

Figure J.2 Energized Electrical Work Permit Flow Chart.

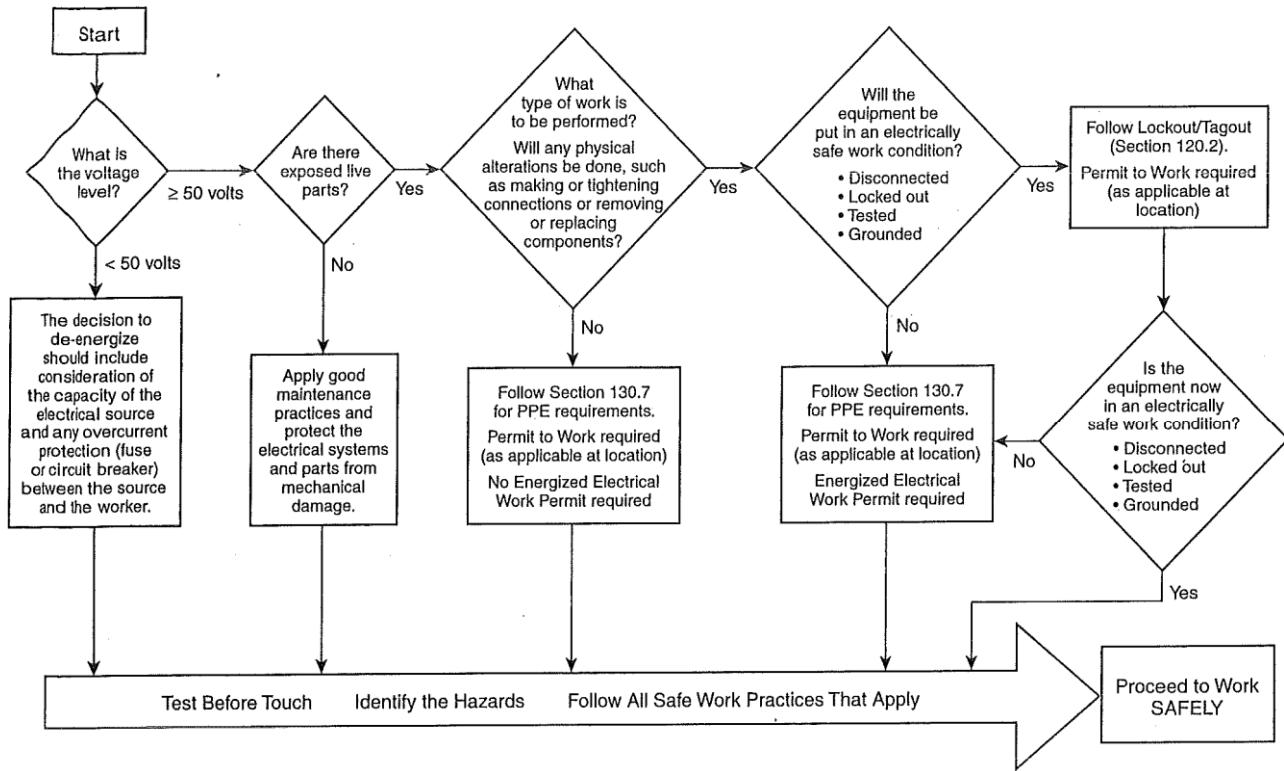


Figure J.2 Energized Electrical Work Permit Flow Chart.

N Table 130.4(D)(a) Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts for Alternating-Current Systems

Nominal System Voltage Range, Phase to Phase ^a	(1)	(2)	(3)	(4)
			Limited Approach Boundary ^b	
Less than 50 V	Not specified	Not specified	Not specified	Not specified
50 V–150 V ^d	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	Avoid contact	
151 V–750 V	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	0.3 m (1 ft 0 in.)	
751 V–15 kV	3.0 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	0.7 m (2 ft 2 in.)	
15.1 kV–36 kV	3.0 m (10 ft 0 in.)	1.8 m (6 ft 0 in.)	0.8 m (2 ft 9 in.)	
36.1 kV–46 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	0.8 m (2 ft 9 in.)	
46.1 kV–72.5 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 6 in.)	
72.6 kV–121 kV	3.3 m (10 ft 8 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 6 in.)	
138 kV–145 kV	3.4 m (11 ft 0 in.)	3.0 m (10 ft 0 in.)	1.2 m (3 ft 10 in.)	
161 kV–169 kV	3.6 m (11 ft 8 in.)	3.6 m (11 ft 8 in.)	1.3 m (4 ft 3 in.)	
230 kV–242 kV	4.0 m (13 ft 0 in.)	4.0 m (13 ft 0 in.)	1.7 m (5 ft 8 in.)	
345 kV–362 kV	4.7 m (15 ft 4 in.)	4.7 m (15 ft 4 in.)	2.8 m (9 ft 2 in.)	
500 kV–550 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)	3.6 m (11 ft 8 in.)	
765 kV–800 kV	7.2 m (23 ft 9 in.)	7.2 m (23 ft 9 in.)	4.9 m (15 ft 11 in.)	

