NFPA® 70E®

Standard for Electrical Safety in the Workplace®

2021

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NFPA 70E®

Standard for

Electrical Safety in the Workplace®

2021 Edition

This edition of *NFPA 70E®*, *Standard for Electrical Safety in the Workplace®*, was prepared by the Technical Committee on Electrical Safety in the Workplace and released by the Correlating Committee on National Electrical Code®. It was issued by the Standards Council on June 1, 2020, with an effective date of June 21, 2020, and supersedes all previous editions.

This edition of *NFPA 70E* was approved as an American National Standard on June 21, 2020.

Foreword to *NFPA 70E*

The Standards Council of the National Fire Protection Association announced the formal appointment of a new electrical standards development committee on January 7, 1976. The Committee on Electrical Safety Requirements for Employee Workplaces reported to the association through the Technical Correlating Committee on *National Electrical Code® (NEC®)*. The committee was formed to assist OSHA in preparing an electrical safety standard that would serve OSHA's needs and that could be expeditiously promulgated through the provisions of Section 6(b) of the Occupational Safety and Health Act. OSHA found that in attempting to utilize the latest edition of the *NEC*, it was confronted with the following problems:

(1) OSHA could only adopt or modify a standard through procedures that provide for public notice, opportunity for public comment, and public hearings. The adoption of a new *NEC* edition by these procedures would require extensive effort and application of resources by OSHA and others. Going through the procedures might result in requirements substantially different from those of the *NEC*, thereby creating a conflict between the two standards.

(2) The *NEC* is intended for use primarily by those who design, install, and inspect electrical installations. Most of the *NEC* requirements are not electrical safety–related work practices, electrical system maintenance, or directly related to employee safety. However, OSHA electrical regulations, which address employers and employees in their workplaces, needed to consider and develop these safety areas.

It became apparent that a need existed for a new standard tailored to fulfill OSHA's responsibilities that would still be fully consistent with the *NEC*. This led to the concept of a new document that would extract suitable portions from the *NEC* and from other documents applicable to electrical safety. This concept and an offer of assistance was submitted in May 1975 to the Assistant Secretary of Labor for OSHA, who responded as follows: "The concept, procedures, and scope of the effort discussed with my staff for preparing the subject standard appear to have great merit, and an apparent need exists for this proposed consensus document which OSHA could consider for promulgation under the provisions of Section 6(b) of the Act. OSHA does have an interest in this effort and believes the proposed standard would serve a useful purpose." With this positive encouragement from OSHA, the NFPA Electrical Section unanimously supported a recommendation that the *NEC* Correlating Committee examine the feasibility of developing a document for evaluating electrical safety in the workplace. With recommendations from the Electrical Section and Correlating Committee, the Standards Council authorized the establishment of a committee to carry out this examination.

The committee would develop a standard for electrical installations that would be compatible with the OSHA requirements for employee safety in locations covered by the *NEC*. The standard was visualized as consisting of four major parts: Part I, Installation Safety Requirements; Part II, Safety-Related Work Practices; Part III, Safety-Related Maintenance Requirements; and Part IV, Safety Requirements for Special Equipment. It was not considered essential for all of the parts to be completed before the standard was published and made available. Each part was recognized as being

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an important aspect of electrical safety in the workplace, but the parts were sufficiently independent of each other to permit their separate publication. The first edition of NFPA *70E, Standard for Electrical Safety Requirements for Employee Workplaces*, was published in 1979 and included only Part I, Installation Safety Requirements.

The second edition published in 1981 included a new Part II, Safety-Related Work Practices. In 1983, the third edition added a new Part III, Safety-Related Maintenance Requirements. In 1988, the fourth edition was published with only minor revisions.

The 1995 edition included major revisions to Part I to conform to the 1993 edition of the *NEC*. The concepts of "limits of approach" and establishment of an "arc" were introduced in Part II. In 2000, the sixth edition included an update of Part I to the 1999 *NEC*, as well as a new Part IV, Safety Requirements for Special Equipment. Part II continued to focus on establishing flash protection boundaries and the use of personal protective equipment (PPE). Also, charts were added to Part II to assist in applying appropriate protective clothing and personal protective equipment for common tasks.

The 2004 edition presented several significant changes. The major changes emphasized safe work practices. Clarity and usability of the document were also enhanced. The title was changed to *Standard for Electrical Safety in the Workplace*. The document was reformatted to comply with the *National Electrical Code Style Manual*. The existing parts were renamed as chapters and were reorganized with the safety-related work practices relocated to the front of the document to highlight the emphasis, followed by safety-related maintenance requirements, safety requirements for special equipment, and safety-related installation requirements. The chapter on safety-related work practices also was reorganized to emphasize that working on live parts is the last alternative work practice. An energized electrical work permit and related requirements were incorporated into the document.

This standard is compatible with the *NEC* but is not intended to be used, nor can it be used, in lieu of the *NEC*. Chapter 4, Specific Purpose Equipment and Installations, was intended to serve a very specific need of OSHA. It was not intended to be applied as a design, installation, modification, or construction standard for an electrical installation or system. Its content was intentionally limited in comparison to the *NEC* in order to apply to an electrical installation or a system as part of an employee's workplace. Chapter 4 was updated to correlate with the 2002 edition of the *NEC*, but requirements not directly associated with employee safety were not included. Omission of *NEC* requirements did not affect the *NEC*, nor were omitted requirements considered as unimportant. They are essential to the *NEC* and its intended application — that is, its use by those who design, install, and inspect electrical installations. NFPA *70E*, on the other hand, is intended for use by employers, employees, and OSHA.

Requirements were upgraded throughout the 2009 edition. Chapter 4 was deleted because it was a duplicate of *NEC* installation requirements. Article 350 was added for R&D facilities. Other changes included significant revisions to Annex D, Annex F, and Annex J and the addition of Annex M, Annex N, and Annex O.

The 2012 edition marked another waypoint as this standard continued to evolve to meet the electrical safety needs of employers and employees. New research, new technology, and technical input from users provided the foundation for new and revised requirements that addressed the electrical hazards encountered by employees in current workplaces. Expanded or clarified requirements, inclusion of technical material not previously covered, and removal of requirements related to the safe installation of electrical equipment rather than being safe electrical work practices were some of the major actions undertaken during the revision cycle. In addition, requirements covering the separate but directly related concepts of hazard identification and risk assessment were revised to clarify the concepts. A significant revision to Annex F provided extensive coverage of this topic to assist users with implementing effective hazard identification and risk assessment procedures. Annex P on aligning NFPA *70E* implementation with occupational health and safety management standards was added.

The majority of changes occurred in Chapter 1. Article 105, Application of Safety-Related Work Practices, and a requirement for hearing protection when working within an arc flash boundary were added, as were work practice requirements on the use of GFCIs to protect employees. Clarification was made that Article 130 applies whether incident energy analysis or the hazard/risk table was used to determine use and level of PPE. Short-circuit current, fault clearing time, and arc flash boundary information were included in the hazard/risk category tables. Another major revision included changing "flame-resistant (FR)" to "arc-rated (AR)" in regard to PPE.

The 2015 edition incorporated a major shift in how stakeholders evaluate electrical risk. In support of this, new definitions for *hazard*, *hazardous*, *risk*, and *risk assessment* were added to Article 100. Throughout the document, changes were made to provide clarity to users, such as changing *hazard analysis* to *risk assessment*. These global changes ensured consistent use of these terms throughout the document and provided consistency between *NFPA 70E* and other standards that address hazards and risk. Other major revisions included the following:

(1) The definition of a qualified person was revised to correlate with the OSHA definition.

(2) Safety-related maintenance requirements and other administrative controls were added to the scope statement to clarify that training and auditing are equally important safety-related work practices.

(3) An electrical safety program must consider condition of maintenance.

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(4) Clarification was provided that the equipment owner or the owner's designated representative is responsible for maintenance of the electrical equipment and documentation.

(5) New maintenance requirements were added for test instruments and associated test leads utilized in the verification of the absence or presence of voltages.

(6) New requirements clarified where normal operation of electric equipment is permitted.

(7) Clarification was made that either the incident energy analysis method or arc flash PPE category method can be used on a piece of equipment for the selection of PPE, but not both. The revision clarified that the results of an incident energy analysis is not permitted to be used to specify an arc flash PPE category.

(8) A new task-based table combined the previously separate ac and dc tables used to determine when arc flash PPE is required and made them consistent, improving usability.

(9) New equipment-based tables were added for determining the arc flash PPE category for ac systems and for dc systems.

(10) Hazard/risk category 0 was removed because the new PPE table only specifies PPE for work within the arc flash boundary. Hazard/risk category was also changed to PPE category.

(11) Prohibited approach boundary was deleted because additional protective equipment was not required when crossing this boundary.

(12) The criterion to use insulated tools or handling equipment was changed from the limited approach boundary to restricted approach boundary.

(13) All references to bare-hand work were removed. This work is considered to be a "utility type" line work technique more appropriately addressed in other standards.

(14) Field-marked equipment labeling requirements were revised to require an updated label when the arc flash hazard risk assessment identifies a change that renders the label inaccurate.

(15) A risk assessment is required prior to any work on a battery system to identify the chemical, electrical shock, and arc flash hazards and assess the risks associated with the type of tasks to be performed.

The 2018 edition continued to evolve to address risk assessment and introduce human factors, such as human error, as part of that assessment. Annex Q, Human Performance and Workplace Electrical Safety, was included to provide guidance in this area. This edition emphasized the need to use the hierarchy of risk controls by moving it from an informational note into the text of the standard. *NFPA 70E* explicitly stated that the first priority must be the elimination of the hazard.

The previous arc flash hazard identification table [Table 130.7(C)(15)(A)(a)] was modified to determine the likelihood that an arc flash could occur and renumbered as Table 130.5(C). This modified table could be used with either method of arc flash risk assessment.

The most notable change for the 2018 edition was that tables and text that specified PPE standards were moved to informational tables or notes. In previous editions employers were, and still are, required to verify that appropriate PPE is given to employees. Section 130.7(C)(14)(b) was added to provide guidance on conformity assessment of PPE. These changes did not alter the employer's responsibility for determining the validity of the PPE manufacturer's claims.

Definitions for *fault current* and *available fault current* were added, and other terms used throughout the standard for this current were changed for consistency. Article 120 was rearranged to present the requirements for establishing an electrically safe work condition in a logical order of application of the program. Article 320 introduced voltage thresholds of 50 Vac and 100 Vdc specifically for batteries and battery rooms to address the unique situations in these locations. Article 330 addressing lasers was extensively revised to address safety-related maintenance issues rather than issues associated with laser use. Article 350 introduced an Electrical Safety Authority as a possible authority having jurisdiction for laboratories.

For the 2021 edition, Article 110 was revised to incorporate the general requirements for electrical safety-related work programs, practices, and procedures from other articles. The reference to arc-resistant switchgear has been changed to arc-resistant equipment in Tables 130.5(C) and 130.7(C)(15)(a) to address the use of other types of arc-resistant equipment. Article 360, Safety-Related Requirements for Capacitors, and Annex R, Working with Capacitors, were added to address specific electrical safety requirements unique to capacitors. Annex D, Incident Energy and Arc Flash Boundary Calculation Methods, was revised to reference IEEE-1584-2018 as a method of calculation.

