Fuels & Lubricants

Electrical Safe Work Standard

Approved: November 2021
Version 1.0

Electrical Safe Work

1.0 Introduction

Electrical safe work procedures are designed to help prevent personnel injuries, property damage or adverse environmental impact due to electrical shock, arc flash, arc blast and fire ignition.

This standard defines DS&C and Fuels & Lubricants (F&L) requirements for performing work safely on or near electrical equipment operating at 50 volts dc or ac (rms) and above. This standard does not apply to work on low voltage/low current capacity electrical systems defined as less than 50 volts dc or ac (rms); and are not required to be placed in an electrically safe condition.

In addition to the requirements of this standard, local electrical code and safety code regulations shall apply and may require additional or more conservative practices than those defined in this standard. In the absence of local codes or regulatory standards for electrical safety in the workplace, "The Standard for Electrical Safety in the Workplace" (NFPA 70E - 2015), as supplemented by this standard shall apply.

Note on text formatting:

Letters in Parentheses (e.g., (A)) indicate linkage to the requirement in the Corporate Electrical Safe Work Standard

2.0 Requirements

A written program for electrical safe work practices and procedures shall be in place and include the following elements at a minimum:

1. Always consider alternatives before beginning energized electrical work activities.
2. All electrical system, power lines, electrical equipment or electrical parts shall be considered energized until they are verified to be in an electrically safe work condition. (A)
3. All electrical systems, power lines, electrical equipment or electrical parts shall be placed into an electrically safe work condition before personnel performs work if either of the following circumstances exist: (B)
    a. Personnel are within the limited approach boundary for shock protection.
    b. Personnel interacts with electrical equipment (e.g., throwing a switch, turning on/off) where conductors or circuit parts are not exposed but there is an increased risk of injury from an exposure to an arc flash hazard.
    c. Exceptions to the requirements (3.a) and (3.b) above are:
        i. A properly installed and maintained isolation element or a means of disconnection is operated, opened, closed, removed or inserted to achieve an electrically safe work condition for connected equipment (de-energize) or
        ii. To return connected equipment to service (energize) that has been placed in an electrically safe work condition provided a risk assessment is performed and does not identify unacceptable risks for the task.
4. Electrical equipment that exposes a worker to incident energy levels greater than 40 cal/cm2 (167.4 J/cm 2), calculated at the distance for working on the energized

electrical conductors or circuit parts, shall only be worked on with the circuit placed in an electrical safe work condition. (C)

5. A Permit to Work shall be required for work on energized electrical equipment or electrical parts. (D)
6. An Energized Electrical Work Permit or certificate (See Annex 1 for an example) shall be required when performing work (e.g., physical work such as replacing fuses, tightening bolts) inside the restricted approach boundary of exposed, energized electrical conductors or circuit parts that are not placed in an electrically safe work condition with the following exceptions for work conducted by a Qualified Electrical Person: (E)
    a. Electric diagnostic testing and maintenance troubleshooting where no physical alteration of equipment is required (e.g., testing for voltage, testing for permissive elements).
    b. Attach grounds on equipment that is in an electrically safe condition.
    c. Perform switching operations using live line tools.
    d. Preventive and predictive maintenance observation and infrared thermography performed outside the restricted approach boundary.
    e. Reset device overloads.
    f. Covering exposed energized circuit parts with voltage rated blankets or covers.
7. An Energized Electrical Work Permit shall be used in conjunction with a Permit to Work in accordance with the DS&C and F&L Required Permit to Work Standard. Alternatively, locations may only use an Energized Electrical permit providing that it complies with all the requirements of a General Work Permit in the F&L Permit to Work Standard. (F)
8. Electrical systems and electrical equipment shall be de-energized, isolated and re-energized in accordance with the DS&C and F&L Required Isolation of Hazardous Energy Standard. (G)
9. Electrical work conducted within a Hazardous Classified Location shall be performed in accordance with DS&C and F&L Required Hot Work Standard. (H)
10. A Hazard Analysis shall be performed in accordance with the DS&C and F&L Hazard Analysis Standard when planning work on or near electrical equipment: (I)
    a. To identify significant, potential hazards (e.g., shock and arc flash).
    b. To identify the need for special processes such as gas testing.
    c. To identify if work will require permits or certificates (e.g., Permit to Work, Isolation of Hazardous Energy, Confined Space, Work at Height and Excavation).
    d. To assess the need for Simultaneous Operations (SimOps), and if so, to evaluate potential hazards associated with the SimOps.
    e. To identify and evaluate any other precautions to ensure that work will be conducted safely.
11. A Job Safety Analysis (JSA) or equivalent shall be conducted by a Qualified Electrical Person at the work site in accordance with the DS&C and F&L Hazard Analysis Standard prior to beginning work on or near electrical equipment. (T)
12. A shock and arc flash hazard analysis shall be performed and reviewed by a Qualified Electrical Person considering approach or other boundaries established by regulatory