Notes:

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

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

^aFor 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.

^bSee definition in Article 100 and text in 130.4(D)(2) and Informative Annex C for elaboration.

^c*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.

^dThis includes circuits where the exposure does not exceed 120 volts nominal.

N Table 130.4(D)(b) Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts for Direct-Current Voltage Systems

Nominal Potential Difference	(1)	(2)	(3)	(4)
			Limited Approach Boundary	
Less than 50 V	Not specified	Not specified	Not specified	Not specified
50 V–300 V	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	Avoid contact	
301 V–1 kV	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	0.3 m (1 ft 0 in.)	
1.1 kV–5 kV	3.0 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	0.5 m (1 ft 5 in.)	
5 kV–15 kV	3.0 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	0.7 m (2 ft 2 in.)	
15.1 kV–45 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	0.8 m (2 ft 9 in.)	
45.1 kV–75 kV	3.0 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.)	3.0 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.

^c*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.

#3 c

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

Arc-Flash PPE Category	PPE
1	Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm² (16.75 J/cm²)^a Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated face shield ^b or arc flash suit hood Arc-rated jacket, parka, rainwear, or hard hat liner (AN) Protective Equipment Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) ^c Heavy-duty leather gloves ^d Leather footwear (AN)
2	Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm² (33.5 J/cm²)^a Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated flash suit hood or arc-rated face shield ^b and arc-rated balaclava Arc-rated jacket, parka, rainwear, or hard hat liner (AN) Protective Equipment Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) ^c Heavy-duty leather gloves ^d Leather footwear
3	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm² (104.7 J/cm²)^a 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 ^d Arc-rated jacket, parka, rainwear, or hard hat liner (AN) Protective Equipment Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) ^c Leather footwear
4	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm² (167.5 J/cm²)^a 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 ^c Arc-rated jacket, parka, rainwear, or hard hat liner (AN) Protective Equipment Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) ^c Leather footwear

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

^aArc rating is defined in Article 100.^bFace 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.^cOther 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.^dIf rubber insulating gloves with leather protectors are used, additional leather or arc-rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement.

(D) Other Protective Equipment.

▲ (1) **Insulated Tools and Equipment.** Employees shall use insulated tools or handling equipment, or both, when working inside the restricted approach boundary of exposed energized electrical conductors or circuit parts where tools or handling equipment might make **unintentional** contact. Insulated tools shall be protected from damage to the insulating material.

Informational Note: See 130.4(D), Shock Protection Boundaries.

(a) *Requirements for Insulated Tools.* The following requirements shall apply to insulated tools:

- (1) Insulated tools shall be rated for the voltages on which they are used.
- (2) Insulated tools shall be designed and constructed for the environment to which they are exposed and the manner in which they are used.
- (3) Insulated tools and equipment shall be inspected prior to each use. The inspection shall look for damage to the insulation or damage that can limit the tool from performing its intended function or could increase the potential for an incident (e.g., damaged tip on a screwdriver).

(b) *Fuse or Fuseholder Handling Equipment.* Fuse or fuseholder handling equipment, insulated for the circuit voltage, shall be used to remove or install a fuse if the fuse terminals are energized.

(c) *Ropes and Handlines.* Ropes and handlines used within the limited approach boundary shall be nonconductive.

(d) *Fiberglass-Reinforced Plastic Rods.* Fiberglass-reinforced plastic rod and tube used for live-line tools shall meet the requirements of applicable portions of electrical codes and standards dealing with electrical installation requirements.

Informational Note: For further information concerning electrical codes and standards dealing with installation requirements, refer to ASTM F711, *Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools*.

(e) *Portable Ladders.* Portable ladders shall have nonconductive side rails when used within the limited approach boundary or where the employee or ladder could contact exposed energized electrical conductors or circuit parts. Nonconductive ladders shall meet the requirements of **applicable state, federal, or local codes and standards**.

