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

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

Notes:

1. For arc flash boundary see 130.5(A)

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

a. 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

b. See 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

d. This includes circuits where the exposure does not exceeed 120 Volts nominal.

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

1	2	3	4
	Limited Approach Boundary		***Restricted Approach Boundary^b; Includes Inadvertent Movement Adder***
Nominal Potential Difference	***Exposed Movable Conductor****	***Exposed Fixed Circuit Part***	
Less than 50V	Not Specified	Not Specified	Not Specified
50V - 300V	3.0m (10 ft 0 in)	1.0m (3ft 6in)	Avoid Contact
301V - 1kV	3.0m (10 ft 0 in)	1.0m (3ft 6in)	0.3m (1ft 0in)
1.1kV - 5kV	3.0m (10 ft 0 in)	1.5m (5ft 0 in)	0.5m (1ft 5in)
5kV - 15kV	3.0m (10 ft 0 in)	1.5m (5ft 0 in)	0.7m (2ft 2in)
15.1kV - 45kV	3.0m (10 ft 0 in)	2.5m (8ft 0in)	0.8m (2ft 9in)
45.1kV - 75kV	3.0m (10 ft 0 in)	2.5m (8ft 0in)	1.0m (3ft 6in)
75.1kV - 150kV	3.3m (10ft 8 in)	3.0m (10 ft 0 in)	1.2m (3ft 10in)
150.1kV - 250kV	3.6m (11ft 8in)	3.6m (11ft 8in)	1.6m (5ft 3in)
250.1kV - 500kV	6.0m (20ft 0in)	6.0m (20ft 0in)	3.5m (11ft 6in)
500.1kV - 800kV	8.0m (26ft 0in)	8.0m (26ft 0in)	5.0m (16ft 5in)

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

*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.

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 25kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18in)	1	485mm (19 in.)
Panelboards or other equipment rated greater than 240 Volts and up to 600 volts. Parameters; Maximum of 25kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18in)	2	900mm (3 ft)
600 - volt class motor control centers (MCCs) Parameters; Maximum of 65kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18in)	2	1.5 m (5 ft)
600 - volt class motor control centers (MCCs) Parameters; Maximum of 42kA available fault current; maximum of 0.33 sec (20 cycles) fault clearing time; minimum working distance 455 mm (18in)	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 35kA available fault current; maximum of 0.5 sec (30 cycles) fault clearing time; minimum working distance 455 mm (18in)	4	6 m (20 ft)
Other 600 - volt class (277 volts throgh 600 volts, nominal) equipment Parameters; Maximum of 65kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18in)	2	1.5 m (5 ft)
NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV Parameters; Maximum of 35kA available fault current; maximum of 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36in)	4	12 m (40 ft)
Metal - clad switchgear, 1 kV through 15kV Parameters; Maximum of 35kA available fault current; maximum of 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36in)	4	12 m (40 ft)
Arc - resistant switchgear 1 kV through 15 kV [for clearing tines of less than 0.5sec (30 cycles) with an available fault current 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 15kV. Parameters; Maximum of 35kA available fault current; maximum of 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36in)	N/A (doors closed) 4 (doors open)	N/A (doors closed) 12 m (40 ft)
Other equipment 1 kV through 15kV Parameters; Maximum of 35kA available fault current; maximum of 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36in)	4	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 are flash PPE category 1.

Informational Note to Table 130.7(C)(15)(a): The following are typical fault clearing times of over - current 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 reguarding 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 100V and less than or equal to 250V		
Maximum arc duration and minimum working distance: 2 sec @ 455 mm (18in)		
Available fault current less than 4 kA	2	900 mm (3 ft)
Available fault current greater than or equal to 4 kA and less than 7 kA	2	1.2 m (4 ft)
Available fault current greater than or equal to 7 kA and less than 15kA	3	1.8 m (6 ft)
Storage batteries, dc switchboards and other dc supply sources		
Parameters: Greater than 250V and less than or equal to 600V		
Maximum arc duration and minimum working distance: 2 sec @ 455 mm (18in)		
Available fault current less than 1.5kA	2	900 mm (3 ft)
Available fault current greater than or equal to 1.5kA 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 10kA	4	2.5 m (8ft)

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: 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 isn no overcurrent protection device (OCPD) or if the fault clearing time is not known. If the fault clearing time is not known. If the fault clearing time is know ans 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 impedences 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 an 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 calcuations. 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 mutliplier 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.

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

Table 130.7(C)(15)(c) Is not applicable to evaluations conducted using the incident energy analysis method. For arc flash PPE clothing requirments fo rthe incident energy analysis method, see 130.5(G) and 130.7(C)(1) through (C)(14).

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

[a] Arc rating is defined in Article 100

[b] 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

[c] 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.

[d] If rubber insulated 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.

Arc - Flash PPE Category	PPE
1	**Arc - Rated Clothing, Minimum Arc Rating of 4 cal / cm^2 (16.75 J / cm^2) [a]** Arc - rated long sleeve shirt and pants or arc rated overall Arc - rated face shield [b] or ar flash suit hood Arc - rated jacket, parka, rainwear, or harhat liner (AN) **Protective Equipment** Har 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 / cm^2 (33.5 J / cm^2) [a]** Arc - rated long sleeve shirt and pants or arc rated overall Arc - rated suit hood or arc rated face shield [b] and arc rated balaclava Arc - rated jacket, parka, rainwear, or harhat liner (AN) **Protective Equipment** Har hat Safety Glasses or safety goggles (SR) Hearing protection (ear canal inserts) [c] Heavy duty leather gloves [d] Leather footwear (AN)
3	**Arc - Rated Clothing, Selected so that the Systme Arc Rating Meets the Required Minimum Arc Rating of 25 cal / cm^2 (104.7 J / cm^2) [a]** Arc - rated long sleeve shirt 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 harhat liner (AN) **Protective Equipment** Har hat Safety Glasses or safety goggles (SR) Hearing protection (ear canal inserts) [c] Heavy duty leather gloves [d] Leather footwear (AN)

4	**Arc - Rated Clothing, Selected so that the Systme Arc Rating Meets the Required Minimum Arc Rating of 40 cal / cm^2 (167.5 J / cm^2) [a]** Arc - rated long sleeve shirt 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 harhat liner (AN) **Protective Equipment** Har hat Safety Glasses or safety goggles (SR) Hearing protection (ear canal inserts) [c] Heavy duty leather gloves [d] Leather footwear (AN)

The arc - rated clothing and protective equipment shown in Table 130.7(C)(15)(c) are only to be used with Tabe 130.7(C)(15)(a) for ac systems and Table 130.7(C)(15)(b) for dc systems. Table 130.7(C)(15)(c) is not to be used to select PPE as a result of an incident energy calculation. The PPE listed in these tables protect only from an arc flash hazard. Arc - rated clothing is available in many constructions, and arc flash PPE rated in cal/cm^2 is suitable for that incidient energy level. Table 130.7(C)(15)(c) suggests acceptable combinations of clothing items to achieve a desired arc flash PPE category. Other combinations are possible.

Table 130.7(C)(15)(c) provides general information that can help an employee understand the process for selecting clothing based on arc flash PPE category designation, but it does not describe any required combination or construction of a protective system. The manufactured system can differ from what is described in the table; the clothing manufacturer needs to be consulte. See Informational Note No. 3 to 130.7(C)(15)(c).