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Contents

90 Introduction **70E–** 8

Chapter 1 Safety-Related Work Practices

100 Definitions **70E–** 10
105 Application of Safety-Related Work Practices and Procedures **70E–** 15
110 General Requirements for Electrical Safety-Related Work Practices **70E–** 15
120 Establishing an Electrically Safe Work Condition **70E–** 20
130 Work Involving Electrical Hazards **70E–** 24

Chapter 2 Safety-Related Maintenance Requirements

200 Introduction **70E–** 42
205 General Maintenance Requirements **70E–** 42
210 Substations, Switchgear Assemblies, Switchboards, Panelboards, Motor Control Centers, and Disconnect Switches **70E–** 43
215 Premises Wiring **70E–** 43
220 Controller Equipment **70E–** 43
225 Fuses and Circuit Breakers **70E–** 43
230 Rotating Equipment **70E–** 43
235 Hazardous (Classified) Locations **70E–** 44
240 Batteries and Battery Rooms **70E–** 44
245 Portable Electric Tools and Equipment **70E–** 44
250 Personal Safety and Protective Equipment **70E–** 44

Chapter 3 Safety Requirements for Special Equipment

300 Introduction **70E–** 46
310 Safety-Related Work Practices for Electrolytic Cells **70E–** 46
320 Safety Requirements Related to Batteries and Battery Rooms **70E–** 48
330 Safety-Related Work Practices: Lasers **70E–** 50
340 Safety-Related Work Practices: Power Electronic Equipment **70E–** 51
350 Safety-Related Work Requirements: Research and Development Laboratories **70E–** 52
360 Safety-Related Requirements for Capacitors **70E–** 53

Informative Annex A: Informative Publications **70E–** 56

Informative Annex B: Reserved **70E–** 59

Informative Annex C: Limits of Approach **70E–** 60

Informative Annex D: Incident Energy and Arc Flash Boundary Calculation Methods **70E–** 62

Informative Annex E: Electrical Safety Program **70E–** 68

Informative Annex F: Risk Assessment and Risk Control **70E–** 69

Informative Annex G: Sample Lockout/Tagout Program **70E–** 72

Informative Annex H: Guidance on Selection of Protective Clothing and Other Personal Protective Equipment (PPE) **70E–** 75

Informative Annex I: Job Briefing and Job Safety Planning Checklist **70E–** 78

Informative Annex J: Energized Electrical Work Permit **70E–** 81

Informative Annex K: General Categories of Electrical Hazards **70E–** 83

Informative Annex L: Typical Application of Safeguards in the Cell Line Working Zone **70E–** 84

Informative Annex M: Layering of Protective Clothing and Total System Arc Rating **70E–** 85

Informative Annex N: Example Industrial Procedures and Policies for Working Near Overhead Electrical Lines and Equipment **70E–** 86

Informative Annex O: Safety-Related Design Requirements **70E–** 89

Informative Annex P: Aligning Implementation of This Standard with Occupational Health and Safety Management Standards **70E–** 91

Informative Annex Q: Human Performance and Workplace Electrical Safety **70E–** 92

Informative Annex R: Working with Capacitors **70E–** 97

Index **70E–** 107

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Committee Scope: This Committee shall have primary responsibility for documents for work practices that are necessary to provide a practical safe workplace relative to the hazards associated with electrical energy. This Committee shall have primary jurisdiction, but shall report to Correlating Committee of the National Electrical Code.

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NFPA 70E

Electrical Safety in the Workplace

2021 Edition

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Information on referenced and extracted publications can be found in Informative Annex A.

ARTICLE 90
Introduction

90.1 Purpose. The purpose of this standard is to provide a practical safe working area for employees relative to the hazards arising from the use of electricity.

90.2 Scope.

(A) Covered. This standard addresses electrical safety-related work practices, safety-related maintenance requirements, and other administrative controls for employee workplaces that are necessary for the practical safeguarding of employees relative to the hazards associated with electrical energy during activities such as the installation, removal, inspection, operation, maintenance, and demolition of electric conductors, electric equipment, signaling and communications conductors and equipment, and raceways. This standard also includes safe work practices for employees performing other work activities that can expose them to electrical hazards as well as safe work practices for the following:

(1) Installation of conductors and equipment that connect to the supply of electricity
(2) Installations used by the electric utility, such as office buildings, warehouses, garages, machine shops, and recreational buildings that are not an integral part of a generating plant, substation, or control center

Informational Note: This standard addresses safety of workers whose job responsibilities involve interaction with energized electrical equipment and systems with potential exposure to electrical hazards. Concepts in this standard are often adapted to other workers whose exposure to electrical hazards is unintentional or not recognized as part of their job responsibilities. The highest risk for injury from electrical hazards for other workers involve unintentional contact with overhead power lines and electric shock from machines, tools, and appliances.

(B) Not Covered. This standard does not cover safety-related work practices for the following:

(1) Installations in ships, watercraft other than floating buildings, railway rolling stock, aircraft, or automotive vehicles other than mobile homes and recreational vehicles
(2) Installations of railways for generation, transformation, transmission, or distribution of power used exclusively for operation of rolling stock or installations used exclusively for signaling and communications purposes
(3) Installations of communications equipment under the exclusive control of communications utilities located outdoors or in building spaces used exclusively for such installations
(4) Installations under the exclusive control of an electric utility where such installations:
   a. Consist of service drops or service laterals, and associated metering, or
   b. Are located in legally established easements or rights-of-way designated by or recognized by public service commissions, utility commissions, or other regulatory agencies having jurisdiction for such installations, or
   c. Are on property owned or leased by the electric utility for the purpose of communications, metering, generation, control, transformation, transmission, or distribution of electric energy, or
   d. Are located by other written agreements either designated by or recognized by public service commissions, utility commissions, or other regulatory agencies having jurisdiction for such installations. These written agreements shall be limited to installations for the purpose of communications, metering, generation, control, transformation, transmission, or distribution of electric energy where legally established easements or rights-of-way cannot be obtained. These installations shall be limited to federal lands, Native American reservations through the U.S. Department of the Interior Bureau of Indian Affairs, military bases, lands controlled by port authorities and state agencies and departments, and lands owned by railroads.

90.3 Standard Arrangement. This standard is divided into the introduction and three chapters, as shown in Figure 90.3. Chapter 1 applies generally, Chapter 2 addresses safety-related maintenance requirements, and Chapter 3 supplements or modifies Chapter 1 with safety requirements for special equipment.

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Informative annexes are not part of the requirements of this standard but are included for informational purposes only.

90.4 Mandatory Rules, Permissive Rules, and Explanatory Material.

(A) Mandatory Rules. Mandatory rules of this standard are those that identify actions that are specifically required or prohibited and are characterized by the use of the terms *shall* or *shall not*.

(B) Permissive Rules. Permissive rules of this standard are those that identify actions that are allowed but not required, are normally used to describe options or alternative methods, and are characterized by the use of the terms *shall be permitted* or *shall not be required*.

(C) Explanatory Material. Explanatory material, such as references to other standards, references to related sections of this standard, or information related to a rule in this standard, is included in this standard in the form of informational notes. Such notes are informational only and are not enforceable as requirements of this standard.

Brackets containing section references to another NFPA document are for informational purposes only and are provided as a guide to indicate the source of the extracted text. These bracketed references immediately follow the extracted text.

Informational Note: The format and language used in this standard follow guidelines established by NFPA and published in the *National Electrical Code Style Manual*. Copies of this manual can be obtained from NFPA.

(D) Informative Annexes. Nonmandatory information relative to the use of this standard is provided in informative annexes. Informative annexes are not part of the requirements of this standard, but are included for information purposes only.

90.5 Formal Interpretations. To promote uniformity of interpretation and application of the provisions of this standard, formal interpretation procedures have been established and are found in the Regulations Governing the Development of NFPA Standards.

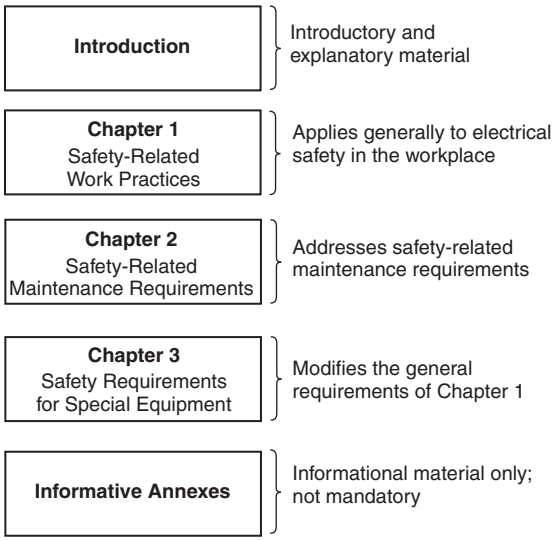

FIGURE 90.3 Standard Arrangement.

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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]

•

Approved. Acceptable to the authority having jurisdiction.

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 a manner that could cause an electric arc. An arc flash incident is not likely to occur under normal operating conditions when enclosed energized equipment has been properly installed and maintained. See 110.4(D) for further information.

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.

Δ **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_{BT}) (should a material system exhibit a breakopen response below the ATPV value). Arc rating is reported as either ATPV or E_{BT}, 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: 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. 3: E_{BT} 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 a material response evidenced by the formation of one or more holes of a defined size [an area of 1.6 cm^2 (0.5 in.^{2}) or an opening of 2.5 cm (1.0 in.) in any dimension] in the innermost layer of arc-rated material that would allow thermal energy to pass through the material.

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.

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

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

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

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

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]

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

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

• **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]

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

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

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

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

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

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

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

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 (Disconnector, 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.

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.

Informational Note: An electrically safe work condition is not a procedure, it is a state wherein all hazardous electrical conductors or circuit parts to which a worker might be exposed are maintained in a de-energized state for the purpose of temporarily eliminating electrical hazards for the period of time for which the state is maintained.

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]

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

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

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

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

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

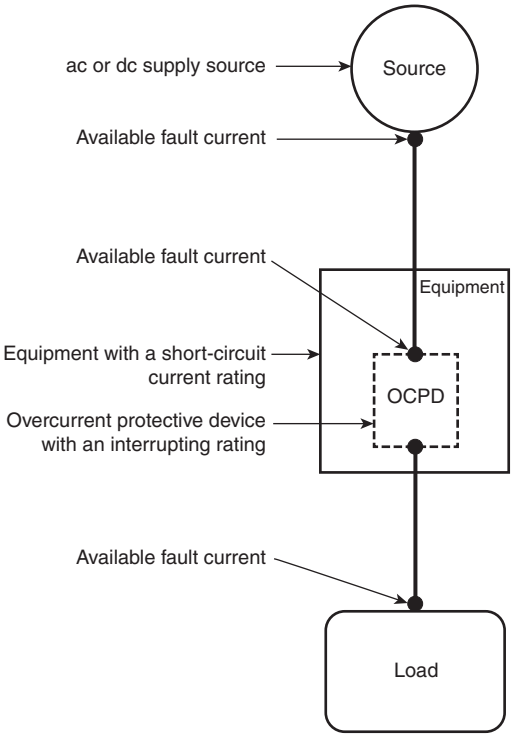
Fault Current. The amount of current delivered at a point on the system during a short-circuit condition.

Fault Current, Available. 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.

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



Δ **FIGURE 100.0 Available Fault 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]

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

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.

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

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

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

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

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

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

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

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

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

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

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

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

Maintenance, Condition of. 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]

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

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

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

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

Informational Note No. 3: Certain battery units are rated at nominal 48 volts dc but have a charging float voltage up to 58 volts. In dc applications, 60 volts is used to cover the entire range of float voltages.

Δ **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, conductors, or circuit parts with approved test equipment that does not require making any physical change to the electrical equipment, conductors, or circuit parts. *Repair* is any physical alteration of electrical equipment, conductors, or circuit parts (such as making or tightening connections, removing or replacing components, etc.).

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ARTICLE 105
Application of Safety-Related Work Practices and Procedures

105.1 Scope. Chapter 1 covers electrical safety-related work practices and procedures for employees who are exposed to an electrical hazard in workplaces covered in the scope of this standard.

105.2 Purpose. These practices and procedures are intended to provide for employee safety relative to electrical hazards in the workplace.

Informational Note: For general categories of electrical hazards, see Informative Annex K.

105.3 Responsibility.

(A) Employer Responsibility. The employer shall have the following responsibilities:

(1) Establish, document, and implement the safety-related work practices and procedures required by this standard.
(2) Provide employees with training in the employer's safety-related work practices and procedures.

(B) Employee Responsibility. The employee shall comply with the safety-related work practices and procedures provided by the employer.

105.5 Organization. Chapter 1 of this standard is divided into five articles. Article 100 provides definitions for terms used in one or more of the chapters of this document. Article 105 provides for application of safety-related work practices and procedures. Article 110 provides general requirements for electrical safety-related work practices and procedures. Article 120 provides requirements for establishing an electrically safe work condition. Article 130 provides requirements for work involving electrical hazards.

ARTICLE 110
General Requirements for Electrical Safety-Related Work Practices

110.1 Priority. Hazard elimination shall be the first priority in the implementation of safety-related work practices.

Informational Note No. 1: Elimination is the risk control method listed first in the hierarchy of risk control identified in 110.5(H)(3). See Annex F for examples of hazard elimination.

Informational Note No. 2: An electrically safe work condition is a state wherein all hazardous electrical conductors or circuit parts to which a worker might be exposed are placed and maintained in a de-energized state, for the purpose of temporarily eliminating electrical hazards. See Article 120 for requirements to establish an electrically safe work condition for the period of time for which the state is maintained. See Informative Annex F for information regarding the hierarchy of risk control and hazard elimination.

110.2 General. Electrical conductors and circuit parts shall not be considered to be in an electrically safe work condition until all of the requirements of Article 120 have been met.

Safe work practices applicable to the circuit voltage and energy level shall be used in accordance with Article 110 and Article 130 until such time that electrical conductors and circuit parts are in an electrically safe work condition.

Informational Note: See 120.5 for the steps to establish and verify an electrically safe work condition.

110.3 Electrically Safe Work Condition. Energized electrical conductors and circuit parts operating at voltages equal to or greater than 50 volts shall be put into an electrically safe work condition before an employee performs work if any of the following conditions exist:

(1) The employee is within the limited approach boundary.
(2) The employee interacts with equipment where conductors or circuit parts are not exposed but an increased likelihood of injury from an exposure to an arc flash hazard exists.