standards, Chevron Standards and accepted best practices before a person approaches any exposed energized electrical conductor or circuit part that has not been placed in an electrically safe work condition. Including work that: (J)

a. Places equipment into an electrically safe work condition.

b. Re-energizes equipment for return to service.

13. A shock and arc flash hazard analysis shall include but is not limited to identifying: (K)

    a. The voltage to which a worker may be exposed.

    b. The associated shock and arc flash boundaries.

    c. The personal protective equipment required by persons working with the shock and arc flash boundaries.

    d. The arc flash energy that is present when energized

14. The conditions under which an arc flash hazard analysis is not required shall be documented. (L)

15. Electrical hazard approach boundaries to energized electrical conductors or circuit parts for Unqualified, Authorized and Qualified Electrical Persons shall be specified and be in accordance with regulatory standards, Chevron Standards or accepted best practices. (M)

16. Personnel working within the limited approach boundary of exposed energized electrical conductors or circuit parts shall remove all jewelry and other conductive apparel.(N)

17. Only Qualified Electrical Personnel shall work inside the restricted approach boundary when there a presence of exposed or energized conductors or circuit parts.(O)

18. A minimum of two workers shall be present for work on energized circuit parts 50V or greater or work within the restricted approach boundary, for work on exposed energized circuits above 300V, where a shock hazard exits. One worker shall be a Qualified Electrical Person and the second worker shall act as an Electrical Stand-by Person. Exceptions to this requirement are permitted if one of the following conditions are satisfied: (P)

    a. All voltage sources greater than 50 V to the equipment have been proven to be de-energized, including possible back-feeds prior to starting work

    b. The equipment has a built-in grounding device that is clearly visible to confirm that grounding has been accomplished.

    c. Additionally, prior to working on a previously energized conductor or circuit part, the Qualified Electrical Person shall test for voltage while using insulated rubber gloves rated for the equipment's nominal value.

19. The special hazards of arc flash in a confined space shall be considered before authorizing Confined Space Entry work. (Q)

20. Voltage testing procedures (e.g., for verification of zero energy or troubleshooting) shall include, but are not limited to: (R)

    a. Appropriately rated PPE (e.g., gloves, clothing, arc rated face shield, hearing protection, non-conductive safety toe footwear and Class E hard hat).

    b. Test Instrument is the correct rating, type and is calibrated per manufacturer requirements and approved for checking voltage. The calibration shall be performed annually and documented (only applicable for instruments used for quantitative testing).

c. Verify that the test instrument is working properly before and after testing for the presence of voltage.

d. Establish the safe work area around the equipment for which work is performed (what equipment will be tested and work area boundaries).

e. Test every exposed conductor and circuit part in identified work plan (e.g., phase-to-ground and phase-to- phase for all three-phase systems). Alternate methods of voltage detection may be used for high voltage (HV) systems (i.e., HV proximity test instruments rated for the voltage and appropriate training on the use of the equipment).

f. Retest for absence of voltage any time conditions change or the work site is left unattended.

g. Identify approved alternate voltage testing methods when there are no accessible exposed points to take readings.

