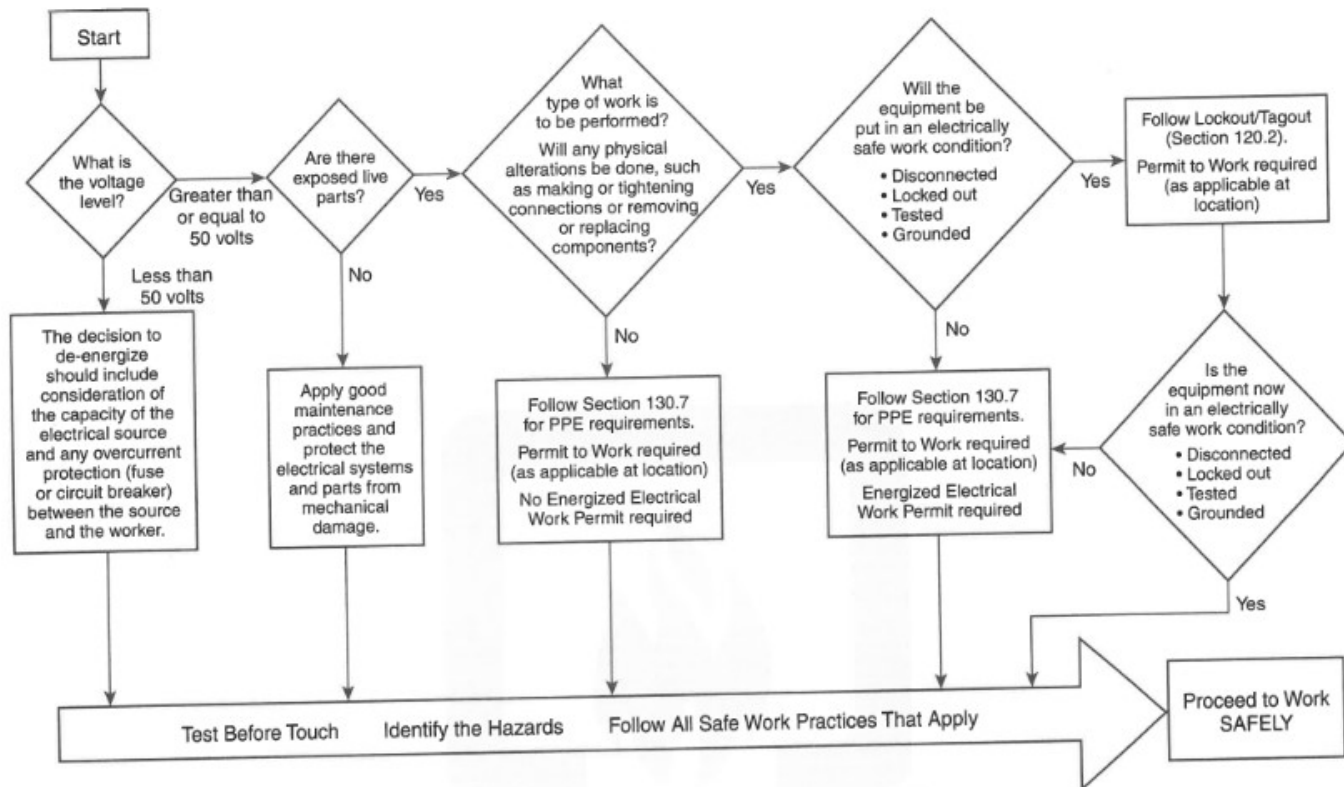


# Energized Work Permit Flow Chart

## INFORMATIVE ANNEX J

**J.2 Energized Electrical Work Permit.** Figure J.2 illustrates items to consider when determining the need for an energized electrical work permit.



**FIGURE J.2 Energized Electrical Work Permit Flow Chart.**

Shaded text = Revisions. Δ = Text deletions and figure/table revisions. • = Section deletions. N = New material.

70E-81

### #3 a, b Approach Boundaries – Table 130.4(E)(a)

130.4

ARTICLE 130 — WORK INVOLVING ELECTRICAL HAZARDS

Δ Table 130.4(E)(a) **Electric Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts for Alternating-Current Systems**

(1)	(2)	(3)	(4)
Nominal System Voltage Range, Phase to Phase <sup>a</sup>	Limited Approach Boundary <sup>b</sup>		Restricted Approach Boundary <sup>b,d</sup> ; Includes Inadvertent Movement Adder
	Exposed Movable Conductor <sup>c</sup>	Exposed Fixed Circuit Part	
Less than 50 V	Not specified	Not specified	Not specified
50 V–150 V <sup>e</sup>	3.1 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	Avoid contact
151 V–750 V	3.1 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	0.31 m (1 ft 0 in.)
751 V–5 kV	3.1 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	0.63 m (2 ft 1 in.)
5.1 kV–15 kV	3.1 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	0.65 m (2 ft 2 in.)
15.1 kV–36 kV	3.1 m (10 ft 0 in.)	1.8 m (6 ft 0 in.)	0.77 m (2 ft 7 in.)
36.1 kV–46 kV	3.1 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	0.84 m (2 ft 10 in.)
46.1 kV–72.5 kV	3.1 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 4 in.)
72.6 kV–121 kV	3.3 m (10 ft 8 in.)	2.5 m (8 ft 0 in.)	1.2 m (3 ft 9 in.)
121.1 kV–145 kV	3.4 m (11 ft 0 in.)	3.1 m (10 ft 0 in.)	1.3 m (4 ft 4 in.)
145.1 kV–169 kV	3.6 m (11 ft 8 in.)	3.6 m (11 ft 8 in.)	1.5 m (4 ft 10 in.)
169.1 kV–242 kV	4.0 m (13 ft 0 in.)	4.0 m (13 ft 0 in.)	2.1 m (6 ft 8 in.)
242.1 kV–362 kV	4.7 m (15 ft 4 in.)	4.7 m (15 ft 4 in.)	3.5 m (11 ft 2 in.)
362.1 kV–420 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)	4.3 m (14 ft 0 in.)
420.1 kV–550 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)	5.1 m (16 ft 8 in.)
550.1 kV–800 kV	7.2 m (23 ft 9 in.)	7.2 m (23 ft 9 in.)	6.9 m (22 ft 7 in.)