110.4 Energized Work.

(A) Additional Hazards or Increased Risk. Energized work shall be permitted where the employer can demonstrate that de-energizing introduces additional hazards or increased risk.

Informational Note: Examples of additional hazards or increased risk include, but are not limited to, interruption of life-support equipment, deactivation of emergency alarm systems, and shutdown of hazardous location ventilation equipment.

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

Informational Note: Examples of work that might be performed within the limited approach boundary of exposed energized electrical conductors or circuit parts because of infeasibility due to equipment design or operational limitations include performing diagnostics and testing (for example, start-up or troubleshooting) of electric circuits that can only be performed with the circuit energized and work on circuits that form an integral part of a continuous process that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment.

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

(D) Normal Operating Condition. Normal operation of electric equipment shall be permitted where a normal operating condition exists. A normal operating condition exists when all of the following conditions are satisfied:

(1) The equipment is properly installed.
(2) The equipment is properly maintained.
(3) The equipment is used in accordance with instructions included in the listing and labeling and in accordance with manufacturer's instructions.

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(4) The equipment doors are closed and secured.
(5) All equipment covers are in place and secured.
(6) There is no evidence of impending failure.

Informational Note: The phrase *properly installed* means that the equipment is installed in accordance with applicable industry codes and standards and the manufacturer's recommendations. The phrase *properly maintained* means that the equipment has been maintained in accordance with the manufacturer's recommendations and applicable industry codes and standards. The phrase *evidence of impending failure* means that there is evidence such as arcing, overheating, loose or bound equipment parts, visible damage, or deterioration.

110.5 Electrical Safety Program.

Δ **(A) General.** The employer shall implement and document an overall electrical safety program that directs activity appropriate to the risk associated with electrical hazards.

Informational Note No. 1: Safety-related work practices such as verification of proper maintenance and installation, alerting techniques, auditing requirements, and training requirements provided in this standard are administrative controls and part of an overall electrical safety program.

Informational Note No. 2: See Informative Annex P for information on implementing an electrical safety program within an employer's occupational health and safety management system.

Informational Note No. 3: IEEE 3007.1, *Recommended Practice for the Operation and Management of Industrial and Commercial Power Systems*, provides additional guidance for the implementation of the electrical safety program.

Informational Note No. 4: IEEE 3007.3, *Recommended Practice for Electrical Safety in Industrial and Commercial Power Systems*, provides additional guidance for electrical safety in the workplace.

(B) Inspection. The electrical safety program shall include elements to verify that newly installed or modified electrical equipment or systems have been inspected to comply with applicable installation codes and standards prior to being placed into service.

(C) Condition of Maintenance. The electrical safety program shall include elements that consider condition of maintenance of electrical equipment and systems.

(D) Awareness and Self-Discipline. The electrical safety program shall be designed to provide an awareness of the potential electrical hazards to employees who work in an environment with the presence of electrical hazards. The program shall be developed to provide the required self-discipline for all employees who must perform work that may involve electrical hazards. The program shall instill safety principles and controls.

(E) Electrical Safety Program Principles. The electrical safety program shall identify the principles upon which it is based.

Informational Note: For examples of typical electrical safety program principles, see Informative Annex E.

(F) Electrical Safety Program Controls. An electrical safety program shall identify the controls by which it is measured and monitored.

Informational Note: For examples of typical electrical safety program controls, see Informative Annex E.

(G) Electrical Safety Program Procedures. An electrical safety program shall identify the procedures to be utilized before work is started by employees exposed to an electrical hazard.

Informational Note: For an example of a typical electrical safety program procedure, see Informative Annex E.

(H) Risk Assessment Procedure. The electrical safety program shall include a risk assessment procedure and shall comply with 110.5(H)(1) through 110.5(H)(3).

Δ **(1) Elements of a Risk Assessment Procedure.** The risk assessment procedure shall address employee exposure to electrical hazards and shall identify the process to be used before work is started to carry out the following:

(1) Identify hazards
(2) Assess risks
(3) Implement risk control according to the hierarchy of risk control methods

Informational Note No. 1: The risk assessment procedure could include identifying when a second person could be required and the training and equipment that person should have.

Informational Note No. 2: For more information regarding risk assessment and the hierarchy of risk control, see Informative Annex F.

(2) Human Error. The risk assessment procedure shall address the potential for human error and its negative consequences on people, processes, the work environment, and equipment relative to the electrical hazards in the workplace.

Informational Note: The potential for human error varies with factors such as tasks and the work environment. See Informative Annex Q.

Δ **(3) Hierarchy of Risk Control Methods.** The risk assessment procedure shall require that preventive and protective risk control methods be implemented in accordance with the following hierarchy:

(1) Elimination
(2) Substitution
(3) Engineering controls
(4) Awareness
(5) Administrative controls
(6) PPE

Informational Note No. 1: Elimination, substitution, and engineering controls are the most effective methods to reduce risk as they are usually applied at the source of possible injury or damage to health and they are less likely to be affected by human error. Awareness, administrative controls, and PPE are the least effective methods to reduce risk as they are not applied at the source and they are more likely to be affected by human error.

Informational Note No. 2: See Informative Annex F for more information regarding the hierarchy of risk control methods and examples of those methods.

(I) Job Safety Planning and Job Briefing. Before starting each job that involves exposure to electrical hazards, the employee in charge shall complete a job safety plan and conduct a job briefing with the employees involved.

(1) Job Safety Planning. The job safety plan shall be in accordance with the following:

(1) Be completed by a qualified person
(2) Be documented

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(3) Include the following information:

a. A description of the job and the individual tasks
b. Identification of the electrical hazards associated with each task
c. A shock risk assessment in accordance with 130.4 for tasks involving a shock hazard
d. An arc flash risk assessment in accordance with 130.5 for tasks involving an arc flash hazard
e. Work procedures involved, special precautions, and energy source controls

Informational Note: For an example of a job safety planning checklist see Figure I.2.

(2) Job Briefing. The job briefing shall cover the job safety plan and the information on the energized electrical work permit, if a permit is required.

Δ **(3) Change in Scope.** Additional job safety planning and job briefings shall be held if changes occur during the course of the work that might affect the safety of employees.

Informational Note: For an example of a job briefing checklist, see Figure I.1.

(J) Incident Investigations. The electrical safety program shall include elements to investigate electrical incidents.

Informational Note: Electrical incidents include events or occurrences that result in, or could have resulted in, a fatality, an injury, or damage to health. Incidents that do not result in fatality, injury, or damage to health are commonly referred to as a "close call" or "near miss."

N **(K) Electrically Safe Work Condition Policy.** An electrical safety program shall include an electrically safe work condition policy that complies with 110.3.

N **(L) Lockout/Tagout Program.** The electrical safety program shall include the information required by one of the following:

(1) A lockout/tagout program in accordance with 120.1(A)
(2) A reference to the employer's lockout/tagout program established in accordance with 120.1(A)

(M) Auditing.

(1) Electrical Safety Program Audit. The electrical safety program shall be audited to verify that the principles and procedures of the electrical safety program are in compliance with this standard. Audits shall be performed at intervals not to exceed 3 years.

(2) Field Work Audit. Field work shall be audited to verify that the requirements contained in the procedures of the electrical safety program are being followed. When the auditing determines that the principles and procedures of the electrical safety program are not being followed, the appropriate revisions to the training program or revisions to the procedures shall be made. Audits shall be performed at intervals not to exceed 1 year.

(3) Lockout/Tagout Program and Procedure Audit. The lockout/tagout program and procedures required by Article 120 shall be audited by a qualified person at intervals not to exceed 1 year. The audit shall cover at least one lockout/tagout in progress. The audit shall be designed to identify and correct deficiencies in the following:

(1) The lockout/tagout program and procedures
(2) The lockout/tagout training
(3) Worker execution of the lockout/tagout procedure

(4) Documentation. The audits required by 110.5(M) shall be documented.

110.6 Training Requirements.

(A) Electrical Safety Training. The training requirements contained in 110.6(A) shall apply to employees exposed to an electrical hazard when the risk associated with that hazard is not reduced to a safe level by the applicable electrical installation requirements. Such employees shall be trained to understand the specific hazards associated with electrical energy. They shall be trained in safety-related work practices and procedural requirements, as necessary, to provide protection from the electrical hazards associated with their respective job or task assignments. Employees shall be trained to identify and understand the relationship between electrical hazards and possible injury.

Informational Note: For further information concerning installation requirements, see *NFPA 70, National Electrical Code.*

(1) Qualified Person. A qualified person shall be trained and knowledgeable in the construction and operation of equipment or a specific work method and be trained to identify and avoid the electrical hazards that might be present with respect to that equipment or work method.

(a) Such persons shall also be familiar with the proper use of the special precautionary techniques, applicable electrical policies and procedures, PPE, insulating and shielding materials, and insulated tools and test equipment.

(b) A person can be considered qualified with respect to certain equipment and tasks but still be unqualified for others.

(c) Such persons permitted to work within the limited approach boundary shall, at a minimum, be additionally trained in all of the following:

(1) Skills and techniques necessary to distinguish exposed energized electrical conductors and circuit parts from other parts of electrical equipment
(2) Skills and techniques necessary to determine the nominal voltage of exposed energized electrical conductors and circuit parts
(3) Approach distances specified in Table 130.4(E)(a) and Table 130.4(E)(b) and the corresponding voltages to which the qualified person will be exposed
(4) Decision-making process necessary to be able to do the following:

a. Perform the job safety planning
b. Identify electrical hazards
c. Assess the associated risk
d. Select the appropriate risk control methods from the hierarchy of controls identified in 110.5(H)(3), including PPE

(d) An employee who is undergoing on-the-job training for the purpose of obtaining the skills and knowledge necessary to be considered a qualified person, and who in the course of such training demonstrates an ability to perform specific duties safely at his or her level of training, and who is under the direct supervision of a qualified person shall be considered to be a qualified person for the performance of those specific duties.

(e) Employees shall be trained to select an appropriate test instrument and shall demonstrate how to use a device to verify the absence of voltage, including interpreting indications provided by the device. The training shall include information

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that enables the employee to understand all limitations of each test instrument that might be used.

(f) The employer shall determine through regular supervision or through inspections conducted on at least an annual basis that each employee is complying with the safety-related work practices required by this standard.

(2) Unqualified Persons. Unqualified persons shall be trained in, and be familiar with, any electrical safety-related practices necessary for their safety.

Δ **(3) Additional Training and Retraining.** Additional training and retraining in safety-related work practices and applicable changes in this standard shall be performed at intervals not to exceed 3 years. An employee shall receive additional training or retraining if any of the following conditions exists:

(1) The supervision or annual inspections indicate the employee is not complying with the safety-related work practices.
(2) New technology, new types of equipment, or changes in procedures necessitate the use of safety-related work practices different from those that the employee would normally use.
(3) The employee needs to review tasks that are performed less often than once per year.
(4) The employee needs to review safety-related work practices not normally used by the employee during regular job duties.
(5) The employee's job duties change.

(4) Type of Training. The training required by 110.6(A) shall be classroom, on-the-job, or a combination of the two. The type and extent of the training provided shall be determined by the risk to the employee.

Informational Note: Classroom training can include interactive electronic or interactive web-based training components.

(5) Electrical Safety Training Documentation. The employer shall document that each employee has received the training required by 110.6(A). This documentation shall be in accordance with the following:

(1) Be made when the employee demonstrates proficiency in the work practices involved
(2) Be retained for the duration of the employee's employment
(3) Contain the content of the training, each employee's name, and dates of training

Informational Note No. 1: Content of the training could include one or more of the following: course syllabus, course curriculum, outline, table of contents, or training objectives.

Informational Note No. 2: Employment records that indicate that an employee has received the required training are an acceptable means of meeting this requirement.

(B) Lockout/Tagout Procedure Training.

Δ **(1) Initial Training.** Employees involved in the lockout/tagout procedures required by 120.2(B) shall be trained in the following:

(1) The lockout/tagout procedures
(2) Their responsibility in the execution of the procedures

(2) Retraining. Retraining in the lockout/tagout procedures shall be performed as follows:

(1) When the procedures are revised
(2) At intervals not to exceed 3 years
(3) When supervision or annual inspections indicate that the employee is not complying with the lockout/tagout procedures

(3) Lockout/Tagout Training Documentation.

(a) The employer shall document that each employee has received the training required by 110.6(B).

(b) The documentation shall be made when the employee demonstrates proficiency in the work practices involved.

(c) The documentation shall contain the content of the training, each employee's name, and the dates of the training.

Informational Note: Content of the training could include one or more of the following: course syllabus, course curriculum, outline, table of contents, or training objectives.

(C) Emergency Response Training.

