EFCOG Best Practice # 206

Title: Adoption of NFPA 70E 2018 in place of NFPA 70E 2015

Facility: DOE Complex

Points of Contact:
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Brief Description of Best Practice: NFPA 70E® – 2018 is recommended for approval across the DOE Complex as an upgrade to NFPA 70E® – 2015 in 10 CFR 851 Worker Safety and Health Plans (WSHP). Previously, EFCOG BP#193 determined that the use of the 2015 edition of NFPA 70E® is at least as protective as the 2012 edition, and even more protective in some areas, such that the new edition should be considered for DOE Complex wide acceptance.

Why the Best Practice was used: 10 CFR 851 lists safety and health consensus standards with which the contractor must comply when applicable with site hazards (851.23). Only the versions of consensus standards that were in effect on February 9, 2006 were promulgated pursuant to rulemaking therefore only those specifically cited versions are required by the Rule. Contractors may include successor versions of the consensus standards that provide equal or greater worker protection if included in their DOE-approved worker safety and health program.

What are the benefits of the Best Practice: The use of the 2018 edition of NFPA 70E® is at least as protective as the 2015 edition, and even more protective in some areas, such that the new edition should be considered for DOE Complex wide acceptance. NFPA 70E® – 2018 is recommended for approval across the DOE Complex as an upgrade to NFPA 70E® – 2015.

What problems/issues were associated with the Best Practice: No problems were noted with Best Practice. Adoption of the 2018 Edition of NFPA 70 provides a level of protection "As Safe or Safer" than the 2015 edition.

How the success of the Best Practice was measured:
A detailed gap analysis of NFPA 70E version 2018 against the 2015 version was performed and the link to the document is provided below. Success will be measured by the use of this Best Practice into each sites adoption of this standard.

Description of process experience using the Best Practice: This Best Practice can be used by a DOE site as justification for adopting the 2018 revision of the NFPA 70E standard.

EFCOG Working Group Members Participating on Best Practice Review Team:

2018 NFPA 70E Article or Section	Added or Deleted Text Underlined text is added. ~~Strikethrough~~ indicates deleted text.	Change Description Impact to Worker Safety
Global	Replace the term “accident” with “incident” in two places and remove it in one location as follows: 330.3(B)(2)d - Replace the term “accident” with “incident” Annex C.1 - Replace the term “accident” with “incident” 130.7(E)(1) – Delete the term “accident prevention”	This revision provides additional consistency of the term incident with other well recognized occupational health and safety standards. The term “accident prevention” was removed in 130.7(E)(1) as direct replacement of “accident” with “incident” would reduce clarity and may not correlate with the ANSI Z535 standards. Safety Impact: No negative impact.
Global	The term “accidental” is replaced with “unintentional” in the 13 places that it appears in the standard. The term “accidentally” is replaced with “unintentionally” in the 3 places that it appears in the standard.	This revision provides additional consistency within this standard and with other well recognized occupational health and safety standards. Safety Impact: No negative impact.
Global	Where the term “cal/cm2” appears in the standard proceeded by a specific number [i.e. 1.2 cal/cm^2], provide dual units of both Calories and Joules.	This revision improves usability of the standard and is consistent with terminology presently used for markings on equipment labels, arc-rated clothing and PPE which utilize calories / square centimeter as the primary units. Providing dual units makes the alternate units (joules / square centimeter) readily accessible without the need for conversion calculations. Safety Impact: No negative impact.
Global	Replaced “short circuit current” with "available fault current"	The term “short circuit current” is replaced with “available fault current” in several locations to improve clarity of the standard. Safety Impact: No negative impact.
90.2(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:	The word “removal” is added to the scope of NFPA 70E to correlate with the newly added word “removal” in 90.2(A) of the 2017 edition of NFPA 70, the National Electrical Code. Safety Impact: No negative impact.

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	(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	
	Boundary, Arc Flash. When an arc flash hazard exists, an approach limit ~~at a distance~~ from ~~a prospective~~ an arc source ~~within which a person could receive a second degree burn if an electrical arc flash were to occur~~ at which incident energy equals 1.2 cal/cm ^{2}	The definition is revised for clarity. Safety Impact: No negative impact.
	Accessible, Readily (Readily Accessible). Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to take actions such as to use tools (other than keys) , to climb over or under, to remove obstacles, or to resort to portable ladders, and so forth. Informational Note: Use of keys is a common practice under controlled or supervised conditions and a common alternative to the ready access requirements under such supervised conditions as provided in *NFPA 70 , National Electrical Code*	This revision updates the definition of "readily accessible" to correlate with the definition in the 2017 edition of the National Electrical Code. Both the original and the newly updated definitions are extracted verbatim from the NEC. The informational note is revised to provide clarity. Safety Impact: No negative impact.
	Arc Flash Hazard A ~~dangerous condition~~ source of possible injury or damage to health associated with the ~~possible~~ release of energy caused by an electric arc. Informational Note No. 1: ~~An~~ The likelihood of occurrence of an arc flash ~~hazard may exist~~ 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. ~~Under~~ An arc flash incident is not likely to occur under normal operating conditions, when enclosed energized equipment that has been properly installed and maintained ~~is not likely to pose an arc flash hazard~~. Informational Note No. 2: See ~~Table 130.7(C) (15) (A) (a)~~ Table 130.5 for examples of ~~activities that could pose~~ tasks that increase the likelihood of an arc flash ~~hazard~~ incident occurring.	This revision adds clarity and harmonizes the language in Informational Notes No. 1 and No. 2 with risk assessment principles found elsewhere in the standard. The term "dangerous condition" is replaced with "source of possible injury or damage to health" to provide consistency with the definition of "shock hazard". The word "possible" is removed from the definition as it was redundant. Safety Impact: No negative impact.
	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~~, for personnel working in close proximity to the energized electrical conductor or circuit part.~~	This revision provides improved clarity for the definition of the restricted approach boundary by eliminating unessential language. Safety Impact: No negative impact.

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	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.	The revised definition better defines "arc blast." Safety Impact: No negative impact.
	Electrical Safety ~~Recognizing~~ Identifying hazards associated with the use of electrical energy and taking precautions ~~so that hazards do not cause injury or death~~ to reduce the risk associated with those hazards.	The definition of "electrical safety" is revised to correlate with the risk assessment principles found in the document. Safety Impact: No negative impact.
	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 ~~ensure~~ verify the absence of voltage and , ~~and grounded~~ if ~~determined~~ necessary, temporarily grounded for personnel protection.	Sentence structure is modified to improve clarity. Safety Impact: No negative impact.
	Fault Current The amount of current delivered at a point on the system during a short-circuit condition.	This revision defines the terms fault current and available fault current which are used throughout the document. This improves usability of the document by creating definite, distinct, clear and concise definitions of widely used terms. Safety Impact: No negative impact.
	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.	This revision defines the terms fault current and available fault current which are used throughout the document. This improves usability of the document by creating definite, distinct, clear and concise definitions of widely used terms. The figure was added to assist in understanding these terms. Safety Impact: No negative impact.
	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 ~~avoid~~ reduce ~~the hazards involved~~ associated risk	The revised definition of "qualified person" correlates with the risk assessment principles found in the document.
	Risk Assessment	The order of the sentence is

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	An overall process that identifies hazards, estimates the ~~potential severity~~ likelihood of occurrence of injury or damage to health, estimates the ~~likelihood of occurrence~~ 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.	changed to provide consistency of the terms with the defined term "risk". Safety Impact: No negative impact.
	Shock Hazard A ~~dangerous condition~~ source of possible injury or damage to health associated with ~~the possible release of energy~~ current through the body caused by contact or approach to energized electrical conductors or circuit parts. Informational Note: Injury and damage to health resulting from shock is dependent on the electrical current, 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.	The revised definition and new informational note provides clarity for the user of the standard. Safety Impact: No negative impact.
	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.	The new concise, descriptive definition of an electrical safety program enhances clarity and usability of the Standard. Safety Impact: No negative impact.
	Maintenance, Condition of The state of the electrical equipment considering the manufacturer's instructions, manufacturer's recommendations and applicable industry codes, standards and recommended practices.	This revision improves clarity by defining the term "condition of maintenance" which is used twice in the standard. Safety Impact: No negative impact.
	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.	A new definition for working distance is added since this term is used in multiple places throughout the standard. Safety Impact: No negative impact.
105.4	**Priority** Hazard elimination shall be the first priority in implementation of safety-related work practices. Informational Note: Elimination is the first risk control method listed in the hierarchy of risk control identified in 110.1(H).	Hazard elimination is emphasized as a priority in accordance with the hierarchy of risk control methods referenced in 110.1(H). Safety Impact: No negative impact.
105.3	**Responsibility**	The revision provides clarity

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	(A) Employer Responsibility. The employer shall have the following responsibilities: ~~provide the safety-related work practices and shall train the employee, who shall then implement them~~. (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. **(B)** Employee Responsibility. The employee shall comply with the safety-related work practices and procedures provided by the employer.	regarding employer and employee responsibilities. Safety Impact: No negative impact.
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.	Added "and procedures" to clarify the definition of Organization. Previously 105.4 in NEC-2015. Safety Impact: No negative impact.
110.1(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.	An electrical safety program inspection requirement is created for newly installed or modified electrical equipment to enhance worker safety. Safety Impact: No negative impact.
110.1(C)	**Condition of Maintenance** The electrical safety program shall include elements that consider condition of maintenance of electrical equipment and systems.	This revision clarifies the intent of the requirements of this section. Safety Impact: No negative impact.
110.1(H)	**Risk Assessment Procedure** The electrical safety program shall include a risk assessment procedure and shall comply with (H)(1) through (H)(3) **(1) Elements of a Risk Assessment Procedure** ~~An electrical safety program shall include a risk assessment procedure that addresses employee exposure to electrical hazards.~~ The risk assessment procedure shall address employee exposure to electrical hazards and shall identify the process to be used by the employee before work is started to carry out the following: (1) Identify hazards (2) Assess risks (3) Implement risk control according to a hierarchy of methods **(2) Human Error**	The hierarchy of risk control methods is moved from an Informational Note to a requirement to correlate with 110.2(A)(1)(c)(4) which requires qualified workers to be additionally trained to select appropriate risk control methods from the hierarchy of risk controls. A requirement to take human error into consideration during a risk assessment was added to provide additional clarity and to correlate with existing requirements in the Standard such as 130.6(A) Alertness and 130.6(B) Blind Reaching. A new Informational Note No. 1 has