Notes:

(1) For arc flash boundary, see 130.5(E).

(2) All dimensions are distance from exposed energized electrical conductors or circuit part to employee.

<sup>a</sup>For single-phase systems above 250 volts, select the range that is equal to the system's maximum phase-to-ground voltage multiplied by 1.732.

<sup>b</sup>See definition in Article 100 and text in 130.4(F) (3) and Informative Annex C for elaboration.

<sup>c</sup>*Exposed movable conductors* 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.

<sup>d</sup>The restricted approach boundary in Column 4 is based on an elevation not exceeding 900 m (3000 ft). For higher elevations, adjustment of the restricted approach boundary shall be considered.

<sup>e</sup>This includes circuits where the exposure does not exceed 120 volts nominal.

Δ Table 130.4(E)(b) **Electric Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts for Direct-Current Voltage Systems**

(1)	(2)	(3)	(4) <sup>b</sup>
Nominal Potential Difference	Limited Approach Boundary		Restricted Approach Boundary; Includes Inadvertent Movement Adder
	Exposed Movable Conductor <sup>**</sup>	Exposed Fixed Circuit Part	
Less than 50 V	Not specified	Not specified	Not specified
50 V–300 V	3.1 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	Avoid contact
301 V–1 kV	3.1 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	0.3 m (1 ft 0 in.)
1.1 kV–5 kV	3.1 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	0.5 m (1 ft 5 in.)
5.1 kV–15 kV	3.1 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	0.7 m (2 ft 2 in.)
15.1 kV–45 kV	3.1 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	0.8 m (2 ft 9 in.)
45.1 kV– 75 kV	3.1 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 6 in.)
75.1 kV–150 kV	3.3 m (10 ft 8 in.)	3.1 m (10 ft 0 in.)	1.2 m (3 ft 10 in.)
150.1 kV–250 kV	3.6 m (11 ft 8 in.)	3.6 m (11 ft 8 in.)	1.6 m (5 ft 3 in.)
250.1 kV–500 kV	6.0 m (20 ft 0 in.)	6.0 m (20 ft 0 in.)	3.5 m (11 ft 6 in.)
500.1 kV–800 kV	8.0 m (26 ft 0 in.)	8.0 m (26 ft 0 in.)	5.0 m (16 ft 5 in.)

Note: All dimensions are distance from exposed energized electrical conductors or circuit parts to worker.

<sup>\*\*</sup>*Exposed movable conductor* 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.

<sup>b</sup>The restricted approach boundary in Column 4 is based on an elevation not exceeding 900 m (3000 ft). For higher elevations, adjustment of the restricted approach boundary shall be considered.

### #3(a), #4(b) Personal Protective Equipment (PPE) Table 130.7(C)(15)(c)

130.7

ARTICLE 130 — WORK INVOLVING ELECTRICAL HAZARDS

**Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)**

Arc-Flash PPE Category	PPE
1	<p><b>Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm<sup>2</sup> (16.75 J/cm<sup>2</sup>)<sup>a</sup></b>            Arc-rated long-sleeve shirt and pants or arc-rated coverall            Arc-rated face shield<sup>b</sup> or arc flash suit hood            Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN)<sup>f</sup>  <b>Protective Equipment</b>            Hard hat            Safety glasses or safety goggles (SR)            Hearing protection (ear canal inserts)<sup>c</sup>            Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with protectors (SR)<sup>d</sup>            Leather footwear<sup>e</sup> (AN)</p>
2	<p><b>Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm<sup>2</sup> (33.5 J/cm<sup>2</sup>)<sup>a</sup></b>            Arc-rated long-sleeve shirt and pants or arc-rated coverall            Arc-rated flash suit hood or arc-rated face shield<sup>b</sup> and arc-rated balaclava            Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN)<sup>f</sup>  <b>Protective Equipment</b>            Hard hat            Safety glasses or safety goggles (SR)            Hearing protection (ear canal inserts)<sup>c</sup>            Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with protectors (SR)<sup>d</sup>            Leather footwear<sup>e</sup></p>
3	<p><b>Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm<sup>2</sup> (104.7 J/cm<sup>2</sup>)<sup>a</sup></b>            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 or rubber insulating gloves with protectors (SR)<sup>d</sup>            Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN)<sup>f</sup>  <b>Protective Equipment</b>            Hard hat            Safety glasses or safety goggles (SR)            Hearing protection (ear canal inserts)<sup>c</sup>            Leather footwear<sup>e</sup></p>
4	<p><b>Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm<sup>2</sup> (167.5 J/cm<sup>2</sup>)<sup>a</sup></b>            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 or rubber insulating gloves with protectors (SR)<sup>d</sup>            Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN)<sup>f</sup>  <b>Protective Equipment</b>            Hard hat            Safety glasses or safety goggles (SR)            Hearing protection (ear canal inserts)<sup>c</sup>            Leather footwear<sup>e</sup></p>

AN: As needed (optional). AR: As required. SR: Selection required.

<sup>a</sup>Arc rating is defined in Article 100.

<sup>b</sup>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.

<sup>c</sup>Other types of hearing protection are permitted to be used in lieu of or in addition to ear canal inserts provided they are worn under an arc-rated arc flash suit hood.

<sup>d</sup>Rubber insulating gloves with protectors provide arc flash protection in addition to electric shock protection. Higher class rubber insulating gloves with protectors, due to their increased material thickness, provide increased arc flash protection.

<sup>e</sup>Footwear other than leather or dielectric shall be permitted to be used provided it has been tested to demonstrate no ignition, melting or dripping at the minimum arc rating for the respective arc flash PPE category.