21. Electrical work that requires a written work plan or procedure shall be defined by a Qualified Electrical Person. (S)
22. Measures (e.g., safety signs and tags, barricades, attendants) shall be taken to prevent or limit access to electrical work areas containing energized conductors or circuit parts. (U)
23. Safe work zones (as defined by the greater of either the limited approach boundary or arc flash boundary) shall be visibly barricaded and marked with warning labels (V)
24. Tools and equipment used within restricted approach boundary of exposed energized conductors or circuit parts shall be insulated or rated for the voltages at which they can be safely used. (W)
25. Tools and equipment used for live-line work shall be stored in a clean dry location and shall be cleaned and inspected for defects before each use. (X)
26. Live line tools and equipment shall be tested annually (preferred), or as required by local codes or regulations and shall be documented. (Y)
27. Energized insulated cables, cords or conductors without personnel ground fault protections (i.e. on a circuit protected by a GFCI or RCD that meets regulatory requirements) shall only be handled using safe work practices or insulating protective equipment rated for the voltages on which they are used. (Z)
28. Personnel performing electrical work shall be provided with PPE in conformance with industry standards (e.g., ASTM/ANSI) and used for the intended part of the body to be protected and for the work to be performed. (AA)

    a. Voltage rated gloves shall be worn for the insertion and removal of draw-out starters of 1000v or more to/from their associated switchgear cubicles. (This does not include circuit breakers used as motor starters).

29. Ground-fault circuit interrupters (GFCIs) or residual current devices (RCDs) shall be provided for personnel protection and used according to regulatory standards, Chevron Standards or local codes on cord-connected power tools and other cord-connected devices used outdoors, in damp environments, or on concrete slabs that originate at grade level. (BB)
30. Power System Switching

    a. A switching procedure written by a qualified person (one knowledgeable of the distribution system, associated hazards and anticipated consequences), is required before any switching is performed on a power distribution system (this does not include switching of individual motors).

b. Written switching procedures shall be reviewed by at least one other qualified person and the switching procedure shall be signed and dated by both.

c. Routine switching may employ a standard switching procedure. Such standard procedures shall be properly approved, and on file for ready access.

d. The written switching procedure (standard or one-time) shall be executed by a qualified person and the steps shall be followed in the order in which the steps are written, checking off each switching step when completed, and recording the time of completion. After each switching step verification shall be made that the equipment operated as expected (i.e. all three phases of switch opened).

e. If the steps outlined in the written procedure must be changed in the field, during the execution of the switching procedure, the changes shall be reviewed, documented and approved by two qualified persons prior to implementing the changes.

f. All employees that will be involved in the switching shall attend the job briefing and all areas affected by switching activities shall be notified prior to initiating the switching procedure.

g. Personnel performing switching activities shall ensure compliance with required PPE for appropriate tasks and establish or confirm appropriate flash protective boundaries

h. Following the completion of the switching activities the switching procedure shall remain in the possession of the person/group doing the work.

i. The status of the power system when switching is complete, including the location of any and all safety grounds, shall be documented. Use of a status board or pin board is an acceptable method of documentation.

j. When returning equipment to normal service, the switching plan shall be followed using the same protocol as stated above

31. Portable and vehicle-mounted generators that are used to provide power to cord-connected tools and equipment shall meet the following requirements: (CC)

    a. Generators greater than 5kW single phase shall have a connection to ground (earth).

    b. Only the receptacles (plug sockets) mounted on the generator or vehicle are used to provide power to cord-connected tools or cord-connected equipment.

    c. Non-current carrying metal parts of the equipment and the equipment grounding conductor of the receptacles are bonded to the generator frame.

    d. For vehicle mounted generators, the frame of the generator is bonded to the frame of the vehicle.

    e. Any neutral conductor is bonded to the generator frame.

32. Ladders used for electrical work shall have vertical components (the rung side supports) made of non-conductive materials according to regulatory standards, Chevron standards and accepted best practices. (DD)

33. Equipment, including mobile equipment (e.g., scaffolds, cranes, bucket trucks (not rated for electrical work), cement pumpers, aerial man-lifts, fork trucks and similar equipment (or any part of equipment, load line or load) shall maintain an approach distance of: (EE)

a. 20 feet of an overhead power line if voltages are unknown or

b. The Minimum Clearance Distances specified in Table 1 provided the requirements of the DS&C Lifting and Rigging Standard are followed including but not limited to: the use of barricades; warning decals, labels and/or signs; and dedicated spotters, proximity alarms, warning devices, range limiter and or insulating devices.

i. Table 1. Minimum Clearance Distance for overhead power lines at Specific Voltages (OSHA 1926.1408 Table A)

c. Table 1 in Electrical Safe Work Standard

Voltage (nominal, kV, alternating current)	Minimum (proximity) Clearance Distance (feet)
Up to 50	10 (3.1 meters)
Over 50 to 200	15 (4.6 meters)
Over 200 to 350	20 (6.2 meters)
Over 350 to 500	25 (7.6 meters)
Over 500 to 750	35 (10.7 meters)
Over 750 to 1,000	45 (13.7 meters)
Over 1,000	As established by the utility owner/operator or registered professional engineer who is a qualified person with respect to electrical power transmission and distribution.