(1) Contact Release. Employees exposed to shock hazards and those responsible for the safe release of victims from contact with energized electrical conductors or circuit parts shall be trained in methods of safe release. Refresher training shall occur annually.

(2) First Aid, Emergency Response, and Resuscitation.

(a) Employees responsible for responding to medical emergencies shall be trained in first aid and emergency procedures.

(b) Employees responsible for responding to medical emergencies shall be trained in cardiopulmonary resuscitation (CPR).

(c) Employees responsible for responding to medical emergencies shall be trained in the use of an automated external defibrillator (AED) if an employer's emergency response plan includes the use of this device.

(d) Training shall occur at a frequency that satisfies the requirements of the certifying body.

Informational Note: Employees responsible for responding to medical emergencies might not be first responders or medical professionals. Such employees could be a second person, a safety watch, or a craftsperson.

(3) Training Verification. Employers shall verify at least annually that employee training required by 110.6(C) is current.

(4) Documentation. The employer shall document that the training required by 110.6(C) has occurred.

110.7 Host and Contract Employers' Responsibilities.

(A) Host Employer Responsibilities.

(1) The host employer shall inform contract employers of the following:

(1) Known hazards that are covered by this standard, that are related to the contract employer's work, and that might not be recognized by the contract employer or its employees
(2) Information about the employer's installation that the contract employer needs to make the assessments required by Chapter 1

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(2) The host employer shall report observed contract employer–related violations of this standard to the contract employer.

Informational Note: Examples of a host employer can include owner or their designee, construction manager, general contractor, or employer.

(B) Contract Employer Responsibilities.

(1) The contract employer shall ensure that each of his or her employees is instructed in the hazards communicated to the contract employer by the host employer. This instruction shall be in addition to the basic training required by this standard.

(2) The contract employer shall ensure that each of his or her employees follows the work practices required by this standard and safety-related work rules required by the host employer.

(3) The contract employer shall advise the host employer of the following:

(1) Any unique hazards presented by the contract employer's work
(2) Hazards identified during the course of work by the contract employer that were not communicated by the host employer
(3) The measures the contractor took to correct any violations reported by the host employer under 110.7(A)(2) and to prevent such violation from recurring in the future

(C) Documentation. Where the host employer has knowledge of hazards covered by this standard that are related to the contract employer's work, there shall be a documented meeting between the host employer and the contract employer.

Informational Note to 110.7: On multi-employer work sites (in all industry sectors), more than one employer can be responsible for identifying hazardous conditions and creating safe work practices.

110.8 Test Instruments and Equipment.

(A) Testing. Only qualified persons shall perform tasks such as testing, troubleshooting, and voltage measuring on electrical equipment where an electrical hazard exists.

(B) Rating. Test instruments, equipment, and their accessories shall be as follows:

(1) Rated for circuits and equipment where they are utilized
(2) Approved for the purpose
(3) Used in accordance with any instructions provided by the manufacturer

Informational Note: See UL 61010-1, *Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements*, for rating and design requirements for voltage measurement and test instruments intended for use on electrical systems 1000 volts and below and UL 61010-2-033, *Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use — Part 2-033: Particular Requirements for Hand-Held Multimeters and Other Meters, for Domestic and Professional use, Capable of Measuring Mains Voltage.*

(C) Design. Test instruments, equipment, and their accessories shall be designed for the environment to which they will be exposed and for the manner in which they will be utilized.

(D) Visual Inspection and Repair. Test instruments and equipment and all associated test leads, cables, power cords, probes, and connectors shall be visually inspected for external defects and damage before each use. If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service. No employee shall use it until a person(s) qualified to perform the repairs and tests that are necessary to render the equipment safe has done so.

(E) Operation Verification. When test instruments are used for testing the absence of voltage on conductors or circuit parts operating at voltages equal to or greater than 50 volts, the operation of the test instrument shall be verified on any known voltage source before and after an absence of voltage test is performed.

110.9 Portable Cord- and-Plug-Connected Electric Equipment. This section applies to the use of cord- and plug-connected equipment, including cord- and plug-connected test instruments and cord sets (extension cords).

(A) Handling and Storage. Portable equipment shall be handled and stored in a manner that will not cause damage. Flexible electric cords connected to equipment shall not be used for raising or lowering the equipment. Flexible cords shall not be fastened with staples or hung in such a fashion as could damage the outer jacket or insulation.

(B) Grounding-Type Equipment.

(a) A flexible cord used with grounding-type utilization equipment shall contain an equipment grounding conductor.

(b) Attachment plugs and receptacles shall not be connected or altered in a manner that would interrupt continuity of the equipment grounding conductor. Additionally, these devices shall not be altered in order to allow use in a manner that was not intended by the manufacturer.

(c) Adapters that interrupt the continuity of the equipment grounding conductor shall not be used.

Δ **(C) Visual Inspection and Repair of Portable Cord- and Plug-Connected Equipment and Flexible Cord Sets.**

(a) *Frequency of Inspection.* Before each use, portable cord- and plug-connected equipment shall be visually inspected for external defects (such as loose parts or deformed and missing pins) and for evidence of possible internal damage (such as a pinched or crushed outer jacket).

Exception: Stationary cord- and plug-connected equipment that remain connected once they are put in place and are installed such that the cord and plug are not subject to physical damage during normal use shall not be required to be visually inspected until they are relocated or repaired.

(b) *Defective Equipment.* If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service. No employee shall use it until a person(s) qualified to perform the repairs and tests necessary to render the equipment safe has done so.

(c) *Proper Mating.* When an attachment plug is to be connected to a receptacle, the relationship of the plug and receptacle contacts shall first be checked to ensure that they are of mating configurations.

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Δ **(D) Conductive or Wet Work Locations.** Portable cord-and-plug-connected electric equipment used in conductive or wet work locations shall be approved for use in those locations. In work locations where employees are likely to contact or be drenched with water or conductive liquids, ground-fault circuit-interrupter protection for personnel shall be used.

Informational Note: The risk assessment procedure can also include identifying when the use of portable tools and equipment powered by sources other than 120 volts ac, such as batteries, air, and hydraulics, should be used to minimize the potential for injury from electrical hazards for tasks performed in conductive or wet locations.

(E) Connecting Attachment Plugs.

(a) Employees' hands shall not be wet when plugging and unplugging flexible cords and cord- and plug-connected equipment if energized equipment is involved.

(b) Energized plug and receptacle connections shall be handled only with insulating protective equipment if the condition of the connection could provide a conductive path to the employee's hand (e.g, if a cord connector is wet from being immersed in water).

(c) Locking-type connectors shall be secured after connection.

(F) Manufacturer's Instructions. Portable equipment shall be used in accordance with the manufacturer's instructions and safety warnings.

110.10 Ground-Fault Circuit-Interrupter (GFCI) Protection.

(A) General. Employees shall be provided with ground-fault circuit-interrupter (GFCI) protection where required by applicable state, federal, or local codes and standards. Listed cord sets or devices incorporating listed GFCI protection for personnel identified for portable use shall be permitted.

(B) Maintenance and Construction. GFCI protection shall be provided where an employee is operating or using cord sets (extension cords) or cord- and plug-connected tools related to maintenance and construction activity supplied by 125-volt, 15-, 20-, or 30-ampere circuits. Where employees operate or use equipment supplied by greater than 125-volt, 15-, 20-, or 30-ampere circuits, GFCI protection or an assured equipment grounding conductor program shall be implemented.

Informational Note: Where an assured equipment grounding conductor program is used, a special purpose ground-fault circuit interrupter may provide additional protection. See Informative Annex O.

(C) Outdoors. GFCI protection shall be provided when an employee is outdoors and operating or using cord sets (extension cords) or cord- and plug-connected equipment supplied by 125-volt, 15-, 20-, or 30-ampere circuits. Where employees working outdoors operate or use equipment supplied by greater than 125-volt, 15-, 20-, or 30-ampere circuits, GFCI protection or an assured equipment grounding conductor program shall be implemented.

Informational Note: Where an assured equipment grounding conductor program is used, a special purpose ground-fault circuit interrupter may provide additional protection. See Informative Annex O.

(D) Testing Ground-Fault Circuit-Interrupter Protection Devices. GFCI protection devices shall be tested in accordance with the manufacturer's instructions.

110.11 Overcurrent Protection Modification. Overcurrent protection of circuits and conductors shall not be modified, even on a temporary basis, beyond what is permitted by applicable portions of electrical codes and standards dealing with overcurrent protection.

Informational Note: For further information concerning electrical codes and standards dealing with overcurrent protection, refer to Article 240 of *NFPA 70, National Electrical Code*.

N **110.12 Equipment Use.** Equipment shall be used in accordance with the manufacturer's instructions.

ARTICLE 120
Establishing an Electrically Safe Work Condition

120.1 Lockout/Tagout Program.

(A) General. Each employer shall establish, document, and implement a lockout/tagout program. The lockout/tagout program shall specify lockout/tagout procedures to safeguard workers from exposure to electrical hazards. The lockout/tagout program and procedures shall also incorporate the following:

(1) Be applicable to the experience and training of the workers and conditions in the workplace
(2) Meet the requirements of Article 120
(3) Apply to fixed, permanently installed equipment, temporarily installed equipment, and portable equipment

(B) Employer Responsibilities. The employer shall be responsible for the following:

(1) Providing the equipment necessary to execute lockout/tagout procedures
(2) Providing lockout/tagout training to workers in accordance with 110.6(B)
(3) Auditing the lockout/tagout program in accordance with 110.5(M)(3)
(4) Auditing execution of the lockout/tagout procedures in accordance with 110.5(M)(3)

Informational Note: For an example of a lockout/tagout program, see Informative Annex G.

120.2 Lockout/Tagout Principles.

(A) Employee Involvement. Each person who could be exposed directly or indirectly to a source of electrical energy shall be involved in the lockout/tagout procedure.

Informational Note: An example of direct exposure is the qualified electrician who works on the motor starter control, the power circuits, or the motor. An example of indirect exposure is the person who works on the coupling between the motor and compressor.

(B) Lockout/Tagout Procedure. A lockout/tagout procedure shall be developed on the basis of the existing electrical equipment and system and shall use suitable documentation including up-to-date drawings and diagrams. The procedure shall meet the requirements of applicable codes, standards, and regulations for lockout and tagging of electrical sources.

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(C) Control of Energy. All sources of electrical energy shall be controlled in such a way as to minimize employee exposure to electrical hazards.

(D) Electrical Circuit Interlocks. Documentation, including up-to-date drawings and diagrams, shall be reviewed to ensure that no electrical circuit interlock operation can result in re-energizing the circuit being worked on.

(E) Control Devices. Locks/tags shall be installed only on circuit disconnecting means. Control devices, such as push-buttons or selector switches, shall not be used as the primary isolating device.

(F) Identification. The lockout/tagout device shall be unique and readily identifiable as a lockout/tagout device.

(G) Coordination. The following items are necessary for coordinating the lockout/tagout procedure:

(1) The electrical lockout/tagout procedure shall be coordinated with all other employer's procedures for control of exposure to electrical energy sources such that all employer's procedural requirements are adequately addressed on a site basis.
(2) The procedure for control of exposure to electrical hazards shall be coordinated with other procedures for control of other hazardous energy based on similar or identical concepts.
(3) Electrical lockout/tagout devices shall be permitted to be similar to lockout/tagout devices for control of other hazardous energy sources, such as pneumatic, hydraulic, thermal, and mechanical, if such devices are used only for control of hazardous energy and for no other purpose.

(H) Forms of Control of Hazardous Electrical Energy. Two forms of hazardous electrical energy control shall be permitted: simple lockout/tagout and complex lockout/tagout *[see 120.4]*. For the simple lockout/tagout, the qualified person shall be in charge. For the complex lockout/tagout, the person in charge shall have overall responsibility.

120.3 Lockout/Tagout Equipment.

(A) Lock Application. Energy isolation devices for machinery or equipment installed after January 2, 1990, shall be capable of accepting a lockout device.

(B) Lockout/Tagout Device. Each employer shall supply, and employees shall use, lockout/tagout devices and equipment necessary to execute the requirements of 120.3. Locks and tags used for control of exposure to electrical hazards shall be unique, shall be readily identifiable as lockout/tagout devices, and shall be used for no other purpose.

(C) Lockout Device. The lockout device shall meet the following requirements:

(1) A lockout device shall include a lock — either keyed or combination.
(2) The lockout device shall include a method of identifying the individual who installed the lockout device.
(3) A lockout device shall be permitted to be only a lock, if the lock is readily identifiable as a lockout device, in addition to having a means of identifying the person who installed the lock, provided that all of the following conditions exist:
(a) Only one circuit or piece of equipment is de-energized.
(b) The lockout period does not extend beyond the work shift.
(c) Employees exposed to the hazards associated with re-energizing the circuit or equipment are familiar with this procedure.
(4) Lockout devices shall be attached to prevent operation of the disconnecting means without resorting to undue force or the use of tools.
(5) Where a tag is used in conjunction with a lockout device, the tag shall contain a statement prohibiting unauthorized operation of the disconnecting means or unauthorized removal of the device.
(6) Lockout devices shall be suitable for the environment and for the duration of the lockout.
(7) Whether keyed or combination locks are used, the key or combination shall remain in the possession of the individual installing the lock or the person in charge, when provided by the established procedure.