<sup>f</sup>The arc rating of outer layers worn over arc-rated clothing as protection from the elements or for other safety purposes, and that are not used as part of a layered system, shall not be required to be equal to or greater than the estimated incident energy exposure.

## Arc-Flash Hazard PPE – Table 130.7 (C)(15)(a)

130.7

ARTICLE 130 — WORK INVOLVING ELECTRICAL HAZARDS

**Table 130.7(C)(15)(a) Arc Flash PPE Categories for Alternating Current (ac) Systems**

#4 a and c

Equipment	Arc Flash PPE Category	Arc Flash Boundary
Panelboards or other equipment rated 240 volts and below Parameters: Maximum of 25 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	1	485 mm (19 in.)
Panelboards or other equipment rated greater than 240 volts and up to 600 volts Parameters: Maximum of 25 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	2	900 mm (3 ft)
600-volt class motor control centers (MCCs) Parameters: Maximum of 65 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	2	1.5 m (5 ft)
600-volt class motor control centers (MCCs) Parameters: Maximum of 42 kA available fault current; maximum of 0.33 sec (20 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	4	4.3 m (14 ft)
600-volt class switchgear (with power circuit breakers or fused switches) and 600-volt class switchboards Parameters: Maximum of 35 kA available fault current; maximum of up to 0.5 sec (30 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	4	6 m (20 ft)
Other 600-volt class (277 volts through 600 volts, nominal) equipment Parameters: Maximum of 65 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	2	1.5 m (5 ft)
NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV Parameters: Maximum of 35 kA available fault current; maximum of up to 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36 in.)	4	12 m (40 ft)
Metal-clad switchgear, 1 kV through 15 kV Parameters: Maximum of 35 kA available fault current; maximum of up to 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36 in.)	4	12 m (40 ft)
Metal enclosed interrupter switchgear, fused or unfused type construction, 1 kV through 15 kV Parameters: Maximum of 35 kA available fault current; maximum of 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36 in.)	4	12 m (40 ft)
Other equipment 1 kV through 15 kV Parameters: Maximum of 35 kA available fault current; maximum of up to 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36 in.)	4	12 m (40 ft)
Arc-resistant equipment up to 600-volt class Parameters: DOORS CLOSED and SECURED; with an available fault current and a fault clearing time that does not exceed the arc-resistant rating of the equipment*	N/A	N/A
Arc-resistant equipment 1 kV through 15 kV Parameters: DOORS CLOSED and SECURED; with an available fault current and a fault clearing time that does not exceed the arc-resistant rating of the equipment*	N/A	N/A

N/A: Not applicable

Note:

For equipment rated 600 volts and below and protected by upstream current-limiting fuses or current-limiting molded case circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below arc flash PPE category 1.

\*For DOORS OPEN refer to the corresponding non-arc-resistant equipment section of this table.

Informational Note No. 1 to Table 130.7(C)(15)(a): The following are typical fault clearing times of overcurrent protective devices:

- (1) 0.5 cycle fault clearing time is typical for current-limiting fuses and current-limiting molded case circuit breakers when the fault current is within the current limiting range.
- (2) 1.5 cycle fault clearing time is typical for molded case circuit breakers rated less than 1000 volts with an instantaneous integral trip.
- (3) 3.0 cycle fault clearing time is typical for insulated case circuit breakers rated less than 1000 volts with an instantaneous integral trip or relay operated trip.
- (4) 5.0 cycle fault clearing time is typical for relay operated circuit breakers rated 1 kV to 35 kV when the relay operates in the instantaneous range (i.e., "no intentional delay").
- (5) 20 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay for motor inrush.
- (6) 30 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay without instantaneous trip.

Informational Note No. 2 to Table 130.7(C)(15)(a): See Table 1 of IEEE 1584, *Guide for Performing Arc Flash Hazard Calculations*, for further information regarding list items (2) through (4) in Informational Note No. 1.

Informational Note No. 3 to Table 130.7(C)(15)(a): See IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*, for an example of a standard that provides information for arc-resistant equipment referred to in Table 130.7(C)(15)(a).

Informational Note No. 4 to Table 130.7(C)(15)(a): See **Informative Annex O.2.4(9)** for information on arc-resistant equipment.



## Arc-Flash Hazard PPE – Table 130.7 (C)(15)(b)

**Δ Table 130.7(C)(15)(b) Arc Flash PPE Categories for dc Systems**

Equipment	Arc Flash PPE Category	Arc Flash Boundary
Storage batteries, dc switchboards, and other dc supply sources Parameters: Greater than 150 volts and less than or equal to 600 volts Maximum arc duration and minimum working distance: 2 sec @ 455 mm (18 in.)		
Available fault current less than 1.5 kA	2	900 mm (3 ft)
Available fault current greater than or equal to 1.5 kA and less than 3 kA	2	1.2 m (4 ft)
Available fault current greater than or equal to 3 kA and less than 7 kA	3	1.8 m (6 ft.)
Available fault current greater than or equal to 7 kA and less than 10 kA	4	2.5 m (8 ft)

**Notes:**

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

(a) Be evaluated for electrolyte protection

Informational Note: See ASTM F1296, *Standard Guide for Evaluating Chemical Protective Clothing*, for information on evaluating apparel for protection from electrolyte.

(b) Be arc rated

Informational Note: See ASTM F1891, *Standard Specification for Arc and Flame Resistant Rainwear*, for information on evaluating arc-rated apparel.

(2) A two-second arc duration is assumed if there is no overcurrent protective device (OCPD) or if the fault clearing time is not known. If the fault clearing time is known and is less than 2 seconds, an incident energy analysis could provide a more representative result.

Informational Note No. 1: See D.5 for the basis for table values and alternative methods to determine dc incident energy. Methods should be used with good engineering judgment. When determining available fault current, the effects of cables and any other impedances in the circuit should be included. Power system modeling is the best method to determine the available short-circuit current at the point of the arc. Battery cell short-circuit current can be obtained from the battery manufacturer.