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	The risk assessment procedure shall address the potential for human error and its negative consequences on people, processes, the work environment, and equipment. Informational Note: The potential for human error varies with factors such as tasks and the work environment. See Informative Annex Q **(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: ~~The hierarchy of risk control methods specified in ANSI/AIHA Z10, *American National Standard for Occupational Health and Safety Management Systems*, is as follows~~: 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 ANSI/AIHA Z10, *American National Standard for Occupational Health and Safety Management Systems*, for more information regarding the hierarchy of risk control methods. Informational Note No. 3: The risk assessment procedure ~~may~~ could include identifying when a second person could be required and the training and equipment that person should have. Informational Note No. 4: For an example of a risk assessment procedure, see Informative Annex F.	been added regarding the hierarchy of risk control to provide clarity and enhance understanding Safety Impact: No negative impact.
110.1(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.”	This revision creates a requirement for an electrical safety program to include investigation of electrical incidents. Provisions are included, in the electrical safety program, for incident investigations without providing a prescriptive method. The new informational note is added to clarify that electrical incidents

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		include events or occurrences that result in, or could have resulted in, fatality, injury, or damage to health. Safety Impact: No negative impact.
110.1(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. ~~The briefing shall cover such subjects as hazards associated with the job, work procedures involved, special precautions, energy source controls, PPE requirements, and the information on the energized electrical work permit, if required. Additional job briefings shall be held if changes that might affect the safety of employees occur during the course of the work.~~ **(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 (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 **(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. **(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 form and planning checklist, see Informative Annex I, Figure I.1.	The revised requirement clarifies that a job safety plan and an energized electrical work permit might be documented separately, and in such cases, both documents shall be included in the job briefing. Safety Impact: No negative impact.
110.1(K)	~~**Electrical Safety**~~ **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.	The lockout/tagout auditing requirements are relocated from Article 120 to Article 110 to consolidate all auditing requirements in one location in the Standard. Safety Impact: No negative impact.

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	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 110.1(K) shall be documented.	
110.2(A)	**Electrical Safety Training** The training requirements contained in ~~this section~~ 110.2(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	This revision creates clarity and enhances the usability of the Standard by: • Training requirements in Article 120 were relocated to Article 110.2 to consolidate all training requirements to one location. • The content of 110.2 was reorganized into a more logical flow • The term “methods” was changed to “tasks” for clarity and to harmonize with other requirements in the document. • Retraining requirements for tasks performed less than once per year were moved into “Retraining” for consistency • A lockout/tagout retraining requirement was added to closer align with OSHA standards for workers observed to be not in compliance with procedures. “Electrical” was added to title of 110.2A to clarify that requirements of this standard relate specifically to electrical safety training as opposed to safety training in general. Safety Impact: No negative impact.

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	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(C)(a) and Table 130.4(C)(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 110.1(G), including personal protective equipment (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 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. **(3)** Retraining. 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:	

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	(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 ~~this section~~ 110.2(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. **(5)** Electrical Safety Training Documentation. The employer shall document that each employee has received the training required by 110.2(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. **(1)** Initial Training. Employees involved in or affected by the lockout/tagout procedures required by 120.2 shall be trained in the following: (1) The lockout/tagout procedures (2) Their responsibility in the execution of the procedures	

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	(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 110.2(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.	
110.2(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. ~~Employees exposed to shock hazards shall be trained in methods of safe release of victims from contact with exposed energized electrical conductors or circuit parts. 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). ~~Refresher training shall occur annually.~~ (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) ~~Refresher training~~ Training shall occur ~~annually~~ 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.	This revision creates clarity and enhances the usability of the Standard by clarifying contact release training requirements, revising refresher training frequency for those responsible for responding to medical emergencies from a fixed annual requirement to that which satisfies the requirements of the certifying body such as the American Heart Association and the Red Cross and clarifying in the informational note that first responders may not be medical professionals. Safety Impact: No negative impact.

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	Employers shall verify at least annually that employee training required by ~~this section~~ 110.2(C) is current. **(4)** Documentation. The employer shall document that the training required by ~~this section~~ 110.2(C) has occurred.	
110.3(A)(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.	The new informational note provides guidance on who could be the host employer. Safety Impact: No negative impact.
110.4 110.5 110.6 110.7	~~**Use of Electrical Equipment.**~~ **Test Instruments and Equipment** **(A)** Testing. Only qualified persons shall perform tasks such as testing, troubleshooting, and voltage measuring ~~within the limited approach boundary of energized electrical conductors or circuit parts operating at 50 volts or more or where an electrical hazard exists~~. on electrical equipment operating at voltages equal to or greater than 50 Vac. **(B)** Rating. Test instruments, equipment, and their accessories shall be ~~rated for circuits and equipment where they are utilized.~~ 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 ~~ANSI/ISA-61010-1 (82.02.01)/~~ 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	Section 110 is divided by grouping similar requirements into separate section and providing each section with a meaningful title as follows: 110.4 Test Instruments and Equipment 110.5 Portable Cord- and-Plug-Connected Electric Equipment 110.6 Ground-Fault Circuit Interrupter (GFCI) Protection 110.7 Overcurrent Protection Modification This revision provides clarity and enhances usability of the Standard. The test instrument operation verification requirement is revised to clarify the intent of this requirement. The reference to UL 61010-2-033 in the informational note is added due to revisions to the UL 61010 set of Standards. The informational note points to use of Special Purpose Ground Fault Circuit Interrupters in Informative Annex O indicating that this could supplement the current provision for an assured equipment grounding conductor program. Safety Impact: No negative impact.

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	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 ~~50 volts or more~~ 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. **Portable Cord- and-Plug-Connected Electric Equipment.** This section applies to the use of cord- and plug-connected equipment, including 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. **(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: ~~Cord~~ Stationary cord- and plug-connected equipment and flexible cord sets (extension cords) that remain connected once they are put in place and are ~~not exposed to damage~~ 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	

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	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. **(D)** Conductive Work Locations. Portable electric equipment used in highly conductive work locations (such as those inundated with water or other conductive liquids) shall be approved for those locations. In job locations where employees are likely to contact or be drenched with water or conductive liquids, ground-fault circuit-interrupter protection for personnel shall also 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. **110.6 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	

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	operating or using 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. **110.7 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*.	
120	Complete re-write and reorganization of Article 120. (See Code for complete re-write. Only significant changes are included below.) **120.5 Process for ~~Elements of~~ Establishing and Verifying an Electrically Safe Work Condition** (4) Release stored electrical energy (5) Release or block stored mechanical energy	The change creates clarity and enhances the usability of the Standard by: • Relocating the training requirements in Article 120 to Article 110.2 to consolidate all training requirements in one location in the Standard; and • Reorganizing the content of 110.2

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	Exception No. 1: An adequately rated permanently mounted test device shall be permitted to be used to verify the absence of voltage of the conductors or circuit parts at the work location, provided it meets the all 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 verifying 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 verifying the absence of voltage. Exception No. 2: *On electrical systems over 1000 volts, noncontact test instruments shall be permitted to be used to test each phase conductor.* Informational Note No. 2: 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 it could be reasonably anticipated that the conductors or circuit parts be de-energized could contact other exposed energized or circuit parts, apply ~~ground connecting devices rated for the available fault duty~~ temporary protective grounding equipment in accordance with the following: (a) Placement…. (b) Capacity…. (c) Impedance….	into a logical flow of requirements Article 120 is reorganized for clarity, usability and to provide a more logical flow with the following major subheadings: 120.1 Lockout/Tagout Program 120.2 Lockout/Tagout Principles 120.3 Lockout/Tagout Equipment 120.4 Lockout/Tagout Procedures 120.5 Process for Establishing and Verifying an Electrically Safe Work Condition. The training requirements in 120.2(B) (2), 120.2(B)(3) and 120.2(B)(4) are relocated to Article 110 so that all of the training requirements of the Standard are grouped together in one section. The auditing requirements in 120.2(C)(3) are relocated to Article 110 so that all of the auditing requirements of the Standard are grouped together in one section. In 120.2(A), the first "circuit" in "electrical circuit conductors and circuit parts" is deleted to be more consistent with how the phrase is used elsewhere in the Standard. 120.2(D)(3) is relocated and combined with former 120.2(B)(9) to eliminate the redundancy of the two sections on Coordination. 120.3 is relocated to move the requirements for temporary protective grounding equipment closer to the grounding requirements in establishing and verifying an electrically safe work condition. Article 120 was revised in multiple locations to clarify and make consistent the use of the terms "programs", "plans", "process" and "procedures". The following definitions are used as the basis for these changes. "Practice" - to do something customarily (e.g. "work practice") "Procedure" – a series of steps

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		followed in a regular definite order (e.g. "lockout/tagout procedure") "Process" – a series of actions or operations conducing to an end (e.g. "Risk Assessment – an overall process that…") "Program" – a plan or system under which action may be taken toward a goal (e.g. "electrical safety program") Modified 120.5 Informational Note to clarify that both ratings and overvoltage categories are addressed by the use of the referenced standard. Updated standard to reflect current standard making body. Steps (4) and (5) to release stored electrical and mechanical energy are added to 120.5 to reflect the need to release both in order to establish an electrically safe work condition. Changed the term "ground connecting devices" in 120.5(8) to "temporary protective grounding equipment" to better align the term with how it is used elsewhere in the Standard, such as 120.3 and 120.2(F)(2)(g). The title of 120.5 was changed to indicate that the section contains steps not only to verify an electrically safe work condition but also steps to establish and achieve an electrically safe work condition. Exception No. 2 was added to permit using non-contact voltage detectors was added to 120.5 to recognize using non-contact voltage detection over 1000V may be safer than using direct contact instruments. New Informational Note 2 was added to 120.5 to recognize international standards that address the safety and design aspects of voltage detectors rated both <=1000V and >1000V.