(D) Tagout Device. The tagout device shall meet the following requirements:

(1) A tagout device shall include a tag together with an attachment means.
(2) The tagout device shall be readily identifiable as a tagout device and suitable for the environment and duration of the tagout.
(3) A tagout device attachment means shall be capable of withstanding at least 224.4 N (50 lb) of force exerted at a right angle to the disconnecting means surface. The tag attachment means shall be nonreusable, attachable by hand, self-locking, nonreleasable, and equal to an all-environmental tolerant nylon cable tie.
(4) Tags shall contain a statement prohibiting unauthorized operation of the disconnecting means or removal of the tag.
(5) A hold card tagging tool on an overhead conductor in conjunction with a hotline tool to install the tagout device safely on a disconnect that is isolated from the work(s) shall be permitted. Where a hold card is used, the tagout procedure shall include the method of accounting for personnel who are working under the protection of the hold card.

120.4 Lockout/Tagout Procedures. The employer shall maintain a copy of the procedures required by this section and shall make the procedures available to all employees.

(A) Planning. The procedure shall require planning, including the requirements of 120.4(A)(1) through 120.4(B)(14).

(1) Locating Sources. Up-to-date single-line drawings shall be considered a primary reference source for such information. When up-to-date drawings are not available, the employer shall be responsible for ensuring that an equally effective means of locating all sources of energy is employed.

(2) Exposed Persons. The plan shall identify persons who might be exposed to an electrical hazard and the PPE required during the execution of the job or task.

(3) Person in Charge. The plan shall identify the person in charge and his or her responsibility in the lockout/tagout.

(4) Simple Lockout/Tagout Procedure. All lockout/tagout procedures that involve only a qualified person(s) de-energizing one set of conductors or circuit part source for the sole purpose of safeguarding employees from exposure to elec-

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trical hazards shall be considered to be a simple lockout/tagout. Simple lockout/tagout procedures shall not be required to be written for each application. Each worker shall be responsible for his or her own lockout/tagout.

Exception: Lockout/tagout is not required for work on cord- and plug-connected equipment for which exposure to the hazards of unexpected energization of the equipment is controlled by the unplugging of the equipment from the energy source, provided that the plug is under the exclusive control of the employee performing the servicing and maintenance for the duration of the work.

(5) Complex Lockout/Tagout.

(a) A complex lockout/tagout procedure shall be permitted where one or more of the following exists:

(1) Multiple energy source
(2) Multiple crews
(3) Multiple crafts
(4) Multiple locations
(5) Multiple employers
(6) Multiple disconnecting means
(7) Particular sequences
(8) Job or task that continues for more than one work period

(b) All complex lockout/tagout procedures shall require a written plan of execution that identifies the person in charge.

(c) The complex lockout/tagout procedure shall vest primary responsibility in an authorized employee for employees working under the protection of a group lockout or tagout device, such as an operation lock or lockbox. The person in charge shall be held accountable for safe execution of the complex lockout/tagout.

(d) Each authorized employee shall affix a personal lockout or tagout device to the group lockout device, group lockbox, or comparable mechanism when he or she begins work and shall remove those devices when he or she stops working on the machine or equipment being serviced or maintained.

(e) All complex lockout/tagout plans shall identify the method to account for all persons who might be exposed to electrical hazards in the course of the lockout/tagout.

(B) Elements of Control. The procedure shall identify elements of control.

(1) De-energizing Equipment (Shutdown). The procedure shall establish the person who performs the switching and where and how to de-energize the load.

(2) Stored Energy. The procedure shall include requirements for releasing stored electric or mechanical energy that might endanger personnel. All capacitors shall be discharged, and high-capacitance elements shall also be short-circuited and grounded before the associated equipment is touched or worked on. Springs shall be released or physical restraint shall be applied when necessary to immobilize mechanical equipment and pneumatic and hydraulic pressure reservoirs. Other sources of stored energy shall be blocked or otherwise relieved.

Informational Note: For more information on methods and procedures to place capacitors in an electrically safe work condition, see 360.3, 360.5, and Informative Annex R, Working with Capacitors.

(3) Disconnecting Means. The procedure shall identify how to verify that the circuit is de-energized (open).

(4) Responsibility. The procedure shall identify the person who is responsible for verifying that the lockout/tagout procedure is implemented and who is responsible for ensuring that the task is completed prior to removing locks/tags. A mechanism to accomplish lockout/tagout for multiple (complex) jobs/tasks where required, including the person responsible for coordination, shall be included.

(5) Verification. The procedure shall verify that equipment cannot be restarted. The equipment operating controls, such as push-buttons, selector switches, and electrical interlocks, shall be operated or otherwise it shall be verified that the equipment cannot be restarted.

(6) Testing. The procedure shall establish the following:

(1) Test instrument to be used, the required PPE, and the person who will use it to verify proper operation of the test instrument on a known voltage source before and after use
(2) Requirement to define the boundary of the electrically safe work condition
(3) Requirement to test before touching every exposed conductor or circuit part(s) within the defined boundary of the work area
(4) Requirement to retest for absence of voltage when circuit conditions change or when the job location has been left unattended
(5) Planning considerations that include methods of verification where there is no accessible exposed point to take voltage measurements

(7) Grounding. Grounding requirements for the circuit shall be established, including whether the temporary protective grounding equipment shall be installed for the duration of the task or is temporarily established by the procedure. Grounding needs or requirements shall be permitted to be covered in other work rules and might not be part of the lockout/tagout procedure.

(8) Shift Change. A method shall be identified in the procedure to transfer responsibility for lockout/tagout to another person or to the person in charge when the job or task extends beyond one shift.

(9) Coordination. The procedure shall establish how coordination is accomplished with other jobs or tasks in progress, including related jobs or tasks at remote locations as well as the person responsible for coordination.

(10) Accountability for Personnel. A method shall be identified in the procedure to account for all persons who could be exposed to hazardous energy during the lockout/tagout.

(11) Lockout/Tagout Application. The procedure shall clearly identify when and where lockout applies, in addition to when and where tagout applies, and shall address the following:

(1) Lockout shall be defined as installing a lockout device on all sources of hazardous energy such that operation of the disconnecting means is prohibited, and forcible removal of the lock is required to operate the disconnecting means.
(2) Tagout shall be defined as installing a tagout device on all sources of hazardous energy, such that operation of the disconnecting means is prohibited. The tagout device shall be installed in the same position available for the lockout device.
(3) Where it is not possible to attach a lock to existing disconnecting means, the disconnecting means shall not be used as the only means to put the circuit in an electrically safe work condition.

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(4) The use of tagout procedures without a lock shall be permitted only in cases where equipment design precludes the installation of a lock on an energy isolation device(s). When tagout is employed, at least one additional safety measure shall be employed. In such cases, the procedure shall clearly establish responsibilities and accountability for each person who might be exposed to electrical hazards.

Informational Note: Examples of additional safety measures include the removal of an isolating circuit element such as fuses, blocking of the controlling switch, or opening an extra disconnecting device to reduce the likelihood of inadvertent energization.

(12) Removal of Lockout/Tagout Devices. The procedure shall identify the details for removing locks or tags when the installing individual is unavailable. When locks or tags are removed by someone other than the installer, the employer shall attempt to locate that person prior to removing the lock or tag. When the lock or tag is removed because the installer is unavailable, the installer shall be informed prior to returning to work.

(13) Release for Return to Service. The procedure shall identify steps to be taken when the job or task requiring lockout/tagout is completed. Before electric circuits or equipment are re-energized, tests and visual inspections shall be conducted to verify that all tools, mechanical restraints and electrical jumpers, short circuits, and temporary protective grounding equipment have been removed, so that the circuits and equipment are in a condition to be safely energized. When applicable, the employees responsible for operating the machines or process shall be notified when circuits and equipment are ready to be energized, and such employees shall provide assistance as necessary to safely energize the circuits and equipment. The procedure shall contain a statement requiring the area to be inspected to ensure that nonessential items have been removed. One such step shall ensure that all personnel are clear of exposure to dangerous conditions resulting from re-energizing the service and that blocked mechanical equipment or grounded equipment is cleared and prepared for return to service.

(14) Temporary Release for Testing/Positioning. The procedure shall clearly identify the steps and qualified persons' responsibilities when the job or task requiring lockout/tagout is to be interrupted temporarily for testing or positioning of equipment; then the steps shall be identical to the steps for return to service.

Informational Note: See 110.8 for requirements when using test instruments and equipment.

Δ **120.5 Process for Establishing and Verifying an Electrically Safe Work Condition.** Establishing and verifying an electrically safe work condition shall include all of the following steps, which shall be performed in the order presented, if feasible:

(1) Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.
(2) After properly interrupting the load current, open the disconnecting device(s) for each source.
(3) Wherever possible, visually verify that all blades of the disconnecting devices are fully open or that drawout-type circuit breakers are withdrawn to the test or fully disconnected position.
(4) Release stored electrical energy.
(5) Block or relieve stored nonelectrical energy in devices to the extent the circuit parts cannot be unintentionally energized by such devices.
(6) Apply lockout/tagout devices in accordance with a documented and established procedure.
(7) Use an adequately rated portable test instrument to test each phase conductor or circuit part to test for the absence of voltage. Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Before and after each test, determine that the test instrument is operating satisfactorily through verification on any known voltage source.

Exception No. 1 to 7: An adequately rated permanently mounted absence of voltage tester shall be permitted to be used to test for the absence of voltage of the conductors or circuit parts at the work location, provided it meets all of the following requirements: (1) It is permanently mounted and installed in accordance with the manufacturer's instructions and tests the conductors and circuit parts at the point of work; (2) It is listed and labeled for the purpose of testing for the absence of voltage; (3) It tests each phase conductor or circuit part both phase-to-phase and phase-to-ground; (4) The test device is verified as operating satisfactorily on any known voltage source before and after testing for the absence of voltage.

Exception No. 2 to 7: On electrical systems over 1000 volts, noncontact capacitive test instruments shall be permitted to be used to test each phase conductor.

Informational Note No. 1: See UL 61010-1, *Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements*, for rating, overvoltage category, and design requirements for voltage measurement and test instruments intended for use on electrical systems 1000 volts and below.

Informational No. 2: For additional information on rating and design requirements for permanently mounted absence of voltage testers, refer to UL 1436, *Outlet Circuit Testers and Other Similar Indicating Devices.*

Informational Note No. 3: For additional information on rating and design requirements for voltage detectors, refer to IEC 61243-1, *Live Working — Voltage Detectors — Part 1: Capacitive type to be used for voltages exceeding 1kV a.c.*, or IEC 61243-2, *Live Working — Voltage Detectors — Part 2: Resistive type to be used for voltages of 1kV to 36 kV a.c.*, or IEC 61243-3, *Live Working — Voltage Detectors — Part 3: Two-pole low voltage type.*

(8) Where the possibility of induced voltages or stored electrical energy exists, ground all circuit conductors and circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply temporary protective grounding equipment in accordance with the following:

a. *Placement.* Temporary protective grounding equipment shall be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to a shock hazard (i.e., hazardous differences in electrical potential). The location, sizing, and application of temporary protective grounding equipment shall be identified as part of the employer's job planning.
b. *Capacity.* Temporary protective grounding equipment shall be capable of conducting the maximum fault

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current that could flow at the point of grounding for the time necessary to clear the fault.

Informational Note: ASTM F855, *Standard Specification for Temporary Protective Grounds to be Used on De-energized Electric Power Lines and Equipment*, is an example of a standard that contains information on capacity of temporary protective grounding equipment.

c. *Impedance.* Temporary protective grounding equipment and connections shall have an impedance low enough to cause immediate operation of protective devices in case of unintentional energizing of the electric conductors or circuit parts.

ARTICLE 130
Work Involving Electrical Hazards

Δ **130.1 General.** Article 130 covers requirements for work involving electrical hazards such as the electrical safety-related work practices, assessments, precautions, and procedures when an electrically safe work condition cannot be established.

Safety-related work practices shall be used to safeguard employees from injury while they are exposed to electrical hazards from electrical conductors or circuit parts that are or can become energized.

When energized electrical conductors and circuit parts operating at voltages equal to or greater than 50 volts are not put into an electrically safe work condition, and work is performed as permitted in accordance with 110.4, all of the following requirements shall apply:

(1) Only qualified persons shall be permitted to work on electrical conductors or circuit parts that have not been put into an electrically safe work condition.
(2) An energized electrical work permit shall be completed as required by 130.2.
(3) A shock risk assessment shall be performed as required by 130.4.
(4) An arc flash risk assessment shall be performed as required by 130.5.