Informational Note No. 2: The methods for estimating the dc arc flash incident energy that were used to determine the categories for this table are based on open-air incident energy calculations. Open-air calculations were used because many battery systems and other dc process systems are in open areas or rooms. If the specific task is within an enclosure, it would be prudent to consider additional PPE protection beyond the value shown in this table.

Informational Note No. 3: See the following references for dc voltages below 150 volts nominal:

(1) J. G. Hildreth and K. Feeney, "Arc Flash Hazards Station Battery Systems," 2018 IEEE Power & Energy Society General Meeting (PESGM), 2018, pp. 1–5.

(2) US Department of Energy Bonneville Power Administration Engineering and Technical Services Report BPA F 5450.05, "DC Arc Flash: 125V, 1300 amp-hour battery," May 11, 2017, doi: 10.1109/PESGM.2018.8586181.

(3) K. Gray, S. Robert, and T. L. Gauthier, "Low Voltage 100–500 Vdc Arc Flash Testing," 2020 IEEE IAS Electrical Safety Workshop (ESW), 2020, pp. 1–7, doi: 10.1109/ESW42757.2020.9188336.

Shaded text = Revisions. Δ = Text deletions and figure/table revisions. • = Section deletions. N = New material.

70E–37

# Safety Related Work Practice Definitions

## Chapter 1 Safety-Related Work Practices



### ARTICLE 100 Definitions

**Scope.** This article contains only those definitions essential to the proper application of this standard. It is not intended to include commonly defined general terms or commonly defined technical terms from related codes and standards. An article number in parentheses following the definition indicates that the definition only applies to that article.

**Accessible (as applied to equipment).** Admitting close approach; not guarded by locked doors, elevation, or other effective means. [70:100]

**Approved.** Acceptable to the authority having jurisdiction.

**Arc Flash Suit.** A complete arc-rated clothing and equipment system that covers the entire body, except for the hands and feet.

Informational Note: An arc flash suit may include pants or overalls, a jacket or a coverall, and a beekeeper-type hood fitted with a face shield.

**Arc Rating.** The value attributed to materials that describes their performance to exposure to an electrical arc discharge. The arc rating is expressed in cal/cm<sup>2</sup> and is derived from the determined value of the arc thermal performance value (ATPV) or energy of breakopen threshold (E<sub>BT</sub>) (should a material system exhibit a breakopen response below the ATPV value). Arc rating is reported as either ATPV or E<sub>BT</sub>, whichever is the lower value.

Informational Note No. 1: Arc-rated clothing or equipment indicates that it has been tested for exposure to an electric arc. Flame-resistant clothing without an arc rating has not been tested for exposure to an electric arc. All arc-rated clothing is also flame resistant.

Informational Note No. 2: See ASTM F1959/F1959M, *Standard Test Method for Determining the Arc Rating of Materials for Clothing*, which defines ATPV as the incident energy (cal/cm<sup>2</sup>) 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 Stoll curve.

**Attachment Plug (Plug Cap) (Plug).** A device that, by insertion in a receptacle, establishes a connection between the conductors of the attached flexible cord and the conductors connected permanently to the receptacle. [70:100]

**Authority Having Jurisdiction (AHJ).** An organization, office, or individual responsible for enforcing the requirements of a

code or standard, or for approving equipment, materials, an installation, or a procedure.

Informational Note: The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

**Authorized Personnel.** The person in charge of the premises, or other persons appointed or selected by the person in charge of the premises who performs certain duties associated with stationary storage batteries. (320)

**Automatic.** Performing a function without the necessity of human intervention.

**Balaclava.** An arc-rated head-protective fabric that protects the neck and head except for a small portion of the facial area.

Informational Note: Some balaclava designs protect the neck and head area except for the eyes while others leave the eyes and nose area unprotected.

**Barricade.** A physical obstruction such as tapes, cones, or A-frame-type wood or metal structures intended to provide a warning and to limit access.

**Barrier.** A physical obstruction that is intended to prevent contact with equipment or energized electrical conductors and circuit parts.

**Battery.** A system consisting of two or more electrochemical cells connected in series or parallel and capable of storing electrical energy received and that can give it back by reconversion. (320)

**Battery Effect.** A voltage that exists on the electrolytic cell line after the power supply is disconnected. (310)

**Bonding Conductor or Jumper.** A reliable conductor to ensure the required electrical conductivity between metal parts required to be electrically connected. [70:100]

Shaded text = Revisions. Δ = Text deletions and figure/table revisions. • = Section deletions. N = New material.

70E-9

**Boundary, Arc Flash. (Arc Flash Boundary)** When an arc flash hazard exists, an approach limit from an arc source at which incident energy equals 1.2 cal/cm<sup>2</sup> (5 J/cm<sup>2</sup>).

Informational Note: According to the Stoll skin burn injury model, the onset of a second degree burn on unprotected skin is likely to occur at an exposure of 1.2 cal/cm<sup>2</sup> (5 J/cm<sup>2</sup>) for one second.

**N Boundary, Hearing Protection. (Hearing Protection Boundary)** Worker distance at which a 1 percent probability of ear damage exists from a 20 kPa (3.0 psi) shock wave. (360)

**Boundary, Limited Approach. (Limited Approach Boundary)** An approach limit at a distance from an exposed energized electrical conductor or circuit part within which an electric shock hazard exists.

**N Boundary, Lung Protection. (Lung Protection Boundary)** Worker distance at which a 1 percent probability of lung damage exists from a 70 kPa (10 psi) shock wave. (360)

**Boundary, Restricted Approach. (Restricted Approach Boundary)** An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased likelihood of electric shock, due to electrical arc-over combined with inadvertent movement.