Informational Note: The standards listed in Table 130.7(G), Informational Note are examples of standards that contain information on portable ladders.

(f) *Protective Shields.* Protective shields, protective barriers, or insulating materials shall be used to protect each employee from shock, burns, or other electrically related injuries while an employee is working within the limited approach boundary of energized conductors or circuit parts that might be **unintentionally** contacted or where dangerous electric heating or arcing might occur. When normally enclosed energized conductors or circuit parts are exposed for maintenance or repair, they shall be guarded to protect unqualified persons from contact with the energized conductors or circuit parts.

(g) *Rubber Insulating Equipment.* Rubber insulating equipment used for protection from **unintentional** contact with energized conductors or circuit parts shall meet the requirements of **applicable state, federal, or local codes and standards**.

Informational Note: The standards listed in Table 130.7(G), Informational Note are examples of standards that contain information on rubber insulating equipment.

(h) *Voltage-Rated Plastic Guard Equipment.* Plastic guard equipment for protection of employees from **unintentional** contact with energized conductors or circuit parts, or for protection of employees or energized equipment or material from contact with ground, shall meet the requirements of **applicable state, federal, or local codes and standards**.

Informational Note: The standards listed in Table 130.7(G), Informational Note are examples of standards that contain information on voltage-rated plastic guard equipment.

(i) *Physical or Mechanical Barriers.* Physical or mechanical (field-fabricated) barriers shall be installed no closer than the limited approach boundary distance given in Table 130.4(D)(a) and Table 130.4(D)(b). While the barrier is being installed, the limited approach boundary distance specified in Table 130.4(D)(a) and Table 130.4(D)(b) shall be maintained, or the energized conductors or circuit parts shall be placed in an electrical safe work condition.

(E) Alerting Techniques.

▲ (1) **Safety Signs and Tags.** Safety signs, safety symbols, or tags shall be used where necessary to warn employees about electrical hazards that might endanger them. Such signs and tags shall meet the requirements of **applicable state, federal, or local codes and standards**.

Informational Note No. 1: Safety signs, tags, and barricades used to identify energized "look-alike" equipment can be employed as an additional preventive measure.

Informational Note No. 2: The standards listed in Table 130.7(G), Informational Note are examples of standards that contain information on safety signs and tags.

(2) **Barricades.** Barricades shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas containing energized conductors or circuit parts. Conductive barricades shall not be used where it might increase the likelihood of exposure to an electrical hazard. Barricades shall be placed no closer than the limited approach boundary given in Table 130.4(D)(a) and Table 130.4(D)(b). Where the arc flash boundary is greater than the limited approach boundary, barricades shall not be placed closer than the arc flash boundary.

(3) **Attendants.** If signs and barricades do not provide sufficient warning and protection from electrical hazards, an attendant shall be stationed to warn and protect employees. The primary duty and responsibility of an attendant providing manual signaling and alerting shall be to keep unqualified employees outside a work area where the unqualified employee might be exposed to electrical hazards. An attendant shall remain in the area as long as there is a potential for employees to be exposed to the electrical hazards.

▲ (4) **Cutting, Removing, or Rerouting of Conductors.** Where conductors are de-energized in order to cut, remove, or reroute them and conductor terminations are not within sight, such as where they are in a junction or pull box, additional steps to verify absence of voltage or identify the conductors shall be taken prior to cutting, removing, or rerouting the conductors.

#4 a and c

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

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)
Arc-resistant switchgear 1 kV through 15 kV [for clearing times of less than 0.5 sec (30 cycles) with an available fault current not to exceed the arc-resistant rating of the equipment], and metal-enclosed interrupter switchgear, fused or unfused of arc-resistant-type construction, 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.)	N/A (doors closed)	N/A (doors closed)
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 (doors open)	12 m (40 ft)

Note: For equipment rated 600 volts and below and protected by upstream current-limiting fuses or current-limiting 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.

Informational Note 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 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. 1: See Table 1 of IEEE 1584TM, *Guide for Performing Arc Flash Hazard Calculations*, for further information regarding Notes b through d.

Informational Note No. 2: An example of a standard that provides information for arc-resistant switchgear referred to in Table 130.7(C)(15)(a) is IEEE C37.20.7, *Guide for Testing Metal-Enclosed Switchgear Rated Up to 38 kV for Internal Arcing Faults*.