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		Informational note 1, referencing UL 61010-1,is retained because it applies to voltage measuring instruments (instead of voltage detectors) and includes important rating information such as overvoltage categories necessary for the proper selection of voltage instruments rated <=1000V. The informational note in 120.2(A) was modified to recognize there are more than “6 steps” to establish an electrically safe work condition. 120.2(A) was modified to correlate with the requirements of Article 130 related to requiring safe work practices when an electrically safe work condition has not been established. 120.2(C) is updated to clarify the types of documentation required to develop lockout/tagout procedures. During the 2012 edition of the Standard, the Individual Qualified Employee Control Procedure was deleted from the standard. Removal of this clause impacted the ability to isolate cord and plug connected equipment without requiring the application of locks and tags, which is still permitted by OSHA 1910.147. A new exception is added to 120.4(A)(4) to reflect lockout/tagout is not required for cord and plug connected equipment, where the cord and plug are under exclusive control of the person performing the work. In 120.4(A)(5), “a set number of” is deleted because it is vague and adds no clarity to the requirement. “Lockbox” is added to “operation lock” because it is a broadly recognized method of executing complex lockout/tagout where individuals still apply their personal locks as a means of controlling

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		multiple energy sources. The first sentence in 120.4(A)(5)(e) is deleted because it is vague and does not add clarity to the requirements. It is unrealistic for a lockout/tagout procedure to address "all of the concerns" of employees who might be exposed. 120.2(E) is updated to clarify the types of documentation required to verify that operation of electrical interlocks will not result in inadvertent reenergizing of circuits. The committee reaffirms that "up-to-date" is the preferred language. The phrase "on a known voltage source" in 120.4(B)(6)(10 is added to be consistent with other similar requirements in the Standard. "Voltage detector" is changed to "test instrument" in two places to align with changes made in previous editions of the Standard. A new Exception No. 1 was added to 120.5(7) recognizing that a permanently mounted test device that is listed and labeled can be used at the point where work is to be performed. Safety Impact: No negative impact.
130.1	**General.** Article 130 covers the following: (1) When an electrically safe work condition must be established (2) ~~The~~ 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 All requirements of this article shall apply whether an incident energy analysis is completed or if Table ~~130.7(C)(15)(A)(a) , Table 130.7(C)(15)(A)(b) , Table 130.7(C)(15)(B), and Table 130.7(C)(16)~~ ~~Table 130.5 ,~~ 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 ~~in accordance with 130.5~~.	This revision editorially renumbers applicable tables due to changes in 130.5 and 130.7(C)(15). Safety Impact: No negative impact.
130.2	**Electrically Safe ~~Working~~ Work Conditions** Energized electrical conductors and circuit parts operating at	Voltage levels were added to 130.2 for clarity. Informational notes were relocated below the items in

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	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. ~~*Exception: Where a disconnecting means or isolating element that has been properly installed and maintained is operated, opened, closed, removed, or inserted to achieve an electrically safe work condition for connected equipment or to return connected equipment to service that has been placed in an electrically safe work condition, the equipment supplying the disconnecting means or isolating element shall not be required to be placed in an electrically safe work condition provided a risk assessment is performed and does not identify unacceptable risks for the task.*~~ **(A)** Energized Work. **(1)** 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. **(2)** 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. **(3)** 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	130.2(A) for ease of reference. The titles of 130.2(A)(3) and (4) were revised for clarity. A new item was added to 130.4(A)(4) to correlate with NEC 110.3(B). A requirement to document the energized electrical work permit was added to 130.2(B) and a requirement to describe the work to be done was added to the elements of a work permit. Ultrasound was added to the work permit exemptions in 130.2(B)(3). The Exception has been removed since normal operation is already permitted in 130.2(A)(4). Safety Impact: No negative impact.

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	considered and it is determined that there will be no increased exposure to electrical burns or to explosion due to electric arcs. **(4)** Normal ~~Operation~~ 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. (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. **(B)** Energized Electrical Work Permit. **(1)** When Required. When ~~energized~~ work is performed as permitted in accordance with 130.2(A), an energized electrical work permit shall be required and documented under the any of 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 **(2)** Elements of Work Permit. The ~~energized electrical~~ 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 130.2(A)]* (4) Description of the safe work practices to be employed *[see 130.3]* (5) Results of the shock risk assessment *[see 130.4(A)]* a. Voltage to which personnel will be exposed b. Limited approach boundary *[see*	

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	130.4(E)~~130.4(C)130.4(C)130.4(B)~~ , Table 130.4(D)(a)and Table 130.(D)(b) ~~130.4(C)(a)Table 130.4(C)(a)Table 130.4(D)(a)~~ , ~~and Table 130.4(C)(b)Table 130.4(C)(b)Table 130.4(C)(b)Table 130.4(D)(b)] c. Restricted approach boundary *[see 130.4(F)~~130.4(C)130.4(C)130.4(B) and~~ , Table ~~130.4(C)(a)Table 130.4(C)(a)Table 130.4(C)(a)Table~~ 130.4(D)(a) , ~~and Table 130.4(C)(b)Table 130.4(C)(b)Table 130.4(C)(b)~~Table 130.4(D)(b)~~]~~* d. ~~Necessary personal~~ 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(E)~~130.4(D)130.4(D)130.4(C)~~ , 130.7(C)(1) through (C)(16), ~~Table 130.7(C)(15)(A)~~ and 130.7(D) (a) ~~Table 130.5~~ , ~~Table 130.7(C)(15)(c)Table 130.7(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. ~~Necessary PPE to protect against the hazard~~ Personal and other protective equipment required by this standard to protect against the arc flash *[see 130.5(F), 130.7(C)(1) through (C)(16), ~~Table 130.7(C)(15)(A)(a)~~ ~~Table 130.5~~ , Table 130.7(C)(15)(c)~~Table 130.7(C)(16)~~ , 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 130.3]* (8) Evidence of completion of a job briefing, including a discussion of any job-specific hazards *[see 110.1(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. **(3)** Exemptions to Work Permit. ~~An~~ Electrical work shall be permitted without an energized electrical work permit ~~shall not be required~~ 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, ~~and~~ , or voltage measuring (2) Thermography ~~and ,~~ 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	
130.4	**~~Approach Boundaries to Energized Electrical Conductors or Circuit Parts for Shock Protection~~ Shock Risk Assessment**	The revisions increase usability and clarify the application of risk assessment principles to a shock

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	(A) ~~Shock Risk Assessment~~ General. A shock risk assessment shall ~~determine the voltage to which personnel will be exposed, the boundary requirements, and the PPE necessary in order to minimize the possibility of electric shock to personnel.~~ be performed as follows: (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. **(B)** Additional Protective Measures. If additional protective measures are required, they shall be selected and implemented according to the hierarchy of risk control identified in 110.1(H). 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 **(C)** Documentation. The results of the shock risk assessment shall be documented. **(D)** Shock Protection Boundaries. The shock protection boundaries identified as limited approach boundary and restricted approach boundary shall be applicable where ~~approaching~~ personnel are ~~approaching~~ exposed to energized electrical conductors or circuit parts. Table 130.4(C)(a) ~~Table 130.4(C)(a) Table 130.4(C)(a) Table 130.4(D)(a)~~ shall be used for the distances associated with various ac system voltages. Table 130.4(C)(b) ~~Table 130.4(C)(b) Table 130.4(C)(b)~~ Table 130.4(D)(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. **(E)** Limited Approach Boundary. **(1)** Approach by Unqualified Persons. Unless permitted by ~~130.4(C)(3)~~ 130.4(E)(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	risk assessment and correlate to the structure of 130.5. The title is revised to Shock Risk Assessment to correlate with 130.5 Arc Flash Risk Assessment. The parent text of 130.4 is revised for clarity and usability. Three new list items now preface the requirements to: (1) identify the voltage, (2) approach boundaries and (3) determine the required PPE. These new list items provide significant clarity by logically capturing all of the prescriptive steps of a shock risk assessment. In 130.4(B)(3) the phrase “PPE necessary to minimize…” was editorially revised to “PPE required by this Standard” for clarity. A new section 130.4(C) “Documentation” was added for consistency with 130.5. Subsequent sections are renumbered. The phrase “50 Volts or more” was deleted throughout 130.4(D) because it is adequately covered in the Tables. The last sentence of 130.4(F)(1) was deleted because bare-hand live line work is not within the scope of the Standard. The titles of Tables 130.4(D)(a) and 130.4(D)(b) are editorially revised for clarity. The restricted approach boundary distances were adjusted for consistency throughout the tables. In Table 130.4(D)(b), 100 Vdc was changed to 50 Vdc for compliance with the OSHA regulations, such as 1910.333(a)(1).