**Building.** A structure that stands alone or that is cut off from adjoining structures by fire walls with all openings therein protected by approved fire doors. [70:100]

**Cabinet.** An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung. [70:100]

**N Cell.** The basic electrochemical unit, characterized by an anode and a cathode used to receive, store, and deliver electrical energy. (320)

**N Cell, Valve-Regulated Lead Acid (VRLA). (Valve-Regulated Lead Acid Cell)** A lead-acid cell that is sealed with the exception of a valve that opens to the atmosphere when the internal pressure in the cell exceeds atmospheric pressure by a pre-selected amount, and that provides a means for recombination of internally generated oxygen and the suppression of hydrogen gas evolution to limit water consumption. (320)

**N Cell, Vented. (Vented Cell)** A type of cell in which the products of electrolysis and evaporation are allowed to escape freely into the atmosphere as they are generated. (Also called “flooded cell.”) (320)

**N Charge Transfer.** Improper discharging of capacitor networks that results in transferring charge from one capacitor to another capacitor instead of fully discharging the stored energy. (360)

**Circuit Breaker.** A device designed to open and close a circuit by nonautomatic means and to open the circuit automatically on a predetermined overcurrent without damage to itself when properly applied within its rating. [70:100]

Informational Note: The automatic opening means can be integral, direct acting with the circuit breaker, or remote from the circuit breaker.

**N Competent Person.** A person who meets all the requirements of *qualified person*, and who, in addition, is responsible for all work activities or safety procedures related to custom or special

equipment and has detailed knowledge regarding the exposure to electrical hazards, the appropriate control methods to reduce the risk associated with those hazards, and the implementation of those methods. (350)

**Conductive.** Suitable for carrying electric current.

**Conductor, Bare. (Bare Conductor)** A conductor having no covering or electrical insulation whatsoever. [70:100]

**Conductor, Covered. (Covered Conductor)** A conductor encased within material of composition or thickness that is not recognized by *NFPA 70, National Electrical Code*, as electrical insulation. [70:100]

**Conductor, Insulated. (Insulated Conductor)** A conductor encased within material of composition and thickness that is recognized by *NFPA 70, National Electrical Code*, as electrical insulation. [70:100]

**Controller.** A device or group of devices that serves to govern, in some predetermined manner, the electric power delivered to the apparatus to which it is connected. [70:100]

**Current-Limiting Overcurrent Protective Device.** A device that, when interrupting currents in its current-limiting range, reduces the current flowing in the faulted circuit to a magnitude substantially less than that obtainable in the same circuit if the device were replaced with a solid conductor having comparable impedance.

**Cutout.** An assembly of a fuse support with either a fuseholder, fuse carrier, or disconnecting blade. The fuseholder or fuse carrier may include a conducting element (fuse link), or may act as the disconnecting blade by the inclusion of a nonfusible member.

**De-energized.** Free from any electrical connection to a source of potential difference and from electrical charge; not having a potential different from that of the earth.

**Device.** A unit of an electrical system, other than a conductor, that carries or controls electric energy as its principal function. [70:100]

**N Dielectric Absorption.** The property of certain capacitors to recharge after being discharged. (360)

Informational Note: A voltage recharge from 0.02 percent (polystyrene and polypropylene) up to 10 percent (some electrolytics) can occur a few minutes after the grounding or shorting device has been removed.

**N Discharge Time.** The time required to discharge a capacitor to below electrical hazard thresholds. (360)

**Disconnecting Means.** A device, or group of devices, or other means by which the conductors of a circuit can be disconnected from their source of supply. [70:100]

**Disconnecting (or Isolating) Switch (Disconnecter, Isolator).** A mechanical switching device used for isolating a circuit or equipment from a source of power.

**Dwelling Unit.** A single unit providing complete and independent living facilities for one or more persons, including permanent provisions for living, sleeping, cooking, and sanitation. [70:100]



**Electrical Safety.** Identifying hazards associated with the use of electrical energy and taking precautions to reduce the risk associated with those hazards.

**Electrical Safety Program.** A documented system consisting of electrical safety principles, policies, procedures, and processes that directs activities appropriate for the risk associated with electrical hazards.

**Electrically Safe Work Condition.** A state in which an electrical conductor or circuit part has been disconnected from energized parts, locked/tagged in accordance with established standards, tested for the absence of voltage, and, if necessary, temporarily grounded for personnel protection.

**Electrolyte.** A solid, liquid, or aqueous immobilized liquid medium that provides the ion transport mechanism between the positive and negative electrodes of a cell. (320)

**Enclosed.** Surrounded by a case, housing, fence, or wall(s) that prevents persons from unintentionally contacting energized parts.

**Enclosure.** The case or housing of apparatus — or the fence or walls surrounding an installation to prevent personnel from unintentionally contacting energized electrical conductors or circuit parts or to protect the equipment from physical damage.

**Energized.** Electrically connected to, or is, a source of voltage. [70:100]

**Equipment.** A general term, including fittings, devices, appliances, luminaires, apparatus, machinery, and the like, used as a part of, or in connection with, an electrical installation. [70:100]

**Equipment, Arc-Resistant. (Arc-Resistant Equipment)** Equipment designed to withstand the effects of an internal arcing fault and that directs the internally released energy away from the employee.

Informational Note No. 1: See IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*, as an example of a standard that provides information for arc-resistant equipment.

Informational Note No. 2: See Informative Annex O.2.4(9) for information on arc-resistant equipment.

**Exposed (as applied to energized electrical conductors or circuit parts).** Capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to electrical conductors or circuit parts that are not suitably guarded, isolated, or insulated.

**Exposed (as applied to wiring methods).** On or attached to the surface or behind panels designed to allow access. [70:100]

**Fault Current.** The amount of current delivered at a point on the system during a short-circuit condition.

**Fault Current, Available. (Available Fault Current)** The largest amount of current capable of being delivered at a point on the system during a short-circuit condition.

Informational Note No. 1: See Informational Note Figure 100.0. A short circuit can occur during abnormal conditions such as a fault between circuit conductors or a ground fault.

Informational Note No. 2: If the dc supply is a battery system, the term *available fault current* refers to the prospective short-circuit current.

Informational Note No. 3: The available fault current varies at different locations within the system due to the location of sources and system impedances.