34. The minimum clearance distance table above outlines what distance needs to be maintained by personnel from overhead power lines. Only Qualified Electrical Personnel are allowed to enter this zone.

a. If any part of the mobile equipment, load line or load could encroach on the Minimum Clearance Distances noted in Table 1 above, a dedicated spotter in constant communication with the equipment operator is required.

35. The following requirements shall apply to mobile equipment including bucket trucks, cranes, cement pumpers, aerial man-lifts and similar equipment that are required to work within Minimum Clearance Limits noted in Table 1 above. They include but are not limited to: (FF (1-4)).

a. Mobile equipment booms and buckets used specifically for energized electrical work shall be insulated and tested at least annually.

b. Mobile equipment used for electrical work shall be operated only by personnel trained and qualified in the use of this equipment.

c. Qualified Electrical Personnel shall establish a barricade around any mobile equipment that is to be operated within the 10 feet (3.0 meters) safety distance or within any of the Minimum Clearance Distances noted in Table 1 above.

d. Mobile equipment shall be grounded, with the exception that when electrical conductors or circuit parts associated with overhead lines (including any possible back-feeds) have been grounded (earthed) from all possible directions relative to the mobile equipment.

e. A dedicated spotter shall be used when equipment is operated near (within the Minimum Clearance Distances noted in Table 1 above) overhead power lines.

36. Grounding shall be required to prevent back-feeds on equipment that is isolated for maintenance, including but not limited to: (GG)

    a. All switchgear buses

    b. All feeders from sub-stations

    c. All bare conductor circuits

    d. All motor circuits over 690 volts, nominal

37. Conditions for Stopping Work

Electrical work shall be stopped / suspended in but not limited to the following circumstances:

a. Any unexpected energized components are discovered
b. Failure to use insulated equipment and tools within the Restricted Approach Boundary
c. Failure to maintain barricades, signs and boundaries as required by the Flash and Shock Hazard Assessments
d. Stand By Person, when required, leaves post without a qualified replacement

38. The reporting unit/facility shall establish a frequency of inspection and maintenance for electrical equipment (e.g., voltage meters, portable equipment/tools) in accordance with regulatory standards, Chevron standards, manufacturer's recommendation or accepted best practices. (HH)

39. The reporting unit/business/facility shall maintain documentation of employees and contractors authorized to perform electrical work. (II)

3.0 Roles and responsibilities

Table 2: Roles, Responsibilities & Competencies

Role	Responsibilities	Minimum Performance-Based Skills Required
Competent Person	• Identifies existing and potential hazards associated with work • Knowledgeable of applicable standards within area of expertise • Subject Matter Expert for specialized work (e.g. excavation inspector, lifting & rigging specialist, etc.) • Mitigates hazards associated with specialized work • Understands when to stop work • Provides technical support and regulatory advice for specific work-related topics.	• Relevant F&L SWP Stds.
Subject Matter Expert (SME)	• Provide HES or technical expertise to organization. • Provide HES or technical expertise to assessing potentially significant impacts, identifying appropriate	• Knowledge and experience in MSW or technical area of expertise. • Expert level experience in specific subject matter.