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	close to the limited approach boundary, the designated person in charge of the work space where the electrical hazard exists shall 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 ~~him or her~~ 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 ~~the escorted~~ unqualified person(s) be permitted to cross the restricted approach boundary. **(F)** Restricted Approach Boundary. No qualified person shall approach or take any conductive object closer to exposed energized electrical conductors or circuit parts operating at 50 volts or more than the restricted approach boundary set forth in Table 130.4(D)(a)~~Table 130.4(C)(a)Table 130.4(C)(a)Table 130.4(D)(a)~~ and Table 130.4(D)(b)~~Table 130.4(C)(b)Table 130.4(C)(b)Table 130.4(D)(b)~~ , unless one of the following conditions applies: (1) The qualified person is insulated or guarded from ~~the~~ energized electrical conductors or circuit parts operating at 50 volts or more. Insulating gloves ~~or insulating gloves~~ and sleeves are considered insulation only with regard to the energized parts upon which work is ~~being~~ performed. ~~If there is a need for an uninsulated part of the qualified person's body to contact exposed energized electrical conductors or circuit parts, a combination of 130.4(D)(1), 130.4(D)(2), and 130.4(D)(3) shall be used to protect the uninsulated body parts.~~ (2) The energized electrical conductors or circuit parts ~~operating at 50 volts or more~~ are insulated from the qualified person and from any other conductive object at a different potential. (~~2) The qualified person is insulated from any other conductive object.~~ Table 130.4(D)(a) Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts ~~for Shock Protection~~ for Alternating-Current Systems ~~(All dimensions are distance from energized electrical conductor or circuit part to employee.)~~ Restricted Approach Boundary Less than 50 V 15.1 kV–36 kV 0.8 m (2 ft. ~~7~~ 9 in.) 46.1 kV–72.5 kV 1.0 m (3 ft. ~~3~~ 6 in.) 72.6 kV–121 kV 1.0 m (3 ft. ~~4~~ 6 in.) 500 kV–550 kV 3.6 m (11 ft. ~~10~~ 8 in.)	Safety Impact: No negative impact.

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	Table 130.4(C)(b) Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts for ~~Shock Protection~~, Direct-Current Voltage Systems Restricted Approach Boundary Less than ~~100~~ 50 V ~~100~~ 50 V – 300 V 45.1 kV– 75 kV 1.0 m (3 ft. ~~2~~ 6 in.) 75.1 kV–150 kV 1.2 m (~~4 ft. 0 in.~~ 3 ft. 10 in.)	
130.5	**Arc Flash Risk Assessment** (A) General An arc flash risk assessment shall be performed (1) ~~Determine if an arc flash hazard exists. If an arc flash hazard exists, the risk assessment shall determine:~~ 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. (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 110.1(H). When the additional protective measures include the use of PPE, the following shall be determined: a. Appropriate safety-related work practices b. The arc flash boundary c. 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. ~~(3) Be updated when a major modification or renovation takes place. It shall be reviewed periodically, at intervals not to exceed 5 years, to account for changes in the electrical distribution system that could affect the results of the arc flash risk assessment.~~	The parent text of 130.5 is revised for clarity and usability. Three new list items now preface the requirements to: (1) identify safety related work practices, (2) determine the arc flash boundary and (3) determine the PPE necessary inside the arc flash boundary. These new list items provide significant clarity by logically capturing all of the prescriptive steps of an arc flash risk assessment. 130.5(A) is general in nature and requires that an arc flash risk assessment be performed to: identify arc flash hazards, estimate likelihood of occurrence of injury and determine if additional protective measures are needed. 130.5(B) requires the user consider multiple items when estimating the likelihood of occurrence and potential severity of injury including: equipment design, the overcurrent protective device and operating time, and the condition of maintenance. A reference is added to a new Table 130.5(C). The new Table is designed to help the user to identify the likelihood of occurrence an arc flash incident. This new table is based on the existing table 130.7(C)(15)(A)(a) for arc flash hazard identification. The table is editorially revised for clarity. The last column is retitled as likelihood of occurrence to add clarity and to correlate with relocation into 130.5. A new task for "opening a panelboard hinged door

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	~~(3) Take into consideration the design of the overcurrent protective device and its opening time, including its condition of maintenance~~. Table 130.5 Estimate of the Likelihood of Occurrence of an Arc Flash Incident for ac and dc Systems Informational Note No. 1: An example of a standard that provides information for arc-resistant switchgear referred to in Table 130.5(C) is IEEE C37.20.7, *Guide for Testing Metal-Enclosed Switchgear Rated Up to 38 kV for Internal Arcing Faults* Informational Note No. 2: Improper or inadequate maintenance can result in increased ~~opening~~ 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 ~~may might~~ not provide adequate protection from arc flash hazards. Informational Note No. 3: Both larger and smaller available ~~short-circuit~~ fault currents could result in higher ~~available arc flash energies~~ incident energy. If the available ~~short-circuit~~ fault current increases without a decrease in the ~~opening~~ fault clearing time of the overcurrent protective device, the ~~arc flash~~ incident energy will increase. If the available ~~short-circuit fault~~ current decreases, resulting in a longer ~~opening~~ fault clearing time for the overcurrent protective device, ~~arc flash energies~~ 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 volts (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 Calculations*, for more information	or cover to access deadfront overcurrent devices" is added to eliminate confusion with the task for "opening hinged doors." 130.5(C) requires that where additional protective measures are required the user shall select and implement a measure in accordance with the hierarchy of controls in 110.1(G). This clearly points out to the user that elimination of the hazard is the first choice and PPE is the last. Section 130.5 Informational Notes 1 through 5 have been relocated below Table 130.5(C) in order to avoid separating the Table from the driving text. Table 130.5(G): Revised "Leather gloves" to "Heavy duty leather gloves" to correlate with 130.7(C)(10)(d)(1). Added a line in each section of Table 130.5(G) regarding arc rated outerwear (e.g. jacket, parka, rainwear, hard hat liner) (AN). 130.5(G) Incident Energy Analysis Method Informational Note now references all of Annex H to correlate with the relocation of Table H.3(b) into 130.5. 130.5(C) also continues to require that where additional protective measures include the use of PPE, the user shall: (1) identify safety related work practices, (2) determine the arc flash boundary and (3) determine the PPE necessary inside the arc flash boundary. Minor editorial changes are made in Informational Notes No. 1 and 2, Table 130.5(C) to revise "opening time" to "fault clearing time" for clarity. Informational Note No. 5 is modified for clarity. This revision relocates 130.5(C)(1)

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	regarding ~~arc flash hazards~~ incident energy and the arc flash boundary for three-phase systems. † 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 includes estimates of the likelihood of occurrence of injury or damage to health. The estimate of the likelihood of occurrence contained in this table does not cover every possible condition or situation. Where this table identifies "No" for likelihood of occurrence, it means that an arc flash incident is not likely to occur. Where this table identifies "Yes" for likelihood of occurrence, it means that additional protective measures are required to be selected and implemented according to the hierarchy of risk control identified in 110.1(G). **(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 5 J/cm 2 (1.2 cal/cm 2)~~ 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)(b)~~ Table 130.7(C)(15)(a) or ~~Table 130.7(C)(15)(B),~~ Table 130.7(C)(15)(b) when the requirements of these tables apply. **(C)** 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)(16)~~ 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	Incident Energy Analysis Method to become a new first level subdivision 130.5(G). Therefore, 130.5(F) is revised to list items containing permission for either an incident energy analysis or the arc flash PPE method. Minor editorial revisions are made for clarity and usability. The methods permitted for selection of arc flash PPE are revised to include; (1) a new 130.5(G) for the incident energy analysis method and (2) a reference to 130.7(C)(15) for the arc flash PPE category method. Relocated text is added to a new 130.5(G) for the incident energy analysis method to require that the characteristics of the overcurrent protective device, the fault clearing time and the condition of maintenance be considered. The requirement to update the analysis is also relocated here. A new table 130.5(G) is added to relocate the PPE matrix from Annex H, H.3.b, into positive text for the selection of PPE when the incident energy analysis method is used. Additional text is provided in existing Note (b) to clarify the requirement for a balaclava or arc flash hood and to correlate with other requirements in the standard. Note a, Table 130.5(G) was revised to indicate that a tested combination is required for a layered system. Equipment Labeling is renumbered as 130.5(H). The requirement for "field" marking is deleted to allow factory or other installed labels where the data or information is circuit specific. The existing exception in 130.5(H) is editorially retitled as No. 1. This exception is revised for clarity and to replace the existing text that limited the exception to the 2012 edition of the standard. A new exception No.2, 130.5(H), is added to recognize that complex

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	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. 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 12 cal/cm 2** Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy [a] • Long-sleeve shirt and pants or 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) (AN) 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 **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] • Long-sleeve shirt and pants or coverall or arc flash suit (SR) • Arc-rated arc flash suit hood • Arc-rated outerwear (e.g., jacket, parka, rainwear,	distribution systems can result in multiple energy values rendering the placement of single or multiple labels infeasible. This new exception permits the label information 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. A requirement is added in 130.5(H) to review the data to support the information for the label at intervals not to exceed 5 years to correlate with a similar requirement in 130.5(G) Incident Energy Analysis Method. DC tasks were adjusted in Table 130.5(C) to reflect different risks associated with tasks performed in an open rack and within an enclosure. Safety Impact: No negative impact.