All requirements of Article 130 shall apply whether an incident energy analysis is completed or if Table 130.7(C)(15)(a), Table 130.7(C)(15)(b), and Table 130.7(C)(15)(c) are used in lieu of an incident energy analysis.

130.2 Energized Electrical Work Permit.

Δ **(A) When Required.** When work is performed as permitted in accordance with 110.4, an energized electrical work permit shall be required and documented under any of the following conditions:

(1) When work is performed within the restricted approach boundary
(2) When the employee interacts with the equipment when conductors or circuit parts are not exposed but an increased likelihood of injury from an exposure to an arc flash hazard exists

(B) Elements of Work Permit. The work permit shall include, but not be limited to, the following items:

(1) Description of the circuit and equipment to be worked on and their location
(2) Description of the work to be performed
(3) Justification for why the work must be performed in an energized condition *[see 110.4]*
(4) Description of the safe work practices to be employed *(see 130.1)*
(5) Results of the shock risk assessment *[see 130.4(A)]*
   a. Voltage to which personnel will be exposed
   b. Limited approach boundary *[see 130.4(F), Table 130.4(E)(a), and Table 130.4(E)(b)]*
   c. Restricted approach boundary *[see 130.4(G), Table 130.4(E)(a), and Table 130.4(E)(b)]*
   d. Personal and other protective equipment required by this standard to safely perform the assigned task and to protect against the shock hazard *[see 130.4(F), 130.7(C)(1) through (C)(16), and 130.7(D)]*
(6) Results of the arc flash risk assessment *[see 130.5]*
   a. Available incident energy at the working distance or arc flash PPE category *(see 130.5)*
   b. Personal and other protective equipment required by this standard to protect against the arc flash hazard *[see 130.5(F), 130.7(C)(1) through (C)(16), Table 130.7(C)(15)(c), and 130.7(D)]*
   c. Arc flash boundary *[see 130.5(E)]*
(7) Means employed to restrict the access of unqualified persons from the work area *[see 130.7(E)]*
(8) Evidence of completion of a job briefing, including a discussion of any job-specific hazards *[see 110.5(I)]*
(9) Energized work approval (authorizing or responsible management, safety officer, or owner, etc.) signature(s)

Informational Note: For an example of an acceptable energized work permit, see Figure J.1.

Δ **(C) Exemptions to Work Permit.** Electrical work shall be permitted without an energized electrical work permit if a qualified person is provided with and uses appropriate safe work practices and PPE in accordance with Chapter 1 under any of the following conditions:

(1) Testing, troubleshooting, or voltage measuring
(2) Thermography, ultrasound, or visual inspections if the restricted approach boundary is not crossed
(3) Access to and egress from an area with energized electrical equipment if no electrical work is performed and the restricted approach boundary is not crossed
(4) General housekeeping and miscellaneous non-electrical tasks if the restricted approach boundary is not crossed

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130.4 Shock Risk Assessment.

(A) General. A shock risk assessment shall be performed:

(1) To identify shock hazards
(2) To estimate the likelihood of occurrence of injury or damage to health and the potential severity of injury or damage to health
(3) To determine if additional protective measures are required, including the use of PPE

N **(B) Estimate of Likelihood and Severity.** The estimate of likelihood of occurrence of injury or damage to health and the potential severity of injury or damage to health shall take into consideration all of the following:

(1) The design of the electrical equipment

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(2) The electrical equipment operating condition and the condition of maintenance

(C) Additional Protective Measures. If additional protective measures are required, they shall be selected and implemented according to the hierarchy of risk control identified in 110.5(H)(3). When the additional protective measures include the use of PPE, the following shall be determined:

(1) The voltage to which personnel will be exposed
(2) The boundary requirements
(3) The personal and other protective equipment required by this standard to protect against the shock hazard

(D) Documentation. The results of the shock risk assessment shall be documented.

(E) Shock Protection Boundaries. The shock protection boundaries identified as limited approach boundary and restricted approach boundary shall be applicable where personnel are approaching exposed energized electrical conductors or circuit parts. Table 130.4(E)(a) shall be used for the distances associated with various ac system voltages. Table 130.4(E)(b) shall be used for the distances associated with various dc system voltages.

Informational Note: In certain instances, the arc flash boundary might be a greater distance from the energized electrical conductors or circuit parts than the limited approach boundary. The shock protection boundaries and the arc flash boundary are independent of each other.

(F) Limited Approach Boundary.

(1) Approach by Unqualified Persons. Unless permitted by 130.4(F)(3), no unqualified person shall be permitted to approach nearer than the limited approach boundary of energized conductors and circuit parts.

(2) Working at or Close to the Limited Approach Boundary. Where one or more unqualified persons are working at or close to the limited approach boundary, the alerting methods in 130.7(E) shall be applied to advise the unqualified person(s) of the electrical hazard and warn him or her to stay outside of the limited approach boundary.

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

(G) Restricted Approach Boundary. No qualified person shall approach or take any conductive object closer to exposed energized electrical conductors or circuit parts than the restricted approach boundary set forth in Table 130.4(E)(a) and Table 130.4(E)(b), unless one of the following conditions applies:

(1) The qualified person is insulated or guarded from energized electrical conductors or circuit parts operating at 50 volts or more. Insulating gloves and sleeves are considered insulation only with regard to the energized parts upon which work is performed.
(2) The energized electrical conductors or circuit parts are insulated from the qualified person and from any other conductive object at a different potential.

Δ Table 130.4(E)(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]		
Nominal System Voltage Range, Phase to Phase[a]	Exposed Movable Conductor[c]	Exposed Fixed Circuit Part	Restricted Approach Boundary[b]; Includes Inadvertent Movement Adder
Less than 50 V	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(E).
(2) All dimensions are distance from exposed energized electrical conductors or circuit part to 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 exceed 120 volts nominal.

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

(1)	(2)	(3)	(4)
	Limited Approach Boundary		
Nominal Potential Difference	Exposed Movable Conductor*	Exposed Fixed Circuit Part	Restricted Approach Boundary; Includes Inadvertent Movement Adder
Less than 50 V	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.
**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.

130.5 Arc Flash Risk Assessment.

(A) General. An arc flash risk assessment shall be performed:

(1) To identify arc flash hazards
(2) To estimate the likelihood of occurrence of injury or damage to health and the potential severity of injury or damage to health
(3) To determine if additional protective measures are required, including the use of PPE

(B) Estimate of Likelihood and Severity. The estimate of the likelihood of occurrence of injury or damage to health and the potential severity of injury or damage to health shall take into consideration the following:

(1) The design of the electrical equipment, including its overcurrent protective device and its operating time
(2) The electrical equipment operating condition and condition of maintenance

Δ **(C) Additional Protective Measures.** If additional protective measures are required they shall be selected and implemented according to the hierarchy of risk control identified in 110.5(H)(3). When the additional protective measures include the use of PPE, the following shall be determined:

(1) Appropriate safety-related work practices
(2) The arc flash boundary
(3) The PPE to be used within the arc flash boundary

Table 130.5(C) shall be permitted to be used to estimate the likelihood of occurrence of an arc flash event to determine if additional protective measures are required.

(D) Documentation. The results of the arc flash risk assessment shall be documented.

(E) Arc Flash Boundary.

(1) The arc flash boundary shall be the distance at which the incident energy equals 1.2 cal/cm^2 (5 J/cm^2).

Informational Note: For information on estimating the arc flash boundary, see Informative Annex D.

(2) The arc flash boundary shall be permitted to be determined by Table 130.7(C)(15)(a) or Table 130.7(C)(15)(b) when the requirements of these tables apply.

(F) Arc Flash PPE. One of the following methods shall be used for the selection of arc flash PPE:

(1) The incident energy analysis method in accordance with 130.5(G)
(2) The arc flash PPE category method in accordance with 130.7(C)(15)

Either, but not both, methods shall be permitted to be used on the same piece of equipment. The results of an incident energy analysis to specify an arc flash PPE category in Table 130.7(C)(15)(c) shall not be permitted.

(G) Incident Energy Analysis Method. The incident energy exposure level shall be based on the working distance of the employee's face and chest areas from a prospective arc source for the specific task to be performed. Arc-rated clothing and other PPE shall be used by the employee based on the incident energy exposure associated with the specific task. Recognizing that incident energy increases as the distance from the arc flash decreases, additional PPE shall be used for any parts of the body that are closer than the working distance at which the incident energy was determined.

The incident energy analysis shall take into consideration the characteristics of the overcurrent protective device and its fault clearing time, including its condition of maintenance.

The incident energy analysis shall be updated when changes occur in the electrical distribution system that could affect the results of the analysis. The incident energy analysis shall also be reviewed for accuracy at intervals not to exceed 5 years.

Table 130.5(G) identifies the arc-rated clothing and other PPE requirements of Article 130 and shall be permitted to be used with the incident energy analysis method of selecting arc flash PPE.

Informational Note: For information on estimating the incident energy, see Informative Annex D. For information on selection of arc-rated clothing and other PPE, see Informative Annex H.

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Δ Table 130.5(C) Estimate of the Likelihood of Occurrence of an Arc Flash Incident for ac and dc Systems

Task	Equipment Condition[a]	Likelihood of Occurrence[b]
Reading a panel meter while operating a meter switch. Performing infrared thermography and other non-contact inspections outside the restricted approach boundary. This activity does not include opening of doors or covers. Working on control circuits with exposed energized electrical conductors and circuit parts, nominal 125 volts ac or dc, or below without any other exposed energized equipment over nominal 125 volts ac or dc, including opening of hinged covers to gain access. Examination of insulated cable with no manipulation of cable. For dc systems, maintenance on a single cell of a battery system or multi-cell units in an open rack.	Any	No
For ac systems, work on energized electrical conductors and circuit parts, including electrical testing. Operation of a CB or switch the first time after installation or completion of maintenance in the equipment. For dc systems, working on energized electrical conductors and circuit parts of series-connected battery cells, including electrical testing. Removal or installation of CBs or switches. Opening hinged door(s) or cover(s) or removal of bolted covers (to expose bare, energized electrical conductors and circuit parts). For dc systems, this includes bolted covers, such as battery terminal covers. Application of temporary protective grounding equipment, after voltage test. Working on control circuits with exposed energized electrical conductors and circuit parts, greater than 120 volts. Insertion or removal of individual starter buckets from motor control center (MCC). Insertion or removal (racking) of circuit breakers (CBs) or starters from cubicles, doors open or closed. Insertion or removal of plug-in devices into or from busways. Examination of insulated cable with manipulation of cable. Working on exposed energized electrical conductors and circuit parts of equipment directly supplied by a panelboard or motor control center. Insertion or removal of revenue meters (kW-hour, at primary voltage and current). Insertion or removal of covers for battery intercell connector(s). For dc systems, working on exposed energized electrical conductors and circuit parts of utilization equipment directly supplied by a dc source. Opening voltage transformer or control power transformer compartments. Operation of outdoor disconnect switch (hookstick operated) at 1 kV through 15 kV. Operation of outdoor disconnect switch (gang-operated, from grade) at 1 kV through 15 kV.	Any	Yes
Operation of a CB, switch, contactor, or starter. Voltage testing on individual battery cells or individual multi-cell units. Removal or installation of covers for equipment such as wireways, junction boxes, and cable trays that does not expose bare, energized electrical conductors and circuit parts. Opening a panelboard hinged door or cover to access dead front overcurrent devices. Removal of battery nonconductive intercell connector covers.	Normal	No

(continues)

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Δ **Table 130.5(C)** ***Continued***

Task	Equipment Condition[a]	Likelihood of Occurrence[b]
Maintenance and testing on individual battery cells or individual multi-cell units in an open rack	Abnormal	Yes
Insertion or removal of individual cells or multi-cell units of a battery system in an open rack.		
Arc-resistant equipment with the DOORS CLOSED and SECURED, and where the available fault current and fault clearing time does not exceed that of the arc-resistant rating of the equipment in one of the following conditions:		
(1) Insertion or removal of individual starter buckets		
(2) Insertion or removal (racking) of CBs from cubicles		
(3) Insertion or removal (racking) of ground and test device		
(4) Insertion or removal (racking) of voltage transformers on or off the bus		

[a]Equipment is considered to be in a "normal operating condition" if all of the conditions in 110.4(D) are satisfied.

[b]As defined in this standard, the two components of risk are 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 is an overall process that involves estimating both the likelihood of occurrence and severity to determine if additional protective measures are required. The estimate of the likelihood of occurrence contained in this table does not cover every possible condition or situation, nor does it address severity of injury or damage to health. Where this table identifies "No" as an estimate of likelihood of occurrence, it means that an arc flash incident is not likely to occur. Where this table identifies "Yes" as an estimate of likelihood of occurrence, it means an arc flash incident should be considered likely to occur. The likelihood of occurrence must be combined with the potential severity of the arcing incident to determine if additional protective measures are required to be selected and implemented according to the hierarchy of risk control identified in 110.5(H)(3).