**Field Evaluated.** An evaluation of nonlisted or modified equipment in the field that is performed by persons or parties acceptable to the authority having jurisdiction. (330, 350)

Informational Note No. 1: The evaluation approval ensures that the equipment meets appropriate codes and standards or is similarly found suitable for a specified purpose.

Informational Note No. 2: See NFPA 791, *Recommended Practice and Procedures for Unlabeled Electrical Equipment Evaluation*, for additional information on recommended practices and procedures for the field evaluation of nonlisted equipment.

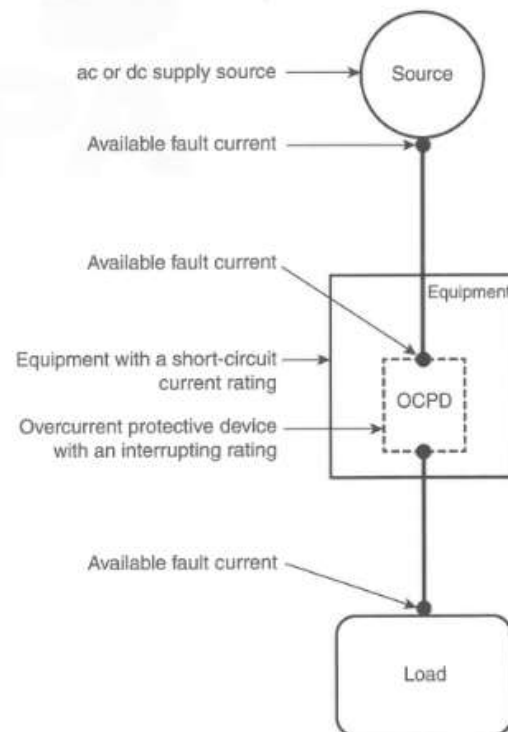
Informational Note No. 3: See NFPA 790, *Standard for Competency of Third-Party Field Evaluation Bodies*, for requirements on evaluating third-party entities.

**Fitting.** An accessory such as a locknut, bushing, or other part of a wiring system that is intended primarily to perform a mechanical rather than an electrical function. [70:100]

**Fuse.** An overcurrent protective device with a circuit-opening fusible part that is heated and severed by the passage of overcurrent through it.

Informational Note: A fuse comprises all the parts that form a unit capable of performing the prescribed functions. It may or may not be the complete device necessary to connect it into an electrical circuit.

**Ground.** The earth. [70:100]



Informational Note Figure 100.0 Available Fault Current.



**Ground Fault.** An unintentional, electrically conductive connection between an ungrounded conductor of an electrical circuit and the normally non-current-carrying conductors, metallic enclosures, metallic raceways, metallic equipment, or earth. [70:100]

**N Ground Stick.** A device that is used to ensure that the capacitor is discharged by applying it to all terminals of the capacitor element. (360)

Informational Note: This is also called a ground hook and could incorporate power-rated discharge resistors for high-energy applications.

**Grounded Conductor.** A system or circuit conductor that is intentionally grounded. [70:100]

**Grounded (Grounding).** Connected (connecting) to ground or to a conductive body that extends the ground connection. [70:100]

**Grounded, Solidly. (Solidly Grounded)** Connected to ground without inserting any resistor or impedance device. [70:100]

**Δ Ground-Fault Circuit Interrupter (GFCI).** A device intended for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a current to ground exceeds the values established for a Class A device. [70:100]

Informational Note: See UL 943, *Ground-Fault Circuit Interrupters*, for further information. Class A ground-fault circuit interrupters trip when the ground-fault current is 6 mA or higher and does not trip when the ground-fault current is less than 4 mA.

**Grounding Conductor, Equipment (EGC). (Equipment Grounding Conductor)** The conductive path(s) that provides a ground-fault current path and connects normally non-current-carrying metal parts of equipment together and to the system grounded conductor or to the grounding electrode conductor, or both. [70:100]

Informational Note No. 1: It is recognized that the equipment grounding conductor also performs bonding.

Informational Note No. 2: See 250.118 of NFPA 70, *National Electrical Code*, for a list of acceptable equipment grounding conductors.

**Grounding Electrode.** A conducting object through which a direct connection to earth is established. [70:100]

**Grounding Electrode Conductor.** A conductor used to connect the system grounded conductor or the equipment to a grounding electrode or to a point on the grounding electrode system. [70:100]

**N Grounding, Hard (Low-Z). (Hard Grounding)** The practice of discharging a capacitor through a low impedance, also called Low-Z (impedance) grounding. (360)

**N Grounding, Soft (High-Z). (Soft Grounding)** The practice of connecting a capacitor to ground through a power resistor to avoid the hazards related with hard grounding. (360)

**Guarded.** Covered, shielded, fenced, enclosed, or otherwise protected by means of suitable covers, casings, barriers, rails, screens, mats, or platforms to remove the likelihood of approach or contact by persons or objects to a point of danger. [70:100]

**Hazard.** A source of possible injury or damage to health.

**N Hazard, Arc Blast (as applied to capacitors). (Arc Blast Hazard)** A source of possible injury or damage to health from the energy deposited into acoustical shock wave and high-velocity shrapnel. (360)

**Δ Hazard, Arc Flash. (Arc Flash Hazard)** A source of possible injury or damage to health associated with the release of energy caused by an electric arc.

Informational Note No. 1: See 110.2(B) Exception No. 1 for further information regarding normal operation. The likelihood of occurrence of an arc flash incident increases when energized electrical conductors or circuit parts are exposed or when they are within equipment in a guarded or enclosed condition, provided a person is interacting with the equipment in such a manner that could cause an electric arc. An arc flash incident is not likely to occur under normal operating conditions when enclosed energized equipment has been properly installed and maintained.

Informational Note No. 2: See Table 130.5(C) for examples of tasks that increase the likelihood of an arc flash incident occurring.

**Hazard, Electric Shock. (Electric Shock Hazard)** A source of possible injury or damage to health associated with current through the body caused by contact or approach to exposed energized electrical conductors or circuit parts.