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	hard hat liner) (AN) Arc-rated gloves or rubber insulating gloves with leather protectors (SR) [c] Hard hat Safety glasses or safety goggles (SR) Hearing protection Leather footwear SR: Selection of one in group is required. [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. ~~**(2)** Arc Flash PPE Categories Method.~~ ~~The requirements of 130.7(C)(15) and 130.7(C)(16) shall apply when the arc flash PPE category method is used for the selection of arc flash PPE.~~ **(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 field-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)(b)~~ 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: ~~Labels~~ Unless changes in electrical distribution system(s) render the label inaccurate, labels applied prior to ~~September 30, 2011 are acceptable if they~~*	

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	~~*contain the available incident energy or required level of PPE.*~~ *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 (E)(1) through (E)(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 ~~arc flash hazard risk assessment~~ 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 ~~field~~-marked label.	
130.7(A)	**General** Employees ~~working in areas where electrical hazards are present~~ 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. ~~Informational Note No. 2: It is the collective experience of the Technical Committee on Electrical Safety in the Workplace that normal operation of enclosed electrical equipment, operating at 600 volts or less, that has been properly installed and maintained by qualified persons is not likely to expose the employee to an electrical hazard.~~ ~~Informational Note No. 3: When incident energy exceeds 40 cal/cm 2 (167.5 J/cm 2) at the working distance, greater emphasis may be necessary with respect to de-energizing~~	This revision provides correlation with the text used elsewhere in this standard. Existing Informational Note No.2 is no longer necessary due to normal operation of equipment being addressed in 130.2.A(4) and in Table 130.5.C. Additionally this note addressed only 600V or less and the present requirements for normal operation are not limited by voltage. Informational Note 3 (e.g. exceeds 40 calories) was deleted since greater emphasis should always be placed on de-energizing regardless of the incident energy level. Safety Impact: No negative impact.

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	~~when exposed to electrical hazards.~~	
130.7(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)~~130.7(G)130.7(G)130.7(F)~~.	This revision provides clarity on minimum requirements related to how to attain safe and reliable condition of protective equipment. The requirement to keep protective equipment clean is intended to provide practical protection for employees that may be required to share protective equipment. Safety Impact: No negative impact.
130.7(C)(7)	**(7) Hand and Arm Protection** **(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. ~~*Exception: Where it is necessary to use rubber insulating gloves without leather protectors, the requirements of ASTM F496, Standard Specification for In-Service Care of Insulating Gloves and Sleeves, shall be met.*~~ 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. Informational Note: See OSHA 29 CFR 1910.137; ~~*Personal Protective Equipment* and~~ 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. Table 130.7(C)(7)(c) Rubber Insulating Equipment, Maximum Test Intervals † * ~~If the insulating equipment has been electrically tested but not issued for service, it~~ New insulating equipment is not	Adding 'exposed' provides consistent use of the term with its definition and meaning. Added criteria for using rubber insulating gloves without the leather protectors Safety Impact: No negative impact.

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	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.	
130.7(C)(9)	(c) *Underlayers.* Meltable fibers such as acetate, nylon, polyester, polypropylene, and spandex shall not be permitted in fabric underlayers ~~(underwear) next to the skin~~.	The reference to "underwear next to the skin" has been removed as this requirement applies to all underlayers Safety Impact: No negative impact.
130.7(C)(10)	(b) *Head Protection.* (1) An arc-rated hood or an arc-rated balaclava ~~shall be used~~ with an arc-rated face shield shall be used when the back of the head is within the arc flash boundary. ~~An arc-rated hood shall be permitted to be used instead of an arc-rated face shield and balaclava.~~ (e) *Foot Protection.* Heavy-duty 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/m^3)	The two sentences in 130.7(C)(10)(b)(1) are combined into one sentence for clarity. Dielectric footwear was added to allow the use of that type of footwear as an option. Safety Impact: No negative impact.
130.7(C)(14)	**Table 130.7(C)(14)** Gloves — Arc Rated Standard Test Method for Determining Arc Ratings of Hand Protective Products Developed and Used for Electrical Arc Flash Protection ASTM F2675/F2675M Head Protection — Hard Hats ~~Requirements for Protective Headwear for Industrial Workers~~ Industrial Head Protection ANSI/ISEA Z89.1 (14) Standards for Personal Protective Equipment, (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: 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*	This revision updates two entries in the table to reflect the current standard. A new table entry for arc rated gloves is added. The title of the table is updated to correlate with section 130.7(C)(14). The level of conformity assessment for any particular piece of PPE is determined by the manufacturer or can be mandated by the purchaser. ANSI/ISEA 125 is referenced as the standard for the conformity assessment methodology and allows for three levels of conformity assessment ranging from supplier self-declaration to independent third party certification. ANSI/ISEA 125 also requires that a Supplier Declaration of Conformity be supplied to users and purchasers upon request. This gives the users a clear indication of the conformance of the products, and documents the manufacturers or sellers chosen level of conformity assessment. Due to the level of conformity assessment being left to the discretion of the manufacturer, this change requires that the conforming PPE be marked with the level of

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	Equipment. See Informative Annex H.4 (c) *Marking.* All suppliers or manufacturers of PPE shall provide the following information on the personal protective equipment, on the smallest unit container, or contained within the manufacturer's instructions. (1) Name of manufacturer (2) The 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	conformity per ANSI/ISEA 125. This will clarify to the purchasers as to what level of conformity assessment the product has been subjected to. Safety Impact: No negative impact.
130.7(C)(15)	~~**Selection of Personal Protective Equipment (PPE) When Required for Various Tasks.**~~ **Arc Flash PPE Category Method** (a) *Alternating Current (ac) Equipment.* When ~~selected~~ 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) (16)~~ Table 130.7(C)(15)(a) shall be used ~~to identify when arc flash PPE is required. When arc flash PPE is required, Table 130.7(C)(15)(A)(b) shall be used to~~ determine the arc flash PPE category. The estimated maximum available short-circuit 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)(b)~~ Table 130.7(C)(15)(a) . An incident energy analysis shall be required in accordance with 130.5 for the following: (1) Power systems with greater than the estimated maximum available ~~fault~~ short-circuit current (2) Power systems with longer than the maximum short circuit clearing times (3) ~~Tasks with less~~ Less than the minimum working distance ~~for the specific task to be performed from the employee's face and chest areas to an arc source~~ (b) *Direct Current (dc) Equipment.* ~~When selected in lieu of the incident energy analysis of 130.5(C)(1), Table 130.7(C)(15)(A)(a)~~ 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 dc systems in lieu of the incident energy analysis of 130.5(G), Table 130.7(C)(15)(b) shall be used ~~to identify when~~ determine the arc flash PPE is required category. ~~When arc flash PPE is required, Table 130.7(C)(15)(B) shall be used to determine the arc flash PPE category.~~ The estimated maximum available short-circuit current, maximum arc duration , and working distances for dc equipment are listed in ~~130.7(C)(15)(B)~~ 130.7(C)(15)(b). An incident energy analysis shall be required in	The title of 130.7(C)(15) is revised to better reflect the content. A new sentence is added as parent text for second level subdivision 130.7(C)(15) to clarify that the requirements contained within shall apply when the arc flash PPE category method is used for the selection of arc flash PPE. Table 130.7(C)(15)(A)(a) is deleted and relocated into Article 130.5 as Table 130.5. The following revisions are made to correlate with the relocation of Table 130.7(C)(15)(A)(a): • All references to Table 130.7(C)(15)(A)(a) have been retitled Table 130.5(c) • Table 130.7(C)(15)(A)(b) is renumbered as Table 130.7(C)(15)(a) The reference to working distance in 130.7(C)(15)(a) and 130.7(C)(15)(b) is clarified by adding additional text similar to that currently found in 130.5(C)(1). This clarifies that "working distance" is measured from the employee's face and chest areas to the arc source. The word "hazard" is deleted from the title of Table 130.7(C)(15)(a) for consistency with the rest of the document. Table 130.7(C)(15)(a) is modified to clarify the working distance parameter as the "minimum" working

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	accordance with 130.5 for the following: (0) ~~Tasks not included in Table 130.5~~ (1) Power systems with greater than the estimated maximum available short-circuit fault current (2) Power systems with longer than the maximum fault clearing times arc duration (3) Less than the minimum working distance ~~for the specific task to be performed from the employee's face and chest areas to an arc source~~ Informational Note No.1: ~~The arc flash PPE category, work tasks, and protective equipment provided in Table 130.7(C)(15)(A)(a), Table 130.7(C)(15)(A)(b), and Table 130.7(C)(15)(B) were identified and selected, based on the collective experience of the NFPA 70E Technical Committee.~~ 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: ~~The collective experience of the NFPA 70E Technical Committee is that, in~~ 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). ~~Informational Note No.3: The premise used by the NFPA 70E Technical Committee in developing the criteria discussed in Informational Note No. 1 and Informational Note No. 2 is considered to be reasonable, based on the consensus judgment of the committee.~~ ~~Informational Note No.3: "Short-circuit current," as used in this table, is determined from the dc power system maximum available short-circuit, including the effects of cables and any other impedances in the circuit. Power system modeling is the best method to determine the available short-circuit current at the point of the arc. Battery cell short-circuit current can be obtained from the battery manufacturer. See Informative Annex D.5 for the basis for table values and alternative methods to determine dc incident energy. Methods should be used with good engineering judgment.~~ ~~Informational Note No.4: The methods for estimating the dc arc-flash incident energy that were used to determine the categories for this table are based on open-air incident energy calculations. Open-air calculations were used because many battery systems and other dc process systems are in open areas or rooms. If the specific task is within in an enclosure, it would be prudent to consider additional PPE protection beyond the value shown in this table. Engineering judgment is required necessary when reviewing the specific conditions of the equipment and task to be performed, including the dimensions of the enclosure and the working distance involved.~~	distance. A new Informational Note is added to Table 130.7(C)(15)(a) to provide the user with typical clearing times of common overcurrent protective devices. This provides significant clarity and informs the user of the Standard that devices such as insulated case or low voltage power circuit breakers may have a short time delay and will have a significantly longer clearing time than, for example, molded case circuit breakers. Section 130.7(C)(16) is combined with 130.7(C)(15) and is renumbered as a first level subdivision 130.7(C)(15)(C) and all references to 130.7(C)(16) are correspondingly modified. The title of the first column of Table 130.7(C)(15)(c) is revised to "Arc Flash" PPE Category for clarity. The requirement for ear canal inserts is deleted as other types of hearing protection may be necessary or preferred. Table 130.7(C)(15)(c) Note (c) informs the user of the standard that other types of hearing protection are permitted to be used in lieu of or in addition to ear canal inserts provided it is worn under arc-rated arc flash suit hood. Safety Impact: No negative impact.