Role	Responsibilities	Minimum Performance-Based Skills Required
	measures to reduce and mitigate potential impacts. • Provides input in determining the effectiveness of MSW or relevant technical standards. • Influence BU decision-making around MSW or technical issues	
Electrical Safe Work ***Authorized Electrical Person***	• Knowledgeable about potential electrical hazards • Performs isolation of (electrical) hazardous energy • Understands the planned work and emergency notification procedures • Only performs electrical work within authorization scope (e.g. electricians vs. mechanics vs. operators, etc.) • Understands when to stop work	• F&L Electrical Safe Work Std. • F&L Isolation of Hazardous Energy Std. • F&L Permit to Work/Hazard Analysis Std. • Specific training to perform specific electrical tasks relevant to work scope.
Electrical Safe Work ***Electrical Standby Person***	• Knowledgeable about potential electrical hazards • Performs isolation of (electrical) hazardous energy • Understands the planned work and emergency notification procedures • Observe the person performing electrical work and assist in emergency situations • Must be either a Qualified Electrical Person or an Authorized Electrical Person. • Understands when to stop work	• F&L Electrical Safe Work Std. • F&L Isolation of Hazardous Energy Std. • F&L Permit to Work/ Hazard Analysis Std. • Specific training to perform specific electrical tasks relevant to work scope. • First Aid & CPR Trained
Electrical Safe Work ***Qualified Electrical Person***	• Knowledgeable about the construction and operation of electrical equipment and installations (e.g. certified electricians, etc.) • Conduct and review shock and arc flash hazard analyses • Authorized to work within the Restricted Approach Boundary. • Performs isolation of (electrical) hazardous energy • Performs testing of de-energized components to assure isolation. • Understands when to stop work	• F&L Electrical Safe Work Std. • F&L Isolation of Hazardous Energy Std. • F&L Permit to Work/Hazard Analysis Std. • First Aid & CPR Trained • Specific Safety Training on the identification and prevention of electrical hazards.
Electrical Safe Work ***Unqualified Person***	• Must remain outside of the Limited Approach Boundary.	• F&L Permit to Work / Hazard Analysis Std. elements pertaining to their work. • F&L Electrical Safe Work Std.

4.0 Training Requirements

4.1. Initial Training

Personnel assigned responsibilities in electrical work shall be trained and competent. (JJ)

Training requirements and competency assessments for personnel conducting electrical work shall be documented including, but not limited to: (KK)

a. Authorized Electrical Person

b. Electrical Standby Person

c. Qualified Electrical Person

Personnel conducting electrical work shall receive refresher training at a minimum of every three years or under any of the following conditions: (LL)

d. When hazards change

e. When new technologies and types of equipment are introduced

f. Whenever a person demonstrates insufficient knowledge of the F&L Electrical Safe Work Standard

g. Changes in the procedures or safety-related work practices differ from those that would be normally used.

h. When applicable regulations or standards change

i. If annual inspections indicate that personnel are not complying with the safety-related work practices.

j. When a serious incident related to Electrical Safe Work occurred and the root cause identified the need to be retrained.

k. Trained on the requirements of this standard, at least every three years

Unqualified Persons shall be trained in any electrical safety-related practices that are necessary as identified by F&L. (MM)

Personnel must meet the competency requirements and be trained on the requirements of this standard, prior to starting work. Refer to the F&L Training Requirements Tool.

5.0 Records

5.1 Records requirements

- Copies of all Permit to Work, Energized Electrical Form, MOC document and other associated documentation (including records of inspection, maintenance and competencies) shall be maintained in accordance with F&L Managing Safe Work Process.

5.2 Retention requirements

Records shall be retained for the periods as specified below:

- All records mentioned above shall be retained by the facility for at least 1 year after the job has been completed.
- Training Records shall be maintained for 3 years or until re-training occurs.

6.0 Document Control Information

6.1 Documents Reference List

Title	Attachment
Energized Electrical Work Form - Template	Energized Electrical Work Form - Template

7.0 Document Control

Description	Corporate	DS&C	F&L Specific
Approval Date			*November 2021*
Next Process Document Review			*November 2026*
Control Number			*Version 1.0*

7.1 Document Change History

Changes to this document are listed in the table below by change date.

Date (DD/MMM/YR)	Version Number	Description of Change
8 Nov. 2021	*1.0*	*New F&L Standard*

Appendix A: Arc Flash and Shock Hazard Approach Boundaries

As a result of accidents in the workplace related to shock and arc flash, the National Fire Protection Association (NFPA) has developed specific approach boundaries designed to protect employees while working on or near energized equipment.

NFPA 70E stipulates two approach boundaries in addition to the **arc flash protection boundary** that must be known and observed. The **shock hazard boundaries** are dependent on the system voltage.