Informational Note No. 1: An example of a standard that provides information for arc-resistant equipment referred to in Table 130.5(C) is IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults.*

Informational Note No. 2: Improper or inadequate maintenance can result in increased fault clearing time of the overcurrent protective device, thus increasing the incident energy. Where equipment is not properly installed or maintained, PPE selection based on incident energy analysis or the PPE category method might not provide adequate protection from arc flash hazards.

Informational Note No. 3: Both larger and smaller available fault currents could result in higher incident energy. If the available fault current increases without a decrease in the fault clearing time of the overcurrent protective device, the incident energy will increase. If the available fault current decreases, resulting in a longer fault clearing time for the overcurrent protective device, incident energy could also increase.

Informational Note No. 4: The occurrence of an arcing fault inside an enclosure produces a variety of physical phenomena very different from a bolted fault. For example, the arc energy resulting from an arc developed in the air will cause a sudden pressure increase and localized overheating. Equipment and design practices are available to minimize the energy levels and the number of procedures that could expose an employee to high levels of incident energy. Proven designs such as arc-resistant switchgear, remote racking (insertion or removal), remote opening and closing of switching devices, high-resistance grounding of low-voltage and 5000-volt (nominal) systems, current limitation, and specification of covered bus or covered conductors within equipment are available to reduce the risk associated with an arc flash incident. See Informative Annex O for safety-related design requirements.

Informational Note No. 5: For additional direction for performing maintenance on overcurrent protective devices, see Chapter 2, Safety-Related Maintenance Requirements.

Informational Note No. 6: See IEEE 1584, *Guide for Performing Arc Flash Hazard Calculations*, for more information regarding incident energy and the arc flash boundary for three-phase systems.

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Δ Table 130.5(G) Selection of Arc-Rated Clothing and Other PPE When the Incident Energy Analysis Method Is Used

Incident energy exposures equal to 1.2 cal/cm^2 up to and including 12 cal/cm^2
Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy[a]
Arc-rated long-sleeve shirt and pants or arc-rated coverall or arc flash suit (SR)
Arc-rated face shield and arc-rated balaclava or arc flash suit hood (SR)[b]
Arc-rated outerwear (e.g., jacket, parka, rainwear, hard hat liner, high-visibility apparel) (AN)[e]
Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR)[c]
Hard hat
Safety glasses or safety goggles (SR)
Hearing protection
Leather footwear[d]
Incident energy exposures greater than 12 cal/cm^2
Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy[a]
Arc-rated long-sleeve shirt and pants or arc-rated coverall or arc flash suit (SR)
Arc-rated arc flash suit hood
Arc-rated outerwear (e.g., jacket, parka, rainwear, hard hat liner, high-visibility apparel) (AN)[e]
Arc-rated gloves or rubber insulating gloves with leather protectors (SR)[c]
Hard hat
Safety glasses or safety goggles (SR)
Hearing protection
Leather footwear[d]

SR: Selection of one in group is required.
AN: As needed.
[a]Arc ratings can be for a single layer, such as an arc-rated shirt and pants or a coverall, or for an arc flash suit or a multi-layer system if tested as a combination consisting of an arc-rated shirt and pants, coverall, and arc flash suit.
[b]Face shields with a wrap-around guarding to protect the face, chin, forehead, ears, and neck area are required by 130.7(C)(10)(c). Where the back of the head is inside the arc flash boundary, a balaclava or an arc flash hood shall be required for full head and neck protection.
[c]Rubber insulating gloves with leather protectors provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with leather protectors, due to their increased material thickness, provide increased arc flash protection.
[d]Footwear other than leather or dielectric shall be permitted to be used provided it has been tested to demonstrate no ignition, melting, or dripping at the estimated incident energy exposure.
[e]The arc rating of outer layers worn over arc-rated clothing as protection from the elements or for other safety purposes, and that are not used as part of a layered system, shall not be required to be equal to or greater than the estimated incident energy exposure.

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

(1) Nominal system voltage
(2) Arc flash boundary
(3) At least one of the following:
  a. Available incident energy and the corresponding working distance, or the arc flash PPE category in Table 130.7(C)(15)(a) or Table 130.7(C)(15)(b) for the equipment, but not both
  b. Minimum arc rating of clothing
  c. Site-specific level of PPE

Exception No. 1: Unless changes in electrical distribution system(s) render the label inaccurate, labels applied prior to the effective date of this edition of the standard shall be acceptable if they complied with the requirements for equipment labeling in the standard in effect at the time the labels were applied.

Exception No. 2: In supervised industrial installations where conditions of maintenance and engineering supervision ensure that only qualified persons monitor and service the system, the information required in 130.5(H)(1) through 130.5(H)(3) shall be permitted to be documented in a manner that is readily available to persons likely to perform examination, servicing, maintenance, and operation of the equipment while energized.

The method of calculating and the data to support the information for the label shall be documented. The data shall be reviewed for accuracy at intervals not to exceed 5 years. Where the review of the data identifies a change that renders the label inaccurate, the label shall be updated.

The owner of the electrical equipment shall be responsible for the documentation, installation, and maintenance of the marked label.

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130.7 Personal and Other Protective Equipment.

(A) General. Employees exposed to electrical hazards when the risk associated with that hazard is not adequately reduced by the applicable electrical installation requirements shall be provided with, and shall use, protective equipment that is designed and constructed for the specific part of the body to be protected and for the work to be performed.

Informational Note: The PPE requirements of 130.7 are intended to protect a person from arc flash and shock hazards. While some situations could result in burns to the skin, even with the protection selected, burn injury should be reduced and survivable. Due to the explosive effect of some arc events, physical trauma injuries could occur. The PPE requirements of 130.7 do not address protection against physical trauma other than exposure to the thermal effects of an arc flash.

(B) Care of Equipment. Protective equipment shall be maintained in a safe, clean, and reliable condition and in accordance with manufacturers' instructions. The protective equipment shall be visually inspected before each use. Protective equipment shall be stored in a manner to prevent damage from physically damaging conditions and from moisture, dust, or other deteriorating agents.

Informational Note: Specific requirements for periodic testing of electrical protective equipment are given in 130.7(C)(14) and 130.7(G).

(C) Personal Protective Equipment (PPE).

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

Informational Note: Where the estimated incident energy exposure is greater than the arc rating of commercially available arc-rated PPE, then for the purpose of testing for the absence of voltage, the following examples of risk reduction methods could be used to reduce the likelihood of occurrence of an arcing event or the severity of exposure:

(1) Use noncontact proximity test instrument(s) or measurement of voltage on the secondary side of a low-voltage transformer (VT) mounted in the equipment before using a contact test instrument to test for the absence of voltage below 1000 volts.
(2) If equipment design allows, observe visible gaps between the equipment conductors and circuit parts and the electrical source(s) of supply.
(3) Increase the working distance.
(4) Consider system design options to reduce the incident energy level.

(2) Movement and Visibility. When arc-rated clothing is worn to protect an employee, it shall cover all ignitible clothing and shall allow for movement and visibility.

(3) Head, Face, Neck, and Chin (Head Area) Protection. Employees shall wear nonconductive head protection wherever there is a danger of head injury from electric shock or burns due to contact with energized electrical conductors or circuit parts or from flying objects resulting from electrical explosion. Employees shall wear nonconductive protective equipment for the face, neck, and chin whenever there is a danger of injury from exposure to electric arcs or flashes or from flying objects resulting from electrical explosion. If employees use hairnets or beard nets, or both, these items shall be arc rated.

Informational Note: See 130.7(C)(10)(b) and (C)(10(c) for arc flash protective requirements.

(4) Eye Protection. Employees shall wear protective equipment for the eyes whenever there is danger of injury from electric arcs, flashes, or from flying objects resulting from electrical explosion.

(5) Hearing Protection. Employees shall wear hearing protection whenever working within the arc flash boundary.

(6) Body Protection. Employees shall wear arc-rated clothing wherever there is possible exposure to an electric arc flash above the threshold incident energy level for a second degree burn [1.2 cal/cm^2 (5 J/cm^2)].

(7) Hand and Arm Protection. Hand and arm protection shall be provided in accordance with 130.7(C)(7)(a), (C)(7)(b), and (C)(7)(c).

(a) *Shock Protection.* Employees shall wear rubber insulating gloves with leather protectors where there is a danger of hand injury from electric shock due to contact with exposed energized electrical conductors or circuit parts. Employees shall wear rubber insulating gloves with leather protectors and rubber insulating sleeves where there is a danger of hand and arm injury from electric shock due to contact with exposed energized electrical conductors or circuit parts. Rubber insulating gloves shall be rated for the voltage for which the gloves will be exposed. Rubber insulating gloves shall be permitted to be used without leather protectors, under the following conditions:

(1) There shall be no activity performed that risks cutting or damaging the glove.
(2) The rubber insulating gloves shall be electrically retested before reuse.
(3) The voltage rating of the rubber insulating gloves shall be reduced by 50 percent for class 00 and by one whole class for classes 0 through 4.

(b) *Arc Flash Protection.* Hand and arm protection shall be worn where there is possible exposure to arc flash burn. The apparel described in 130.7(C)(10)(d) shall be required for protection of hands from burns. Arm protection shall be accomplished by the apparel described in 130.7(C)(6).

(c) *Maintenance and Use.* Electrical protective equipment shall be maintained in a safe, reliable condition. Insulating equipment shall be inspected for damage before each day's use and immediately following any incident that can reasonably be suspected of having caused damage. Insulating gloves shall be given an air test, along with the inspection. Maximum use voltages for rubber insulating gloves shall not exceed that specified in Table 130.7(C)(7)(a). The top of the cuff of the protector glove shall be shorter than the rolled top of the cuff of the insulating glove by at least the distance specified in Table 130.7(C)(7)(a).

(d) *Periodic Electrical Tests.* Rubber insulating equipment shall be subjected to periodic electrical tests. Test voltages shall be in accordance with applicable state, federal, or local codes and standards. The maximum intervals between tests shall not exceed that specified in Table 130.7(C)(7)(b).

Informational Note: See OSHA 29 CFR 1910.137; ASTM F478, *Standard Specification for In-Service Care of Insulating Line Hose and Covers*; ASTM F479, *Standard Specification for In-Service Care of Insulating Blankets*; and ASTM F496, *Standard Specification for In-Service Care of Insulating Gloves and Sleeves*, which contain information related to in-service and testing requirements for rubber insulating equipment.

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N **Table 130.7(C)(7)(a) Maximum Use Voltage for Rubber Insulating Gloves**

Class Designation of Glove or Sleeve	Maximum ac Use Voltage rms, volts	Maximum dc Use Voltage avg, volts	Distances Between Gauntlet and Cuff, minimum
00	500	750	13 mm (0.5 in.)
0	1,000	1,500	13 mm (0.5 in.)
1	7,500	11,250	25 mm (1 in.)
2	17,000	25,500	51 mm (2 in.)
3	26,500	39,750	76 mm (3 in.)
4	36,000	54,000	102 mm (4 in.)

(8) Foot Protection. Where insulated footwear is used as protection against step and touch potential, dielectric footwear shall be required. Insulated soles shall not be used as primary electrical protection.

Informational Note: Electrical Hazard footwear meeting ASTM F2413, *Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear*, can provide a secondary source of electric shock protection under dry conditions.

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

Clothing and equipment required for the degree of exposure shall be permitted to be worn alone or integrated with flammable, nonmelting apparel. Garments that are not arc rated shall not be permitted to be used to increase the arc rating of a garment or of a clothing system.

Informational Note: Protective clothing includes shirts, pants, coveralls, jackets, and parkas worn routinely by workers who, under normal working conditions, are exposed to momentary electric arc and related thermal hazards. Arc-rated rainwear worn in inclement weather is included in this category of clothing.

(a) *Layering.* Nonmelting, flammable fiber garments shall be permitted to be used as underlayers in conjunction with arc-rated garments in a layered system. If nonmelting, flammable fiber garments are used as underlayers, the system arc rating shall be sufficient to prevent breakopen of the innermost arc-rated layer at the expected arc exposure incident energy level to prevent ignition of flammable underlayers. Garments that are not arc rated shall not be permitted to be used to increase the arc rating of a garment or of a clothing system.

Informational Note: A typical layering system might include cotton underwear, a cotton shirt and trouser, and an arc-rated coverall. Specific tasks might call for additional arc-rated layers to achieve the required protection level.