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	Table 130.7(C)(15)(a) Arc-Flash ~~Hazard~~ PPE Categories for Alternating Current (ac) Systems Notes : For equipment rated 600 ~~volts~~ volts and below, and protected by upstream current-limiting fuses or current-limiting circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below arc flash PPE category 1. Informational Note to Table: The following are typical fault clearing times of overcurrent protective devices: (1) 0.5 cycle fault clearing time is typical for current limiting fuses when the fault current is within the current limiting range. (2) 1.5 cycle fault clearing time is typical for molded case circuit breakers rated less than 1000 volts with an instantaneous integral trip. (3) 3.0 cycle fault clearing time is typical for insulated case circuit breakers rated less than 1000 volts with an instantaneous integral trip or relay operated trip. (4) 5.0 cycle fault clearing time is typical for relay operated circuit breakers rated 1 kV to 35 kV when the relay operates in the instantaneous integral trip (i.e., "no intentional time delay"). (5) 20 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay for motor inrush. (6) 30 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay without instantaneous trip. Informational Note 1: (See *Table 1* of IEEE 1584TM, *Guide for Performing Arc Flash Hazard Calculations for further information regarding Notes b through d.)* Informational Note No. 2: An example of a standard that provides information for arc-resistant switchgear referred to in Table 130.7(C)(15)(a) is IEEE C37.20.7, *Guide for Testing Metal-Enclosed Switchgear Rated Up to 38 kV for Internal Arcing Faults* . Table 130.7(C)(15)(b) Arc-Flash ~~Hazard~~ PPE Categories for Direct Current (dc) Systems • ~~Short-circuit~~ available fault • Available fault current less than 4kA PPE ~~1~~ 2 • Available fault current less than 1.5kA PPE ~~1~~ 2 (2) A two-second arc duration is assumed if there is no overcurrent protective device (OCPD) or if the fault clearing time is not known. If the fault clearing time is known and is less than 2 seconds, an incident energy analysis could provide a more representative result.	

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	Informational Note No. 1: When determining available fault current, the effects of cables and any other impedances in the circuit should be included. Power system modeling is the best method to determine the available short-circuit current at the point of the arc. Battery cell short-circuit current can be obtained from the battery manufacturer. See Informative Annex D.5 for the basis for table values and alternative methods to determine dc incident energy. Methods should be used with good engineering judgment. Informational Note No. 2: The methods for estimating the dc arc-flash incident energy that were used to determine the categories for this table are based on open-air incident energy calculations. Open-air calculations were used because many battery systems and other dc process systems are in open areas or rooms. If the specific task is within an enclosure, it would be prudent to consider additional PPE protection beyond the value shown in this table. Research with ac arc flash has shown a multiplier of as much as 3× for arc-in-a-box [508 mm (20 in.) cube] versus open air. Engineering judgment is necessary when reviewing the specific conditions of the equipment and task to be performed, including the dimensions of the enclosure and the working distance involved. Table 130.7(C)(15)(c) Personal Protective Equipment (PPE) Hearing protection (ear canal inserts)[c] c Other types of hearing protection are permitted to be used in lieu of or in addition to ear canal inserts provided they are worn under an arc-rated arc flash suit hood.	
130.7(D)(1)	3(c) *Ropes and Handlines.* Ropes and handlines used within the limited approach boundary ~~of exposed energized electrical conductors or circuit parts operating at 50 volts or more, or used where an electrical hazard exists,~~ shall be nonconductive. (e) *Portable Ladders.* Portable ladders used within the limited approach boundary shall have nonconductive side rails ~~if they are used where an employee or ladder could contact exposed energized electrical conductors or circuit parts operating at 50 volts or more or where an electrical hazard exists.~~ when used within the limited approach boundary or where the employee or ladder could contact exposed energized electrical conductors or circuit parts. Nonconductive ladders shall meet the requirements of applicable state, federal, or local codes and standards. Informational Note: The standards listed in Informational Note Table 130.7(G) are examples of standard that contain information on portable ladders. ~~Nonconductive ladders shall meet the requirements of ANSI standards for ladders listed in Table 130.7(F).~~	All references to voltages are removed to correlate with changes made elsewhere in the document. "Restricted Approach" was changed to "limited approach" to correlate with 130.7(E)(2) Barricades. The additional language in the first sentence recognizes inadvertent movement of the employee or a portable ladder. The mandatory references were relocated into an informational note. Safety Impact: No negative impact.

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	(g) *Rubber Insulating Equipment.* Rubber insulating equipment used for protection from unintentional contact with energized conductors or circuit parts shall meet the requirements of ~~the ASTM standards listed in Table 130.7(G)~~ applicable state, federal or local codes and standards. Informational Note: The standards listed in Informational Note Table 130.7(G) are examples of standards that contain information on rubber insulating equipment. (h) *Voltage-Rated Plastic Guard Equipment.* Plastic guard equipment for protection of employees from unintentional contact with energized conductors or circuit parts, or for protection of employees or energized equipment or material from contact with ground, shall meet the requirements of ~~the ASTM standards listed in Table 130.7(G)~~ applicable state, federal, or local codes and standards. Informational Note: The standards listed in Informational Note Table 130.7(G) are examples of standards that contain information on voltage-rated plastic guard equipment.	
130.7(E)(1)	**Safety Signs and Tags** Safety signs, safety symbols, or tags shall be used where necessary to warn employees about electrical hazards that might endanger them. Such signs and tags shall meet the requirements of ~~ANSI Z535, *Series of Standards for Safety Signs and Tags,* given in Table 130.7(G).~~ applicable state, federal, or local codes and standards. Informational Note No. 1: Safety signs, tags, and barricades used to identify energized "look-alike" equipment can be employed as an additional preventive measure. Informational Note No. 2: The standards listed in Table Informational Note 130.7(G) are examples of standards that contain information on safety signs and tags.	The mandatory reference in 130.7(E)(1) is removed and relocated to an informational note. Safety Impact: No negative impact.
130.7(E)(4)	**Cutting, Removing, or Rerouting of Conductors** Where conductors are de-energized in order to cut, remove, or reroute them and conductor terminations are not within sight, such as where they are in a junction or pull box, additional steps to verify absence of voltage or identify the conductors shall be taken prior to cutting, removing, or rerouting the conductors. Informational Note: Additional steps to be taken would include, but not be limited to, spiking the conductors and pulling the conductors to visually verify movement. Non-shielded conductors could be additionally verified with a noncontact test instrument, and shielded conductors could be verified with devices to identify the conductors.	A new second level subdivision and informational note were added to address the need for an additional alerting technique. Safety Impact: No negative impact.
205.3	**General Maintenance Requirements**	The new informational note provides guidance and enhancement to

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	Informational Note No. 2: Noncontact diagnostic methods in addition to scheduled maintenance activities of electrical equipment can assist in the identification of electrical anomalies.	safety-related maintenance practices. Safety Impact: No negative impact.
205.7	**Guarding of Energized Conductors and Circuit Parts** Enclosures shall be maintained to guard against ~~accidental~~ unintentional contact with exposed energized conductors and circuit parts and other electrical hazards. Covers and doors shall be in place with all associated fasteners and latches secured.	This revision provides clarity to the use of the term "exposed" with the term "energized" and is consistent with other sections of the document. Safety Impact: No negative impact.
240.1	**Ventilation** ~~Ventilation systems~~, When forced or natural, ventilation systems are required by the battery system design and are present, they shall be examined and maintained to prevent buildup of explosive mixtures. This maintenance shall include a functional test of any associated detection and alarm systems. Informational Note: "Natural ventilation" implies there are no mechanical mechanisms. Maintenance includes activities such as inspection and removal of any obstructions to natural air flow.	Changes were made to clarify text. The phrase "and are present" is meant to ensure that ventilation systems are provided when needed because of the battery chemistry. The informational note was added to clarify that the type of maintenance on "natural ventilation" systems would typically be limited to inspection and removal of any obstructions. Safety Impact: No negative impact.
250.2(A)	**Visual** Safety and protective equipment and protective tools shall be visually inspected for damage and defects before initial use and at intervals thereafter, as service conditions require, but in no case shall the interval exceed 1 year, unless specified otherwise by the ~~respective ASTM~~ applicable state, federal, or local codes and standards.	The mandatory reference in 250.2(A) is removed. Safety Impact: No negative impact.
310	**Note: The changes in this section are not evaluated since SRS does not have any electrolytic cells.**	No electrolytic cells at SRS Safety Impact: No negative impact
320.1	**Scope** This article covers electrical safety requirements for the practical safeguarding of employees while working with exposed stationary storage batteries that exceed 50 volts, nominal. Informational Note: For additional information on best practices for safely working on stationary batteries, see the following documents: (1) NFPA 1, *Fire Code*, Chapter 52, Stationary Storage Battery Systems, 2015 (2) *NFPA 70*, *National Electrical Code*, Article 480, Storage Batteries, 2014 (3) IEEE 450, *IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications*, 2010 (4) IEEE 937, *Recommended Practice for Installation and Maintenance of Lead-Acid Batteries for Photovoltaic Systems*, 2007	The references in the informational note have been updated to the current editions. Reference to IEEE 1635 has been added to address batteries that vent explosive gas. Safety Impact: No negative impact.