The arc flash protection boundary is typically the farthest established boundary from the energy source. If an arc flash occurred, this boundary is where an employee would be exposed to a curable second degree burn (1.2 calories/cm2). When an energized conductor is exposed, you may not approach closer than the flash boundary without wearing appropriate personal protective clothing and personal protective equipment.

The limited approach boundary is the minimum distance from an exposed live component where unqualified personnel may safely stand. Only Qualified Electrical personnel and Authorized Electrical personnel are allowed to enter the limited approach boundary. The Qualified Electrical and Authorized Electrical personnel must use the appropriate PPE and be trained to perform the required work to cross the limited approach boundary and enter the limited space.

The restricted approach boundary is the distance from an exposed part which is considered the same as making contact with the live part. Only qualified personnel wearing appropriate personal protective equipment (PPE), having specified training to work on energized conductors or components, and a documented plan justifying the need to perform this work may cross the boundary and enter the Restricted Space.

Barricading the Work Area

A barricade must be set up to prevent unqualified or unauthorized personnel form entering the hazardous area. The barricade should be set up at the greatest of these three distances:

- 10 feet (3.05 meters) from any exposed live part – This is known as the 10 foot rule
- Limited Approach Boundary
- Arc Flash Boundary

Work Inside the Arc Flash Boundary

Measures (e.g., safety signs and tags, barricades, attendants) shall be taken to prevent or limit access to electrical work areas containing energized conductors or circuit parts.

- Safe work zones (as defined by the greater of either the limited approach boundary or arc flash boundary, or 10 feet/3.05 meters (whichever is greatest)) shall be visibly barricaded and marked with warning labels

Personnel working within the arc flash boundary are required to wear full arc flash protection PPE.

Only Qualified Electrical personnel and Authorized Electrical personnel are allowed to enter the arc flash boundary.

Work Inside the Limited Approach Boundary

Measures (e.g., safety signs and tags, barricades, attendants) shall be taken to prevent or limit access to electrical work areas containing energized conductors or circuit parts.

- Safe work zones (as defined by the greater of either the limited approach boundary or arc flash boundary, or 10 feet/3.05 meters (whichever is greatest)) shall be visibly barricaded and marked with warning labels

Personnel working within the limited approach boundary are required to wear full arc flash and shock hazard PPE.

Personnel working within the limited approach boundary of exposed energized electrical conductors or circuit parts shall remove all jewelry and other conductive apparel.

Only Qualified Electrical personnel and Authorized Electrical personnel are allowed to enter the limited approach boundary. These personnel must use the appropriate PPE and be trained to cross the limited approach boundary and enter the limited space.

Work Inside the Restricted Approach Boundary

A minimum of two workers shall be present for work on energized circuit parts 50V or greater. One worker shall be a Qualified Electrical Person and the second worker shall act as an Electrical Stand-by Person. Only the Qualified Electrical Person can conduct the actual work at or inside the restricted approach boundary.

Exceptions to this requirement are permitted if one of the following conditions are satisfied:

- All voltage sources greater than 50 V to the equipment have been proven to be de-energized, including possible back-feeds prior to starting work
- The equipment has a built-in grounding device that is clearly visible to confirm that grounding has been accomplished.
- Additionally, prior to working on a previously energized conductor or circuit part, the Qualified Electrical Person shall test for voltage while using insulated rubber gloves rated for the equipment's nominal value.

Only qualified personnel wearing appropriate personal protective equipment (PPE), having specified training to work on energized conductors or components, and a documented plan justifying the need to perform this work may cross the boundary and enter the Restricted Space.

When the Qualified Electrical Person is working in the Restricted Approach Boundary, an Electrical Standby Person must be in place.

There are two critical functions that the Electrical Standby Person must be prepared to perform:

1. Must be able to isolate the energy "upstream" (next isolation point toward the source) in an emergency. So, the Electrical Standby Person must know where this isolation point is and be qualified to perform this isolation task.
2. Must be able to respond in an emergency
    - Push the Qualified Electrical Person off of an energized circuit in the event they get "locked on". This must be accomplished without entering the Restricted Approach Boundary. A non-conductive pole is one way to accomplish this.
    - Activate the emergency response; call emergency services, etc.
    - Must be able to perform CPR and first aid as appropriate

Appendix B: PPE Hazard Risk Class

Protective Clothing and Personal Protective Equipment
Note: This chart is from NFPA 2012 and refers to an HRC category. This chart and the charts in Appendix B & C cannot be interchanged. This chart can be used as reference ONLY for those IEA labels that list an HRC rating.