Table 130.7(C)(15)(b) Arc-Flash PPE Categories for Direct Current (dc) Systems

Equipment	Arc-Flash PPE Category	Arc-Flash Boundary
Storage batteries, dc switchboards, and other dc supply sources Parameters: Greater than or equal to 100 V and less than or equal to 250 V Maximum arc duration and minimum working distance: 2 sec @ 455 mm (18 in.)		
Available fault current less than 4 kA		
Available fault current greater than or equal to 4 kA and less than 7 kA		
Available fault current greater than or equal to 7 kA and less than 15 kA	3	1.8 m (6 ft)
Storage batteries, dc switchboards, and other dc supply sources Parameters: Greater than 250 V and less than or equal to 600 V 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) Apparatus that can be expected to be exposed to electrolyte must meet both of the following conditions:
 (a) Be evaluated for electrolyte protection

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

(b) Be arc-rated

Informational Note: ASTM F1891, *Standard Specifications for Arc Rated and Flame Resistant Rainwear*, contains 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: 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. See Informative Annex D.5 for the basis for table values and alternative methods to determine dc incident energy. Methods should be used with good engineering judgment.

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. Research with ac arc flash has shown a multiplier of as much as 3x for arc-in-a-box [508 mm (20 in.) cube] versus open air. Engineering judgment is necessary when reviewing the specific conditions of the equipment and task to be performed, including the dimensions of the enclosure and the working distance involved.

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. In general, only those terms that are used in two or more articles are defined in Article 100. Other definitions are included in the article in which they are used but may be referenced in Article 100. The definitions in this article shall apply wherever the terms are used throughout this standard.

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

Accessible (as applied to wiring methods). Capable of being removed or exposed without damaging the building structure or finish or not permanently closed in by the structure or finish of the building. [70:100]

Accessible, Readily (Readily Accessible). Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to take actions such as to use tools (other than keys), to climb over or under, to remove obstacles, or to resort to portable ladders, and so forth. [70:100]

Informational Note: Use of keys is a common practice under controlled or supervised conditions and a common alternative to the ready access requirements under such supervised conditions as provided in NFPA 70, *National Electrical Code*.

Approved. Acceptable to the authority having jurisdiction.

Δ 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: 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 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.

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^2 and is derived from the

determined value of the arc thermal performance value (ATPV) or energy of breakopen threshold (E_{AT}) (should a material system exhibit a breakopen response below the ATPV value). Arc rating is reported as either ATPV or E_{AT} , 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: *Breakopen* is a material response evidenced by the formation of one or more holes in the innermost layer of arc-rated material that would allow flame to pass through the material.

Informational Note No. 3: ATPV is defined in ASTM F1959/F1959M, *Standard Test Method for Determining the Arc Rating of Materials for Clothing*, as the incident energy (cal/cm^2) 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.

Informational Note No. 4: E_{AT} is defined in ASTM F1959/F1959M, *Standard Test Method for Determining the Arc Rating of Materials for Clothing*, as the incident energy (cal/cm^2) on a material or a material system that results in a 50 percent probability of breakopen. Breakopen is defined as a hole with an area of 1.6 cm^2 (0.5 in²) or an opening of 2.5 cm (1.0 in.) in any dimension.

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.

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

Balaclava (Sock Hood). An arc-rated hood that protects the neck and head except for the facial area of the eyes and nose.

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

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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 or to prevent unauthorized access to a work area.

Bonded (Bonding). Connected to establish electrical continuity and conductivity. [70:100]

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

▲ **Boundary, Arc Flash.** When an arc flash hazard exists, an approach limit from an arc source at which incident energy equals 1.2 cal/cm² (5 J/cm²).

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/cm² (5 J/cm²) for one second.

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

▲ **Boundary, Restricted Approach.** 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.

Branch Circuit. The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s). [70:100]

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]

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.

Conductive. Suitable for carrying electric current.

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

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

Conductor, Insulated. A conductor encased within material of composition and thickness that is recognized by this *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]

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 (Disconnect, 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 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.

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

▲ **N 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 to verify the absence of voltage, and, if necessary, temporarily grounded for personnel protection.