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	(5) IEEE 1106, *IEEE Recommended Practice for Installation, Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications*, 2005 (R 2011) (6) IEEE 1184, *IEEE Guide for Batteries for Uninterruptible Power Supply Systems*, 2006 (R 2011) (7) IEEE 1188, *IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications*, 2005 (R 2010) 1188a-2014 (8) IEEE 1657, *Recommended Practice for Personnel Qualifications for Installation and Maintenance of Stationary Batteries,* 2009 (9) OSHA 29 CFR 1910.305(j)(7), "Storage batteries" (10) OSHA 29 CFR 1926.441, "Batteries and battery charging" (11) DHHS (NIOSH) Publication No. 94-110, *Applications Manual for the Revised NIOSH Lifting Equation,* 1994 (12) IEEE/ASHRAE 1635, *Guide for the Ventilation and Thermal Management of Batteries for Stationary Applications,* 2012	
Definitions 320.2	**Prospective Short-Circuit Current** The highest level of fault current that could theoretically occur at a point on a circuit. This is the fault current that can flow in the event of a zero impedance short circuit and if no protection devices operate. Informational Note: Some batteries have built-in management devices to limit maximum short circuit current. The determination of the prospective short-circuit current for these batteries assumes that the internal battery management system protection devices are operable.	An informational note has been added to identify that some batteries rely on internal management systems to limit short-circuit current. Safety Impact: No negative impact.
320.3(A)(1)	**Energy Thresholds** Energy exposure levels shall not exceed those identified in the following list unless appropriate controls are implemented: (1) AC: 50 volts and 5 milliamperes (2) DC: 100 volts Informational Note: This information is extracted from the Department of Energy (DOE) Electrical Safety Handbook, DOE-HDBK-1092.	Adding energy thresholds to Article 320 supplements the actions taken in Chapter 1 to revise the threshold for dc voltages to 50 volts and aligns with Article 350. Safety Impact: No negative impact.
330	**Safety-Related Work Practices: ~~for Use of~~ Lasers** **330.1** Scope. ~~The requirements of this article shall apply to the use of lasers in the laboratory and the workshop.~~ This article applies to safety related work practices for maintaining lasers and their associated equipment. Informational Note No. 1: For recommendations on laser safety requirements for laser use, see ANSI Z136.1. , *Standard for Safe Use of Lasers*	The entire article is revised to better focus on electrical hazards within the scope of NFPA 70E. The article now focuses on the safety related maintenance issues rather that issues associated with laser use. Safety Impact: No negative impact.

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	Informational Note No. 2: For laser product requirements for laser manufacturers, see 21 CFR Part 1040, "Performance Standards for Light-Emitting Products," Sections 1040.10, "Laser products"; and 1040.11, "Specific purpose laser products." **330.2** Definitions. For the purposes of this article, the following definitions that follow shall apply. ~~**Fail Safe.**~~ ~~The design consideration in which failure of a component does not create additional hazards or increased risk. In the failure mode, the system is rendered inoperative or nonhazardous.~~ ~~**Fail-Safe Safety Interlock.**~~ ~~An interlock that in the failure mode does not defeat the purpose of the interlock; for example, an interlock that is positively driven into the off position as soon as a hinged cover begins to open, or before a detachable cover is removed, and that is positively held in the off position until the hinged cover is closed or the detachable cover is locked in the closed position~~. **Field Evaluated.** A thorough evaluation of non-listed or modified equipment in the field that is performed by persons or parties acceptable to the authority having jurisdiction. Informational Note: The evaluation approval ensures that the equipment meets appropriate codes and standards or is similarly found suitable for a specified purpose. **Laser.** ~~Any device that can be made to produce or amplify electromagnetic radiation in the wavelength range from 100 nm to 1 mm primarily by the process of controlled stimulated emission.~~ A device that produces radiant energy at wavelengths between 180 nm (nanometer) and 1 mm (millimeter) predominantly by controlled stimulated emission. Laser radiation can be highly coherent temporally, spatially, or both. **Laser Energy Source.** Any device intended for use in conjunction with a laser to supply energy for the excitation of electrons, ions, or molecules. ~~General energy sources, such as electrical supply services or batteries, shall not be is not considered to constitute a laser energy source~~. ~~**Laser Product.**~~ ~~Any product or assembly of components that constitutes,~~	

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	~~incorporates, or is intended to incorporate a laser or laser system.~~ **Laser Radiation.** All electromagnetic radiation emitted by a laser ~~product between 100 nm and 1 mm~~ or laser system between 180 nm (nanometers) and 1 mm (millimeters) that is produced as a result of a controlled stimulated emission. **Laser System.** A laser in combination with an appropriate laser energy source with or without additional incorporated components. **Protective Barrier.** Prevents user access to a hazardous voltage, current or stored energy area. **330.3** Hazardous Energy. **(A)** Voltage and Current. For the purpose of this section, hazardous voltage and current for ac systems is considered greater than or equal to 50 volts ac and 5 mA. For dc systems, hazardous voltage or current is considered greater than or equal to 100 volts dc and 40 mA. **(B)** Stored Energy. For the purpose of this article, hazardous stored energy is considered greater than or equal to 0.25 joules at 400 volts or greater, or 1 joule at greater than 100 volts up to 400 volts. **330.4** Electrical Safety Training. **(A)** Personnel to Be Trained. Employers shall provide training for all ~~operator and maintenance personnel~~. personnel who work on or near lasers or laser systems with user-accessible hazardous voltage, current, or stored energy (e.g., flashlamp-pumped lasers). **(B)** ~~Scope of Training~~. Electrical Safety Training for Work on or with Lasers. ~~The training~~ Training in electrical safe work practices shall include, but is not limited to, the following: (1) Chapter 1 electrical safe work practices (2) Electrical hazards associated with laser equipment (3) Stored energy hazards, including capacitor bank explosion potential (4) Ionizing radiation (5) X-ray hazards from high-voltage equipment (>5 kV) (6) Assessing the listing status of electrical equipment and the need for field evaluation of non-listed equipment ~~(0) Familiarization with laser principles of operation, laser types, and laser emissions~~ ~~(0) Laser safety, including the following:~~	

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	~~0. System operating procedures~~ ~~0. Risk assessment and risk control procedures~~ ~~0. Need for personnel protection~~ ~~0. Accident reporting procedures~~ ~~0. Biological effects of the laser upon the eye and the skin~~ ~~0. Electrical and other hazards associated with the laser equipment, including the following:~~ ~~High voltages (>1 kV) and stored energy in the capacitor banks~~ ~~Circuit components, such as electron tubes, with anode voltages greater than 5 kV emitting X-rays~~ ~~Capacitor bank explosions~~ ~~Production of ionizing radiation~~ ~~Poisoning from the solvent or dye switching liquids or laser media~~ ~~High sound intensity levels from pulsed lasers~~ ~~**(C)** Proof of Qualification.~~ ~~Proof of qualification of the laser equipment operator shall be readily available.~~ **330.5** Safeguarding of Persons from ~~in the Laser Operating Area.~~ Electrical Hazards Associated with Lasers and Laser Systems. **(A) Temporary** Guarding. Temporary guarding (e.g., covers, protective insulating barriers) shall be used to limit exposure to any electrical hazard, when the permanent laser enclosure covers are removed for maintenance and testing. **(B)** Work Requiring an Electrically Safe Work Condition. Work that might expose employees to electrical hazards shall be performed with the equipment in an electrically safe work condition in accordance with 120.1, 120.2, and 130.2. **(C)** Energized Electrical Testing. Energized electrical testing, troubleshooting, and voltage testing shall not require an energized work permit in accordance with 130.2(B)(3). **(D)** Warning Signs and Labels. Electrical safety warning signs and labels shall be posted as applicable at the entrances to laser work areas and on protective barriers for laser equipment on electrical equipment doors, covers, and protective barriers. The warning signs and labels shall adequately warn of the hazard using effective words, colors, and symbols. These signs and labels shall be permanently affixed to the equipment and shall be of sufficient durability to withstand the environment involved. **(E)** Listing. Laser system electrical equipment shall be listed or field evaluated prior to use.	

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	~~**(A)** Eye Protection.~~ ~~Employees shall be provided with eye protection as required by federal regulation.~~ ~~**(B)** Warning Signs.~~ ~~Warning signs shall be posted at the entrances to areas or protective enclosures containing laser products.~~ ~~**(C)** Master Control.~~ ~~High-power laser equipment shall include a key-operated master control.~~ ~~**(D)** High-Power Radiation Emission Warning.~~ ~~High-power laser equipment shall include a fail-safe laser radiation emission audible and visible warning when it is switched on or if the capacitor banks are charged.~~ ~~**(E)** Beam Shutters or Caps.~~ ~~Beam shutters or caps shall be used, or the laser switched off, when laser transmission is not required.~~ ~~The laser shall be switched off when unattended for 30 minutes or more.~~ ~~**(F)** Aiming.~~ ~~Laser beams shall not be aimed at employees.~~ ~~**(G)** Label.~~ ~~Laser equipment shall bear a label indicating its maximum output.~~ ~~**(H)** Personal Protective Equipment (PPE).~~ ~~PPE shall be provided for users and operators of high-power laser equipment.~~ **330.6** Responsibility for Electrical Safety All persons with access to hazardous voltage, current, or stored energy shall be responsible for the following: (1) Obtaining authorization for ~~laser use~~ work with or on hazardous electrical equipment in lasers and laser systems (2) ~~Obtaining authorization for being in a laser operating area~~ Use of Chapter 1 safety related work practices ~~(2) Observing safety rules~~ (3) Reporting laser equipment failures, accidents, inadequate barriers, and inadequate signage to the employer	
340.1	**Scope** This article shall apply to safety-related work practices around power electronic equipment, including the following: (1) Electric arc welding equipment (2) High-power radio, radar, and television transmitting towers and antennas (3) Industrial dielectric and radio frequency (RF) induction heaters	The mandatory references in Section 340.4 are deleted and relocated as an informational note in Section 340.1. Safety Impact: No negative impact.