Hazard/ Risk Category	Clothing and PPE Selection	Minimum Arc Rating
0	**Protective Clothing** Non-melting or Untreated Natural Fiber (i.e., untreated cotton, wool, rayon, or silk, or blends of these materials) with a Fabric Weight of at Least 4.5 oz/yd2 Shirt (long sleeve) Pants (long) **Protective Equipment** Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy duty leather gloves (AN) *(See Note 1.*)	**N/A**
1	**Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm2** *(See Note 3.)* Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated face shield *(see Note 2)* or arc flash suit hood Arc-rated jacket, parka, rainwear, or hard hat liner (AN) **Protective Equipment** Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy duty leather gloves *(See Note 1.)* Leather work shoes (AN)	**4 cal/cm^2**
2	**Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm2** *(See Note 3.)* Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated flash suit hood or arc-rated face shield *(See Note 2)* and arc rated balaclava Arc-rated jacket, parka, rainwear, or hard hat liner (AN) **Protective Equipment** Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy duty leather gloves *(See Note 1.)* Leather work shoes	**8 cal/cm^2**
3	**Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm2** *(See Note 3.)* Arc-rated long-sleeve shirt (AR) Arc-rated pants (AR) Arc-rated coverall (AR) Arc-rated arc flash suit jacket (AR) Arc-rated arc flash suit pants (AR) Arc-rated arc flash suit hood Arc-rated gloves *(See Note 1.)* Arc-rated jacket, parka, rainwear, or hard hat liner (AN) **Protective Equipment** Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather work shoes	**25 cal/cm^2**
4	**Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm2** *(See Note 3.)* Arc-rated long-sleeve shirt (AR) Arc-rated pants (AR)	**40 cal/cm^2**

	Arc-rated coverall (AR) Arc-rated arc flash suit jacket (AR) Arc-rated arc flash suit pants (AR) Arc-rated arc flash suit hood Arc-rated gloves *(See Note 1.)* Arc-rated jacket, parka, rainwear, or hard hat liner (AN) **Protective Equipment** Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather work shoes	

AN: as needed (optional). AR: as required. SR: selection required.
(1) If rubber insulating gloves with leather protectors are required by Table 130.7(C)(9), additional leather or arc-rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement.
(2) Face shields are to have wrap-around guarding to protect not only the face but also the forehead, ears, and neck, or, alternatively, an arc-rated arc flash suit hood is required to be worn.
(3) Arc rating is defined in Article 100 and can be either the arc thermal performance value (ATPV) or energy of break open threshold (EBT). ATPV is defined in ASTM F 1959, Standard Test Method for Determining the Arc Thermal Performance Value of Materials for Clothing, as the incident energy on a material, or a multilayer system of materials, that results in a 50 percent probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second-degree skin burn injury based on the Stoll curve, in cal/cm2. EBT is defined in ASTM F 1959 as the incident energy on a material or material system that results in a 50 percent probability of breakopen. Arc rating is reported as either ATPV or EBT, whichever is the lower value.

Appendix C: Arc Flash PPE Categories for AC Systems (NFPA 2015)

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

Equipment	Arc Flash PPE Category	Arc-Flash Boundary
Panelboards or other equipment rated 240 V and below Parameters: Maximum of 25 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	1	485 mm (19 in.)
Panelboards or other equipment rated >240 V and up to 600 V Parameters: Maximum of 25 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	2	900 mm (3 ft)
600-V class motor control centers (MCCs) Parameters: Maximum of 65 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	2	1.5 m (5 ft)
600-V class motor control centers (MCCs) Parameters: Maximum of 42 kA short-circuit current available; maximum of 0.33 sec (20 cycles) fault clearing time; working distance 455 mm (18 in.)	4	4.3 m (14 ft)
600-V class switchgear (with power circuit breakers or fused switches) and 600 V class switchboards Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.5 sec (30 cycles) fault clearing time; working distance 455 mm (18 in.)	4	6 m (20 ft)
Other 600-V class (277 V through 600 V, nominal) equipment Parameters: Maximum of 65 kA short circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	2	1.5 m (5 ft)
NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	4	12 m (40 ft)
Metal-clad switchgear, 1 kV through 15 kV Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	4	12 m (40 ft)
Arc-resistant switchgear Type 1 or 2 [for clearing times of < 0.5 sec (30 cycles) with a perspective 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, tested in accordance with IEEE C37.20.7, 1 kV through 15 kV	N/A (doors closed)	N/A (doors closed)
Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	4 (doors open)	12 m (40 ft)
Other equipment 1 kV through 15 kV Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	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 arc flash PPE category 1.