▲ **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]

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]

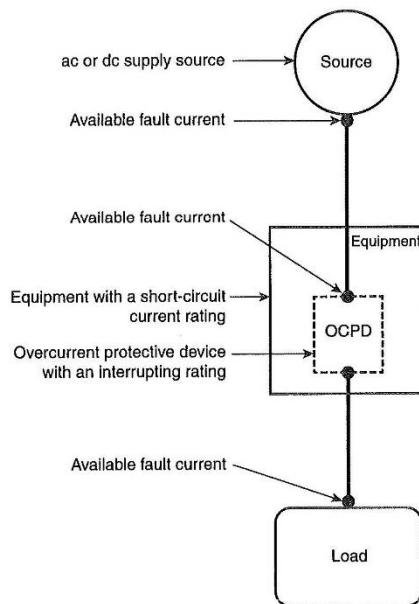
N Fault Current. The amount of current delivered at a point on the system during a short-circuit condition.

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

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

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

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]



▲ FIGURE 100.0 Available Fault Current.

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]

Ground Fault. An unintentional, electrically conducting connection between an ungrounded conductor of an electrical circuit and the normally non-current-carrying conductors, metallic enclosures, metallic raceways, metallic equipment, or earth.

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

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

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

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: Class A ground-fault circuit interrupters trip when the current to ground is 6 mA or higher and do not trip when the current to ground is less than 4 mA. For further information, see ANSI/UL 943, *Standard for Ground-Fault Circuit Interrupters*.

▲ **Grounding Conductor, Equipment (EGC).** 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]

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.

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

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

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an electrical arc event. Incident energy is typically expressed in calories per square centimeter (cal/cm²).

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.

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]

N Maintenance, Condition of. 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]

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.

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]

Receptacle. A receptacle is a contact device installed at the outlet for the connection of an attachment plug. 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]

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 shock risk assessment are types of risk assessments.

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 1: 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.

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

Informational Note: Injury and damage to health resulting from 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.

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

Switchgear, Metal-Clad. 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. 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.

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. 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 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 2: See ANSI C84.1, *Electric Power Systems and Equipment — Voltage Ratings (60 Hz)*.

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

Informational Note: Incident energy increases as the distance from the arc source decreases. See 130.5(C)(1) for further information.

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. There are two categories of "working on": *Diagnostic (testing)* is taking readings or measurements of electrical equipment with approved test equipment that does not require making any physical change to the equipment; *repair* is any physical alteration of electrical equipment (such as making or tightening connections, removing or replacing components, etc.).

Informative Annex C Limits of Approach

This informative annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

C.1 Preparation for Approach. Observing a safe approach distance from exposed energized electrical conductors or circuit parts is an effective means of maintaining electrical safety. As the distance between a person and the exposed energized conductors or circuit parts decreases, the potential for electrical incident increases.

C.1.1 Unqualified Persons, Safe Approach Distance. Unqualified persons are safe when they maintain a distance from the exposed energized conductors or circuit parts, including the longest conductive object being handled, so that they cannot contact or enter a specified air insulation distance to the exposed energized electrical conductors or circuit parts. This safe approach distance is the limited approach boundary. Further, persons must not cross the arc flash boundary unless they are wearing appropriate personal protective clothing and are under the close supervision of a qualified person. Only when continuously escorted by a qualified person should an unqualified person cross the limited approach boundary. Under no circumstance should an unqualified person cross the restricted approach boundary, where special shock protection techniques and equipment are required.

C.1.2 Qualified Persons, Safe Approach Distance.

C.1.2.1 Determine the arc flash boundary and, if the boundary is to be crossed, appropriate arc-rated protective equipment must be utilized.

C.1.2.2 For a person to cross the limited approach boundary and enter the limited space, a person should meet the following criteria:

- (1) Be qualified to perform the job/task
- (2) Be able to identify the hazards and associated risks with the tasks to be performed

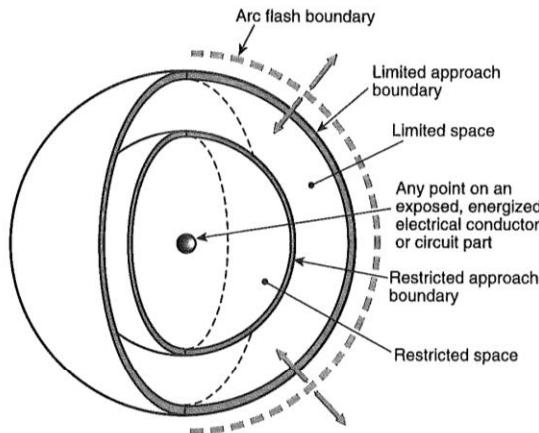
C.1.2.3 To cross the restricted approach boundary and enter the restricted space, qualified persons should meet the following criteria:

- (1) As applicable, have an energized electrical work permit authorized by management
- (2) Use personal protective equipment (PPE) that is rated for the voltage and energy level involved
- (3) Minimize the likelihood of bodily contact with exposed energized conductors and circuit parts from inadvertent movement by keeping as much of the body out of the restricted space as possible and using only protected body parts in the space as necessary to accomplish the work
- (4) Use insulated tools and equipment

(See Figure C.1.2.3.)