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	(4) Shortwave or RF diathermy devices (5) Process equipment that includes rectifiers and inverters such as the following: a. Motor drives b. Uninterruptible power supply systems c. Lighting controllers Informational Note: The following standards provide specific guidance for safety-related work practices around power electronic equipment: International Electrotechnical Commission IEC 60479-1, *Effects of Current on Human Beings and Livestock, Part 1: General Aspects* , and the International Commission on Radiological Protection (ICRP) Publication 33, *Protection Against Ionizing Radiation from External Sources Used in Medicine*.	
340.4	~~**Reference Standards**~~ ~~The following are reference standards for use in the preparation of specific guidance to employees as follows:~~ ~~(0) International Electrotechnical Commission IEC 60479, *Effects of Current Passing Through the Body* :~~ ~~0. 60479-1 Part 1: General aspects~~ ~~0. 60479-1-1 Chapter 1: Electrical impedance of the human body~~ ~~0. 60479-1-2 Chapter 2: Effects of ac in the range of 15 Hz to 100 Hz~~ ~~0. 60479-2 Part 2: Special aspects~~ ~~0. 60479-2-4 Chapter 4: Effects of ac with frequencies above 100 Hz~~ ~~0. 60479-2-5 Chapter 5: Effects of special waveforms of current~~ ~~0. 60479-2-6 Chapter 6: Effects of unidirectional single impulse currents of short duration~~ ~~(0) International Commission on Radiological Protection (ICRP) Publication 33, *Protection Against Ionizing Radiation from External Sources Used in Medicine*~~	The mandatory references in Section 340.4 are deleted and relocated as an informational note in Section 340.1. Safety Impact: No negative impact.
340.5	~~**Effects of Electricity on the Human Body**~~ ~~The employer and employees shall be aware of the following hazards associated with power electronic equipment.~~ ~~(0) Effects of Power Frequency Current:~~ ~~0. At 0.5 mA, shock is perceptible.~~ ~~0. At 10 mA, a person may not be able to voluntarily let go of an energized electrical conductor or circuit part.~~ ~~0. At about 40 mA, the shock, if lasting for 1 second or longer, can be fatal due to ventricular fibrillation.~~ ~~0. Further increasing current leads to burns and cardiac arrest.~~ ~~(0) Effects of Direct Current:~~ ~~0. A dc current of 2 mA is perceptible.~~ ~~0. A dc current of 40 mA is considered the threshold of the let-go current.~~ ~~(0) Effects of Voltage. A voltage of 30 V rms, or 60 V dc, is~~	The content of 340.5 is primarily informational in nature and more accurate information may be found in other scientific works. Safety Impact: No negative impact.

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	~~considered safe, except when the skin is broken. The internal body resistance can be as low as 500 ohms, so fatalities can occur.~~ ~~(0) Effects of Short Contact:~~ ~~0. For contact less than 0.1 second and with currents just greater than 0.5 mA, ventricular fibrillation can occur only if the shock is during a vulnerable part of the cardiac cycle.~~ ~~0. For contact of less than 0.1 second and with currents of several amperes, ventricular fibrillation can occur if the shock is during a vulnerable part of the cardiac cycle.~~ ~~0. For contact of greater than 0.8 second and with currents just greater than 0.5 A, cardiac arrest (reversible) can occur.~~ ~~0. For contact greater than 0.8 second and with currents of several amperes, burns and death are probable.~~ ~~(0) Effects of Alternating Current at Frequencies Above 100 Hz. When the threshold of perception increases from 10 kHz to 100 kHz, the threshold of let-go current increases from 10 mA to 100 mA.~~ ~~(0) Effects of Waveshape. Contact with voltages from phase controls usually causes effects between those of ac and dc sources.~~ ~~(0) Effects of Capacitive Discharge:~~ ~~0. A circuit of capacitance of 1 µF having a 10 kV capacitor charge can cause ventricular fibrillation.~~ ~~0. A circuit of capacitance of 20 µF having a 10 kV capacitor charge can be dangerous and probably will cause ventricular fibrillation.~~	
350.4	~~**Specific Measures and Controls for Personnel**~~ **Electrical Safety Authority (ESA)** Each laboratory or R&D system application shall be ~~assigned~~ permitted to assign an ESA to ensure the use of appropriate electrical safety-related work practices and controls. The ESA shall be permitted to be an electrical safety committee, engineer, or equivalent qualified individual. The ESA shall be permitted to delegate authority to an individual or organization within their control. **(A)** Responsibility. The ESA shall act in a manner similar to an authority having jurisdiction for R&D electrical systems and electrical safe work practices. **(B)** Qualifications. The ESA shall be competent in the following: (1) The requirements of this standard (2) Electrical system requirements applicable to the R&D laboratories **350.5** Specific Measures and Controls for Personnel Safety. Each laboratory or R&D system application shall designate a competent person as defined in this article to ensure the use	This revision to Article 350 improves clarity and specifies responsibilities and authorities for electrical safety within an R&D environment. Safety Impact: No negative impact.

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	of appropriate electrical safety-related work practices and controls. **(A)** Job Briefings. Job briefings shall be performed in accordance with 110.1(I). *Exception: Prior to starting work, a brief discussion shall be permitted if the task and hazards are documented and the employee has reviewed applicable documentation and is qualified for the task.* **(B)** Personnel Protection. Safety-related work practices shall be used to safeguard employees from injury while they are exposed to electrical hazards from exposed electrical conductors or circuit parts that are or can become energized. The specific safety-related work practices shall be consistent with the electrical hazard(s) and the associated risk. For calibration and adjustment of equipment as it pertains to sensors, motor controllers, control hardware, and other devices that need to be installed inside equipment or control cabinet, surrounded by electrical hazards, the ESA shall define the required PPE based on the risk and exposure. Use of electrical insulating blankets, covers, or barriers shall be permitted to prevent inadvertent contact to exposed terminals and conductors. Insulated/nonconductive adjustment and alignment tools shall be used where feasible. **350.6** ~~Listing~~ Approval Requirements. The equipment or systems used in the R&D area or in the laboratory shall be listed or field evaluated prior to use. Informational Note: Laboratory and R&D equipment or systems can pose unique electrical hazards that might require mitigation. Such hazards include ac and dc, low voltage and high amperage, high voltage and low current, large electromagnetic fields, induced voltages, pulsed power, multiple frequencies, and similar exposures. **350.7** Custom Built, Non-Listed Research Equipment, <1000 V AC or DC. **(A)** Equipment Marking and Documentation. **(1)** Marking. Marking of equipment shall be required for, but not limited to, equipment fabricated, designed, or developed for research testing and evaluation of electrical systems. Marking shall sufficiently list all voltages entering and leaving control cabinets, enclosures, and equipment. Caution, Warning, or Danger labels shall be affixed to the exterior describing specific hazards and safety concerns. Informational Note: Refer to ANSI Z535, *Series of Standards for Safety Signs and Tags* for more information on precautionary marking of electrical systems or equipment.	

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	(2) Documentation. Sufficient documentation shall be provided and readily available to personnel that install, operate, and maintain equipment that describes operation, shutdown, safety concerns, and nonstandard installation anomalies. Schematics, drawings, and bill of materials describing power feeds, voltages, currents, and parts used for construction, maintenance, and operation of the equipment shall be provided. **(3) Shutdown Procedures** Safety requirements and emergency shutdown procedures of equipment shall include lockout/tagout (LOTO) requirements. If equipment-specific LOTO is required, then documentation outlining this procedure and PPE requirements shall be made readily available. **(4) Specific Hazards** Specific hazards, other than electrical, associated with research equipment shall be documented and readily available. **(5) Approvals** Drawings, standard operational procedures, and equipment shall be approved by the ESA on site before initial start-up. Assembly of equipment shall comply with national standards where applicable unless research application requires exceptions. Equipment that does not meet the applicable standards shall be required to be approved by the ESA. Proper safety shutdown procedures and PPE requirements shall be considered in the absence of grounding and/or bonding. **(B)** Tools, Training, and Maintenance. Documentation shall be provided if special tools, unusual PPE, or other equipment is necessary for proper maintenance and operation of equipment. The ESA shall make the determination of appropriate training and qualifications required to perform specific tasks. **350.8** Custom Built, Unlisted Research Equipment, >1000 V AC or DC. Installations shall comply with all requirements of 350.7 In the event that research equipment requires PPE beyond what is commercially available, the ESA shall determine safe work practices and PPE to be used. **350.9** Energy Thresholds. Energy exposure levels shall not exceed those identified in the following list unless appropriate controls are implemented as approved by the ESA: (1) AC: 50-Volts and 5 milliamperes.	

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	(2) DC: 100-Volts and 40 milliamperes. (3) Capacitive systems: a. 100-Volts and 100 Joules of stored energy b. 400-Volts and 1.0 Joule of stored energy c. 0.25 Joules of stored energy Informational Note: This information is extracted from the Department of Energy (DOE) Electrical Safety Handbook, DOE-HDBK-1092. **350.10** Establishing an Electrically Safe Work Condition. Energized electrical conductors and circuit parts shall be put into an electrically safe work condition before an employee performs work. *Exception: At the discretion of the ESA, alternative methods of ensuring worker safety shall be permitted to be employed for the following conditions:* *(1) Minor tool changes and adjustments, and other normal production operations that are routine, repetitive, or sequential and integral to the use of the equipment for production* *(2) Minor changes to the unit under test and other minor servicing activities, to include the activities listed under 350.10 Exception condition (1), that take place during research and development* *(3) Work on cord-and-plug-connected equipment for which exposure to the hazards of unexpected energization or start up is controlled by the following:* *a. Unplugging the equipment from the energy source and* *b. The employee performing the work maintaining exclusive control of the plug.*	