Informational Note: Injury and damage to health resulting from electric shock is dependent on the magnitude of the electrical current, the power source frequency (e.g., 60 Hz, 50 Hz, dc), and the path and time duration of current through the body. The physiological reaction ranges from perception, muscular contractions, inability to let go, ventricular fibrillation, tissue burns, and death.

**Hazard, Electrical. (Electrical Hazard)** A dangerous condition such that contact or equipment failure can result in electric shock, arc flash burn, thermal burn, or arc blast injury.

Informational Note: Class 2 power supplies, listed low voltage lighting systems, and similar sources are examples of circuits or systems that are not considered an electrical hazard.

**Hazardous.** Involving exposure to at least one hazard.

**Incident Energy.** The amount of thermal energy impressed on a surface, a certain distance from the source, generated during an electrical arc event. Incident energy is typically expressed in calories per square centimeter ( $\text{cal}/\text{cm}^2$ ).

**Incident Energy Analysis.** A component of an arc flash risk assessment used to predict the incident energy of an arc flash for a specified set of conditions.

**Insulated.** Separated from other conducting surfaces by a dielectric (including air space) offering a high resistance to the passage of current.

Informational Note: When an object is said to be insulated, it is understood to be insulated for the conditions to which it is normally subject. Otherwise, it is, within the purpose of these rules, uninsulated.

**Interrupter Switch.** A switch capable of making, carrying, and interrupting specified currents.

**Interrupting Rating.** The highest current at rated voltage that a device is identified to interrupt under standard test conditions. [70:100]

Informational Note: Equipment intended to interrupt current at other than fault levels may have its interrupting rating implied in other ratings, such as horsepower or locked rotor current.

**Isolated (as applied to location).** Not readily accessible to persons unless special means for access are used. [70:100]

**Labeled.** Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

**Laboratory.** A building, space, room, or group of rooms intended to serve activities involving procedures for investigation, diagnostics, product testing, or use of custom or special electrical components, systems, or equipment. (350)

**Laser.** A device that produces radiant energy at wavelengths between 180 nm (nanometer) and 1 mm (millimeter) predominantly by controlled stimulated emission. Laser radiation can be highly coherent temporally, spatially, or both. (330)

**Laser Energy Source.** Any device intended for use in conjunction with a laser to supply energy for the excitation of electrons, ions, or molecules. (330)

**Laser Radiation.** All electromagnetic radiation emitted by a laser or laser system between 180 nm (nanometers) and 1 mm (millimeters) that is produced as a result of a controlled stimulated emission. (330)

**Laser System.** A laser in combination with an appropriate laser energy source with or without additional incorporated components. (330)

**Listed.** Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

Informational Note: The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

**Luminaire.** A complete lighting unit consisting of a light source, such as a lamp or lamps, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light. A lampholder itself is not a luminaire. [70:100]

**Maintenance, Condition of. (Condition of Maintenance)** The state of the electrical equipment considering the manufacturers' instructions, manufacturers' recommendations, and applicable industry codes, standards, and recommended practices.

**Motor Control Center.** An assembly of one or more enclosed sections having a common power bus and principally containing motor control units. [70:100]

**Outlet.** A point on the wiring system at which current is taken to supply utilization equipment. [70:100]

**Overcurrent.** Any current in excess of the rated current of equipment or the ampacity of a conductor. It may result from overload, short circuit, or ground fault. [70:100]

Informational Note: A current in excess of rating may be accommodated by certain equipment and conductors for a given set of conditions. Therefore, the rules for overcurrent protection are specific for particular situations.

**Overload.** Operation of equipment in excess of normal, full-load rating, or of a conductor in excess of rated ampacity that, when it persists for a sufficient length of time, would cause damage or dangerous overheating. A fault, such as a short circuit or ground fault, is not an overload. [70:100]

**Panelboard.** A single panel or group of panel units designed for assembly in the form of a single panel, including buses and automatic overcurrent devices, and equipped with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall, partition, or other support; and accessible only from the front. [70:100]

**Pilot Cell.** One or more cells chosen to represent the operating parameters of the entire battery (sometimes called "temperature reference" cell). (320)

**Premises Wiring (System).** Interior and exterior wiring, including power, lighting, control, and signal circuit wiring together with all their associated hardware, fittings, and wiring devices, both permanently and temporarily installed. This includes: (a) wiring from the service point or power source to the outlets; or (b) wiring from and including the power source to the outlets where there is no service point.

Such wiring does not include wiring internal to appliances, luminaires, motors, controllers, motor control centers, and similar equipment. [70:100]

Informational Note: Power sources include, but are not limited to, interconnected or stand-alone batteries, solar photovoltaic systems, other distributed generation systems, or generators.

**Protective Barrier.** Prevents user access to a hazardous voltage, current, or stored energy area. (330)

**Protector.** A glove or mitten designed to be worn over rubber insulating gloves.

**Qualified Person.** One who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to identify the hazards and reduce the associated risk.

**Raceway.** An enclosed channel of metal or nonmetallic materials designed expressly for holding wires, cables, or busbars, with additional functions as permitted in this standard. [70:100]

**Radiation, Ionizing. (Ionizing Radiation)** Radiation consisting of particles, X-rays, or gamma rays with sufficient energy to cause ionization of atoms or molecules through which it passes. (340)

**Radiation, Nonionizing. (Nonionizing Radiation)** Static electric and magnetic (0 to 1 Hz), sub radiofrequency (1 Hz to 3 kHz), radiofrequency (3 kHz to 300 GHz) fields, and infrared, visible

light, and near ultraviolet (near UV) that cannot ionize an atom or molecule. (340)

**Receptacle.** A contact device installed at the outlet for the connection of an attachment plug, or for the direct connection of electrical utilization equipment designed to mate with the corresponding contact device. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is two or more contact devices on the same yoke. [70:100]

**Research and Development (R&D).** An activity in an installation specifically designated for research or development conducted with custom or special electrical equipment. (350)

**Resistor, Bleeder. (Bleeder Resistor)** A resistor or resistor network connected in parallel with a capacitor's terminals that dissipates the stored energy after power has been disconnected. (360)

**Risk.** A combination of the likelihood of occurrence of injury or damage to health and the severity of injury or damage to health that results from a hazard.