C.2 Basis for Distance Values in Tables 130.4(D)(a) and 130.4(D)(b).

C.2.1 General Statement. Columns 2 through 5 of Table 130.4(D)(a) and Table 130.4(D)(b) show various distances from the exposed energized electrical conductors or circuit parts. They include dimensions that are added to a basic minimum air insulation distance. Those basic minimum air insula-



▲ FIGURE C.1.2.3 Limits of Approach.

tion distances for voltages 72.5 kV and under are based on IEEE 4, *Standard Techniques for High Voltage Testing*, Appendix 2B; and voltages over 72.5 kV are based on IEEE 516, *Guide for Maintenance Methods on Energized Power Lines*. The minimum air insulation distances that are required to avoid flashover are as follows:

- (1) ≤ 300 V: 1 mm (0 ft 0.03 in.)
- (2) >300 V to ≤ 750 V: 2 mm (0 ft 0.07 in.)
- (3) >750 V to ≤ 2 kV: 5 mm (0 ft 0.19 in.)
- (4) >2 kV to ≤ 15 kV: 39 mm (0 ft 1.5 in.)
- (5) >15 kV to ≤ 36 kV: 161 mm (0 ft 6.3 in.)
- (6) >36 kV to ≤ 48.3 kV: 254 mm (0 ft 10.0 in.)
- (7) >48.3 kV to ≤ 72.5 kV: 381 mm (1 ft 3.0 in.)
- (8) >72.5 kV to ≤ 121 kV: 640 mm (2 ft 1.2 in.)
- (9) >138 kV to ≤ 145 kV: 778 mm (2 ft 6.6 in.)
- (10) >161 kV to ≤ 169 kV: 915 mm (3 ft 0.0 in.)
- (11) >230 kV to ≤ 242 kV: 1,281 m (4 ft 2.4 in.)
- (12) >345 kV to ≤ 362 kV: 2,282 m (7 ft 5.8 in.)
- (13) >500 kV to ≤ 550 kV: 3,112 m (10 ft 2.5 in.)
- (14) >765 kV to ≤ 800 kV: 4,225 m (13 ft 10.3 in.)

C.2.1.1 Column 1. The voltage ranges have been selected to group voltages that require similar approach distances based on the sum of the electrical withstand distance and an inadvertent movement factor. The value of the upper limit for a range is the maximum voltage for the highest nominal voltage in the range, based on ANSI C84.1, *Electric Power Systems and Equipment — Voltage Ratings (60 Hz)*. For single-phase systems, select the range that is equal to the system's maximum phase-to-ground voltage multiplied by 1.732.

C.2.1.2 Column 2. The distances in column 2 are based on OSHA's rule for unqualified persons to maintain a 3.05 m (10 ft) clearance for all voltages up to 50 kV (voltage-to-ground), plus 100 mm (4.0 in.) for each 10 kV over 50 kV.

C.2.1.3 Column 3. The distances in column 3 are based on the following:

- (1) ≤ 750 V: Use *NEC* Table 110.26(A)(1), Working Spaces, Condition 2, for the 151 V to 600 V range.
- (2) >750 V to ≤ 145 kV: Use *NEC* Table 110.34(A), Working Space, Condition 2.
- (3) >145 kV: Use OSHA's 3.05 m (10 ft) rules as used in Column 2.

C.2.1.4 Column 4. The distances in column 4 are based on adding to the flashover dimensions shown in C.2.1 the following inadvertent movement distance:

≤ 300 V: Avoid contact.

Based on experience and precautions for household 120/240-V systems:

>300 V to ≤ 750 V: Add 304.8 mm (1 ft 0 in.) for inadvertent movement.

These values have been found to be adequate over years of use in ANSI/IEEE C2, *National Electrical Safety Code*, in the approach distances for communication workers.

>72.5 kV: Add 304.8 mm (1 ft 0 in.) for inadvertent movement.

These values have been found to be adequate over years of use in ANSI/IEEE C2, *National Electrical Safety Code*, in the approach distances for supply workers.