Appendix D: Arc Flash PPE Categories for DC Systems (NFPA 2015)

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

Equipment	Arc Flash PPE Category	Arc-Flash Boundary
Storage batteries, dc switchboards, and other dc supply sources 100 V > Voltage < 250 V Parameters: Voltage: 250 V Maximum arc duration and working distance: 2 sec @ 455 mm (18 in.)		
Short-circuit current < 4 kA	1	900 mm (3 ft)
4 kA ≤ short-circuit current < 7 kA	2	1.2 m (4 ft)
7 kA ≤ short-circuit current < 15 kA	3	1.8 m (6 ft)
Storage batteries, dc switchboards, and other dc supply sources 250 V ≤ Voltage ≤ 600 V Parameters: Voltage: 600 V Maximum arc duration and working distance: 2 sec @ 455 mm (18 in.)		
Short-circuit current 1.5 kA	1	900 mm (3 ft)
1.5 kA ≤ short-circuit current < 3 kA	2	1.2 m (4 ft)
3 kA ≤ short-circuit current < 7 kA	3	1.8 m (6 ft.)
7 kA ≤ short-circuit current < 10 kA	4	2.5 m (8 ft)

Note: Apparel that can be expected to be exposed to electrolyte must meet both of the following conditions:
(1) Be evaluated for electrolyte protection in accordance with ASTM F1296, *Standard Guide for Evaluating Chemical Protective Clothing*
(2) Be arc-rated in accordance with ASTM F1891, *Standard Specification for Arc Rated and Flame Resistant Rainwear*, or equivalent

Appendix E: De-energizing and Re-energizing Electrical Systems

Procedures for De-energizing

Procedures for de-energizing lines and equipment shall include the following steps:

1. Ensure correct identification of lines/equipment etc where work is to be performed
2. Identify all possible sources of electrical supply to the equipment or line;
3. Interrupt the load current, then open the disconnecting device(s) for each identified source;
4. If possible, visually verify that the blades of disconnecting devices are fully open or that draw-out type circuit breakers are fully removed from cubicles;
5. Verify that the application of lockout/tagout devices is done in accordance with the following document:
6. Use an adequately rated voltage tester on each phase conductor or circuit part to verify de-energization has occurred. Verify that the voltage detector is operating properly before first use and after each test;

   Note: Conduct voltage tests phase-to-ground and phase-to-phase.
7. Perform grounding as required, and

   Note: Ground the phase conductors or circuit parts before touching equipment or lines wherever stored electrical energy or induced voltages are possible. This shall be done in addition to locking and tagging out the device.
8. Establish a safe work zone.

   Note: It is unnecessary to lock and tag out or ground equipment with a cord that is unplugged, when the plug and cord are under the exclusive control of the person working on the equipment.

Procedures for Re-energizing

Procedures for re-energizing equipment or lines shall include all of the following steps:

1. Remove all protective grounds;

   Note: Grounds left on equipment present a short circuit hazard when the equipment is re-energized. A positive method of control shall be used to ensure ground removal before re-energizing equipment (tags, leaving doors or covers open, leaving the ground cables clearly visible, use of magnetic ground signs, utilization of the same crew that conducted the lockout/tagout to remove the grounds, keeping records/lists/schematics showing points of grounding, peer review, check-offs, etc.).
2. Ensure all covers and panels have been replaced;
3. Clear all workers from lines and equipment;
4. Remove all tags and locks;
5. Re-engage or insert (rack) interrupting devices such as circuit breakers or fuses; and
6. Re-energize the equipment or lines as directed by the facility owner and manufacturer recommended procedures.