**Risk Assessment.** An overall process that identifies hazards, estimates the likelihood of occurrence of injury or damage to health, estimates the potential severity of injury or damage to health, and determines if protective measures are required.

Informational Note: As used in this standard, *arc flash risk assessment* and *electric shock risk assessment* are types of risk assessments.

**Safeguarding.** Safeguards for personnel include the consistent administrative enforcement of safe work practices. Safeguards include training in safe work practices, cell line design, safety equipment, PPE, operating procedures, and work checklists. (310)

**Service Drop.** The overhead conductors between the utility electric supply system and the service point. [70:100]

**Service Lateral.** The underground conductors between the utility electric supply system and the service point. [70:100]

**Service Point.** The point of connection between the facilities of the serving utility and the premises wiring. [70:100]

Informational Note: The service point can be described as the point of demarcation between where the serving utility ends and the premises wiring begins. The serving utility generally specifies the location of the service point based on the conditions of service.

**Short-Circuit Current, Prospective. (Prospective Short-Circuit Current)** The highest level of fault current that could theoretically occur at a point on a circuit. This is the fault current that can flow in the event of a zero impedance short circuit and if no protection devices operate. (320)

Informational Note: Some batteries have built-in management devices to limit maximum short-circuit current. The determination of the prospective short-circuit current for these batteries assumes that the internal battery management system protection devices are operable.

**Short-Circuit Current Rating.** The prospective symmetrical fault current at a nominal voltage to which an apparatus or system is able to be connected without sustaining damage exceeding defined acceptance criteria. [70:100]

**Single-Line Diagram.** A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or

system of circuits and the component devices or parts used in the circuit or system.

**Special Permission.** The written consent of the authority having jurisdiction. [70:100]

**Step Potential.** A ground potential gradient difference that can cause current flow from foot to foot through the body.

**Structure.** That which is built or constructed. [70:100]

**Switch, Isolating. (Isolating Switch)** A switch intended for isolating an electric circuit from the source of power. It has no interrupting rating, and it is intended to be operated only after the circuit has been opened by some other means. [70:100]

**Switchboard.** A large single panel, frame, or assembly of panels on which are mounted on the face, back, or both, switches, overcurrent and other protective devices, buses, and usually instruments. These assemblies are generally accessible from the rear as well as from the front and are not intended to be installed in cabinets. [70:100]

**Switchgear, Metal-Clad. (Metal-Clad Switchgear)** A switchgear assembly completely enclosed on all sides and top with sheet metal, having drawout switching and interrupting devices, and all live parts enclosed within grounded metal compartments.

**Switchgear, Metal-Enclosed. (Metal-Enclosed Switchgear)** A switchgear assembly completely enclosed on all sides and top with sheet metal (except for ventilating openings and inspection windows), containing primary power circuit switching, interrupting devices, or both, with buses and connections. This assembly may include control and auxiliary devices. Access to the interior of the enclosure is provided by doors, removable covers, or both. Metal-enclosed switchgear is available in non-arc-resistant or arc-resistant constructions.

**Switching Device.** A device designed to close, open, or both, one or more electric circuits.

**Time Constant.** The time it takes for voltage to drop by ~63 percent (1/e) during discharge. (360)

**Touch Potential.** A ground potential gradient difference that can cause current flow from hand to hand, hand to foot, or another path, other than foot to foot, through the body.

**Ungrounded.** Not connected to ground or to a conductive body that extends the ground connection. [70:100]

**Unqualified Person.** A person who is not a qualified person.

**Utilization Equipment.** Equipment that utilizes electric energy for electronic, electromechanical, chemical, heating, lighting, or similar purposes. [70:100]

**Voltage (of a Circuit).** The greatest root-mean-square (rms) (effective) difference of potential between any two conductors of the circuit concerned. [70:100]

Informational Note: Some systems, such as three-phase 4-wire, single-phase 3-wire, and 3-wire direct-current, may have various circuits of various voltages.

**Voltage, Nominal. (Nominal Voltage)** A nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class (e.g., 120/240 volts, 480Y/277 volts, 600 volts). [70:100]



Informational Note No. 1: The actual voltage at which a circuit operates can vary from the nominal within a range that permits satisfactory operation of equipment.

Informational Note No. 2: See ANSI C84.1, *Electric Power Systems and Equipment — Voltage Ratings (60 Hz)*.

**N Voltage, Nominal (as applied to cell or battery).** (Nominal Voltage) The value assigned to a cell or battery of a given voltage class for the purpose of convenient designation; the operating voltage of the cell or system may vary above or below this value. (320)

Informational Note: The most common cell voltages are 2.0 volts per cell for lead-acid batteries, 1.2 volts per cell for alkali batteries, and 3.2 to 3.8 volts per cell for Li-ion batteries. Nominal voltages might vary with different chemistries.

**Δ Working Distance.** The distance between a person's face and chest area and a prospective arc source.

Informational Note: See 130.5(G) for further information. Incident energy increases as the distance from the arc source decreases.

**Δ Working On (energized electrical conductors or circuit parts).** Intentionally coming in contact with energized electrical conductors or circuit parts with the hands, feet, or other body parts, with tools, probes, or with test equipment, regardless of the personal protective equipment (PPE) a person is wearing.

Informational Note: Examples of "working on" can include but are not limited to *diagnostic testing* (such as taking readings or measurements of electrical equipment, conductors, or circuit parts with approved test equipment that does not require making any physical change to the electrical equipment, conductors, or circuit parts) and *repair* or physical alteration of electrical equipment, conductors, or circuit parts (such as making or tightening connections, removing or replacing components, etc.).

Shaded text = Revisions. Δ = Text deletions and figure/table revisions. • = Section deletions. N = New material.

70E-15