(b) *Outer Layers.* Garments worn as outer layers over arc-rated clothing, such as jackets, high-visibility apparel, or rainwear, shall also be made from arc-rated material. The arc rating of outer layers worn over arc-rated clothing as protection from the elements or for other safety purposes, and that are not used as part of a layered system, shall not be required to be equal to or greater than the estimated incident energy exposure.

(c) *Underlayers.* Meltable fibers such as acetate, nylon, polyester, polypropylene, and spandex shall not be permitted in fabric underlayers.

Table 130.7(C)(7)(b) Rubber Insulating Equipment, Maximum Test Intervals

Rubber Insulating Equipment	When to Test
Blankets	Before first issue; every 12 months thereafter*
Covers	If insulating value is suspect
Gloves	Before first issue; every 6 months thereafter*
Line hose	If insulating value is suspect
Sleeves	Before first issue; every 12 months thereafter*

*New insulating equipment is not permitted to be placed into service unless it has been electrically tested within the previous 12 months. Insulating equipment that has been issued for service is not new and is required to be retested in accordance with the intervals in this table.

Exception: An incidental amount of elastic used on nonmelting fabric underwear or socks shall be permitted.

Informational Note No. 1: Arc-rated garments (e.g., shirts, trousers, and coveralls) worn as underlayers that neither ignite nor melt and drip in the course of an exposure to electric arc and related thermal hazards generally provide a higher system arc rating than nonmelting, flammable fiber underlayers.

Informational Note No. 2: Arc-rated underwear or undergarments used as underlayers generally provide a higher system arc rating than nonmelting, flammable fiber underwear or undergarments used as underlayers.

(d) *Coverage.* Clothing shall cover potentially exposed areas as completely as possible. Shirt and coverall sleeves shall be fastened at the wrists, shirts shall be tucked into pants, and shirts, coveralls, and jackets shall be closed at the neck.

(e) *Fit.* Tight-fitting clothing shall be avoided. Loose-fitting clothing provides additional thermal insulation because of air spaces. Arc-rated apparel shall fit properly such that it does not interfere with the work task.

(f) *Interference.* The garment selected shall result in the least interference with the task but still provide the necessary protection. The work method, location, and task could influence the protective equipment selected.

(10) Arc Flash Protective Equipment.

(a) *Arc Flash Suits.* Arc flash suit design shall permit easy and rapid removal by the wearer. The entire arc flash suit, including the hood's face shield, shall have an arc rating that is suitable for the arc flash exposure. When exterior air is supplied into the hood, the air hoses and pump housing shall be either covered by arc-rated materials or constructed of nonmelting and nonflammable materials.

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(b) *Head Protection.*

(1) An arc-rated hood or an arc-rated balaclava with an arc-rated face shield shall be used when the back of the head is within the arc flash boundary.

(2) An arc-rated hood shall be used when the anticipated incident energy exposure exceeds 12 cal/cm^2 (50.2 J/cm^2).

(c) *Face Protection.* Face shields shall have an arc rating suitable for the arc flash exposure. Face shields with a wrap-around guarding to protect the face, chin, forehead, ears, and neck area shall be used. Face shields without an arc rating shall not be used. Eye protection (safety glasses or goggles) shall always be worn under face shields or hoods.

Informational Note: Face shields made with energy-absorbing formulations that can provide higher levels of protection from the radiant energy of an arc flash are available, but these shields are tinted and can reduce visual acuity and color perception. Additional illumination of the task area might be necessary when these types of arc-protective face shields are used.

(d) *Hand Protection.*

(1) Heavy-duty leather gloves or arc-rated gloves shall be worn where required for arc flash protection.

Informational Note: Heavy-duty leather gloves are made entirely of leather with minimum thickness of 0.03 in. (0.7 mm) and are unlined or lined with nonflammable, nonmelting fabrics. Heavy-duty leather gloves meeting this requirement have been shown to have ATPV values in excess of 10 cal/cm^2 (41.9 J/cm^2).

(2) Where insulating rubber gloves are used for shock protection, leather protectors shall be worn over the rubber gloves.

Informational Note: The leather protectors worn over rubber insulating gloves provide additional arc flash protection for the hands for arc flash protection exposure.

(e) *Foot Protection.* Leather footwear or dielectric footwear or both provide some arc flash protection to the feet and shall be used in all exposures greater than 4 cal/cm^2 (16.75 J/cm^2). Footwear other than leather or dielectric shall be permitted to be used provided it has been tested to demonstrate no ignition, melting, or dripping at the estimated incident energy exposure or the minimum arc rating for the respective arc flash PPE category.

(11) Clothing Material Characteristics. Arc-rated clothing shall meet the requirements described in 130.7(C)(12) and 130.7(C)(14).

Informational Note No. 1: Arc-rated materials, such as flame-retardant-treated cotton, meta-aramid, para-aramid, and polybenzimidazole (PBI) fibers, provide thermal protection. These materials can ignite but will not continue to burn after the ignition source is removed. Arc-rated fabrics can reduce burn injuries during an arc flash exposure by providing a thermal barrier between the arc flash and the wearer.

Informational Note No. 2: Non-arc-rated cotton, polyester-cotton blends, nylon, nylon-cotton blends, silk, rayon, and wool fabrics are flammable. Fabrics, zipper tapes, and findings made of these materials can ignite and continue to burn on the body, resulting in serious burn injuries.

Informational Note No. 3: Rayon is a cellulose-based (wood pulp) synthetic fiber that is a flammable but nonmelting material.

Clothing consisting of fabrics, zipper tapes, and findings made from flammable synthetic materials that melt at temperatures below 315°C (600°F), such as acetate, acrylic, nylon, polyester, polyethylene, polypropylene, and spandex, either alone or in blends, shall not be used.

Informational Note: These materials melt as a result of arc flash exposure conditions, form intimate contact with the skin, and aggravate the burn injury.

Exception: Fiber blends that contain materials that melt, such as acetate, acrylic, nylon, polyester, polyethylene, polypropylene, and spandex, shall be permitted if such blends in fabrics are arc rated and do not exhibit evidence of melting and dripping during arc testing.

Informational Note: ASTM F1959/F1959M, *Standard Test Method for Determining the Arc Rating of Materials for Clothing*, and ASTM F1506, *Standard Performance Specification for Flame Resistant and Electric Arc Rated Protective Clothing Worn by Workers Exposed to Flames and Electric Arcs*, contain information on test methods used to determine the arc rating of fabrics.

(12) Clothing and Other Apparel Not Permitted. Clothing and other apparel (such as hard hat liners and hair nets) made from materials that do not meet the requirements of 130.7(C)(11) regarding melting or made from materials that do not meet the flammability requirements shall not be permitted to be worn.

Informational Note: Some flame-resistant fabrics, such as non-flame-resistant modacrylic and nondurable flame-retardant treatments of cotton, are not recommended for industrial electrical or utility applications.

Exception No. 1: Nonmelting, flammable (non-arc-rated) materials shall be permitted to be used as underlayers to arc-rated clothing, as described in 130.7(C)(11).

Exception No. 2: Where the work to be performed inside the arc flash boundary exposes the worker to multiple hazards, such as airborne contaminants, and the risk assessment identifies that the level of protection is adequate to address the arc flash hazard, non-arc-rated PPE shall be permitted.

Δ **(13) Care and Maintenance of Arc-Rated Clothing and Arc-Rated Arc Flash Suits.**

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

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

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

(d) *Cleaning, Repairing, and Affixing Items.* When arc-rated clothing is cleaned, manufacturer's instructions shall be followed. When arc-rated clothing is repaired, the same arc-rated materials used to manufacture the arc-rated clothing shall be used to provide repairs.

Informational Note No. 1: The purpose of following manufacturer's instructions is to avoid the loss of protection and to remove contaminants such as hydrocarbons and metallic and disease-causing contaminants that could compromise safety.

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Informational Note No. 2: Additional guidance is provided in ASTM F1506, *Standard Performance Specification for Flame Resistant and Electric Arc Rated Protective Clothing Worn by Workers Exposed to Flames and Electric Arcs*, when trim, name tags, logos, or any combination thereof are affixed to arc-rated clothing.

Informational Note No. 3: Additional guidance is provided in ASTM F1449, *Standard Guide for Industrial Laundering of Flame, Thermal, and Arc Resistant Clothing*, and ASTM F2757, *Standard Guide for Home Laundering Care and Maintenance of Flame, Thermal, and Arc Resistant Clothing*.

Δ **(14) Standards for PPE.**

(a) *General.* PPE shall conform to applicable state, federal, or local codes and standards.

Informational Note No. 1: The standards listed in Table 130.7(C)(14), which is part of this Informational Note, are examples of standards that contain information on the care, inspection, testing, and manufacturing of PPE.

Informational Note No. 2: Non-arc-rated or flammable fabrics are not covered by any of the standards in Table 130.7(C)(14), Informational Note. See 130.7(C)(11) and 130.7(C)(12).

(b) *Conformity Assessment.* All suppliers or manufacturers of PPE shall demonstrate conformity with an appropriate product standard by one of the following methods:

(1) Self-declaration with a Supplier's Declaration of Conformity
(2) Self-declaration under a registered quality management system and product testing by an accredited laboratory and a Supplier's Declaration of Conformity
(3) Certification by an accredited independent third-party certification organization

Informational Note No. 1: Examples of a process for conformity assessment to an appropriate product standard can be found in ANSI/ISEA 125, *American National Standard for Conformity Assessment of Safety and Personal Protective Equipment*. See H.4

Informational Note No. 2: An example of a process to accredit independent third-party certification organizations is ISO 17065, *Conformity assessment — Requirements for bodies certifying products, processes, and services*.

(c) *Marking.* All suppliers or manufacturers of PPE shall provide the following information on the PPE, on the smallest unit container, or contained within the manufacturer's instructions:

(1) Name of manufacturer
(2) Product performance standards to which the product conforms
(3) Arc rating where appropriate for the equipment
(4) One or more identifiers such as model, serial number, lot number, or traceability code
(5) Care instructions

Δ **(15) Arc Flash PPE Category Method.** The requirements of 130.7(C)(15) shall apply when the arc flash PPE category method is used for the selection of arc flash PPE.

(a) *Alternating Current (ac) Equipment.* When the arc flash risk assessment performed in accordance with 130.5 indicates that arc flash PPE is required and the arc flash PPE category method is used for the selection of PPE for ac systems in lieu of the incident energy analysis of 130.5(G), Table 130.7(C)(15)(a) shall be used to determine the arc flash PPE category. The estimated maximum available fault current, maximum fault-clearing times, and minimum working distances for various ac equipment types or classifications are listed in Table 130.7(C)(15)(a). An incident energy analysis shall be required in accordance with 130.5(G) for the following:

(1) Power systems with greater than the estimated maximum available fault current
(2) Power systems with longer than the maximum fault clearing times
(3) Less than the minimum working distance

(b) *Direct Current (dc) Equipment.* When the arc flash risk assessment performed in accordance with 130.5(G) indicates that arc flash PPE is required and the arc flash PPE category method is used for the selection of PPE for dc systems in lieu of the incident energy analysis of 130.5(G), Table 130.7(C)(15)(b) shall be used to determine the arc flash PPE category. The estimated maximum available fault current, maximum arc duration, and working distances for dc equipment are listed in 130.7(C)(15)(b). An incident energy analysis shall be required in accordance with 130.5(G) for the following:

(1) Power systems with greater than the estimated maximum available fault current
(2) Power systems with longer than the maximum arc duration
(3) Less than the minimum working distance

Informational Note No.1: The arc flash PPE category of the protective clothing and equipment is generally based on determination of the estimated exposure level.

Informational Note No.2: In most cases, closed doors do not provide enough protection to eliminate the need for PPE in situations in which the state of the equipment is known to readily change (e.g., doors open or closed, rack in or rack out).

(c) *Protective Clothing and Personal Protective Equipment (PPE).* Once the arc flash PPE category has been identified from Table 130.7(C)(15)(a) or Table 130.7(C)(15)(b), Table 130.7(C)(15)(c) shall be used to determine the required PPE. Table 130.7(C)(15)(c) lists the requirements for PPE based on arc flash PPE categories 1 through 4. This clothing and equipment shall be used when working within the arc flash boundary. The use of PPE other than or in addition to that listed shall be permitted provided it meets 130.7(C)(7).

Informational Note No. 1: See Informative Annex H for a suggested simplified approach to ensure adequate PPE for electrical workers within facilities with large and diverse electrical systems.

Informational Note No. 2: The PPE requirements of this section are intended to protect a person from arc flash hazards. While some situations could result in burns to the skin even with the protection described in Table 130.7(C)(15)(c), burn injury should be reduced and survivable. Due to the explosive effect of some arc events, physical trauma injuries could occur. The PPE requirements of this section do not address protection against physical trauma other than exposure to the thermal effects of an arc flash.

Informational Note No. 3: The arc rating for a particular clothing system can be obtained from the arc-rated clothing manufacturer.

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