

Best Practice # 193 (10/18/2016)

Title: Adoption of NFPA 70E 2015 in place of NFPA 70E 2012

Facility: DOE Complex

Points of Contact:

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Brief Description of Best Practice: NFPA 70E®– 2015 is recommended for approval across the DOE Complex as an upgrade to NFPA 70E®– 2012 in 10 CFR 851 Worker Safety and Health Plans (WSHP). Previously, EFCOG BP#111 determined that the use of the 2012 edition of NFPA 70E® is at least as protective as the 2009 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 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. NFPA 70E®– 2015 is recommended for approval across the DOE Complex as an upgrade to NFPA 70E®– 2012.

What problems/issues were associated with the Best Practice: Although Table 130.7(C)(15)(A)(a) may indicate that arc flash PPE is not required for normal operation of a circuit breaker, switch, contactor or starter when all equipment conditions are met, the EFCOG working group consensus concluded that some level of arc rated clothing and non-melting underlayment should be used when energy is ≥ 1.2 calories (Reference: 2016 EFCOG Workshop Task Group 5 presentation)

How the success of the Best Practice was measured:

A detailed gap analysis of NFPA 70E version 2015 against the 2012 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 2015 revision of the NFPA 70E standard.

EFCOG Working Group Members Participating on Best Practice Review Team:

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2015 NFPA 70E Impact Analysis

October 18, 2016

2015 NFPA 70E Article or Section	Added or Deleted Text Underlined text is added. Strikethrough indicates deleted text.	Change Description Impact to Worker Safety
Global Changes	<p>Work shoes <u>Footwear</u></p> <p>Standard Performance Specification for Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards <u>Standard Performance Specification for Flame Resistant and Arc Rated Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards</u></p> <p>Arc flash hazard analysis <u>Arc flash risk assessment</u></p> <p>Shock hazard analysis <u>Shock risk assessment</u></p> <p>Electrical hazard analysis <u>Electrical hazard risk assessment</u></p> <p>Hazard identification and risk assessment <u>Risk Assessment</u></p> <p>Hazard/risk category <u>Arc flash PPE category</u></p> <p>Hazard/risk categories <u>Arc flash PPE categories</u></p> <p>HRC</p>	<p>Change: Replaced <i>work shoes</i> with <i>footwear</i> throughout the standard.</p> <p>ASTM F1506 title changes made throughout the standard.</p> <p><i>Arc flash risk assessment</i> replaces <i>arc flash hazard analysis</i> throughout the standard.</p> <p><i>Shock risk assessment</i> replaces <i>shock hazard analysis</i> throughout the standard.</p> <p><i>Electrical hazard risk assessment</i> replaces <i>electrical hazard analysis</i> throughout the standard.</p> <p><i>Risk assessment</i> replaces <i>hazard identification and risk assessment</i> throughout the standard.</p> <p><i>Arc flash PPE category</i> replaces <i>hazard/risk category</i> throughout the standard.</p> <p><i>Arc flash PPE categories</i> replaces <i>hazard/risk categories</i> throughout the standard.</p> <p>All references to <i>HRC</i> are deleted throughout the standard.</p> <p>Formatting changes to all reference standards titles are made throughout the standard.</p> <p>Safety Impact: As safe or safer.</p>
Article 90 – Introduction		
Section 90.2(A)	<p>(A) Covered. This standard addresses electrical safety-related work practices, <u>safety-related maintenance requirements, and other administrative controls</u> for employee workplaces that are necessary for the practical safeguarding of employees...</p> <p><u>Informational Note: This standard addresses safety of workers whose</u></p>	<p>Change: Added <i>safety related maintenance requirements and other administrative controls</i> to the Scope.</p> <p>Added new informational note to explain that standard can be adapted to workers whose exposure to electrical hazards is unintentional or not recognized.</p> <p>Safety Impact: As safe or safer.</p>

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	<p><u>job responsibilities entail interaction with electrical equipment and systems with potential exposure to energized electrical equipment and circuit parts. Concepts in this standard are often adapted to other workers whose exposure to electrical hazards is unintentional or not recognized as part of their job responsibilities. The highest risk for injury from electrical hazards for other workers involve unintentional contact with overhead power lines and electric shock from machines, tools, and appliances.</u></p>	
Section 90.2(B)(2)	<p>(B) Not Covered. This standard does not cover safety related work practices for the following:</p> <p>(2) Installations underground in mines and self-propelled mobile surface mining machinery and its attendant electrical trailing cable</p>	<p>Change: Deleted old Item (2) <i>Installations underground in mines and self-propelled mobile surface mining machinery and its attendant electrical trailing cable</i> and renumbered remainder of section. Promotes use of NFPA 70E by the Mine Safety and Health Administration.</p> <p>Safety Impact: As safe or safer.</p> <p>This change might require DOE sites having underground facilities to comply with NFPA 70E 2015 requirements if they do not already do so.</p>
Section 90.3	<p>Chapter 1 applies generally for safety-related work practices; Chapter 3 supplements or modifies Chapter 1 with safety requirements for special equipment. Chapter 2...</p> <p><u>Chapter 1 applies generally for safety-related work-practice; Chapter 2 applies to safety-related maintenance requirements for electrical equipment and installations in workplaces; and Chapter 3-supplements or modifies Chapter 1 with safety requirements for special equipment.</u></p> <p><u>Informative annexes are not part of the requirements of this standard but are included for informational purposes only.</u></p>	<p>Change: Reorganized section</p> <p>Added <i>Informative</i> to annexes for clarity</p> <p>Safety Impact: As safe or safer.</p>

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Section 90.4	(9) Informative Annex F, Hazard Analysis, Risk Estimation, and Risk Evaluation Procedure <u>(9) Informative Annex F, Risk Assessment Procedure</u>	Change: Changed Item (9) from <i>Hazard Analysis, Risk Estimation, and Risk Evaluation</i> to <i>Risk Assessment Procedure</i> . Impact: As safe or safer.
Chapter 1 – Safety-Related Work Practices		
Article 100 – Definitions		
	Accessible, Readily (Readily Accessible). Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to climb over or remove obstacles or resort to portable ladders, and so forth. <u>Accessible, Readily (Readily Accessible). Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to actions such as to use tools, to climb over or remove obstacles, or resort to portable ladders, and so forth.</u>	Change: Revised to correlate with the definition in the 2014 <i>NEC</i> . Impact: As safe or safer.
	Arc Flash Hazard Analysis. A study investigating a worker's potential exposure to arc flash energy, conducted for the purpose of injury prevention and the determination of safe work practices, arc flash boundary, and the appropriate levels of personal protective equipment (PPE).	Change: Deleted term for consistency with new term "risk assessment". Risk assessment can be for arc flash or shock. Impact: As safe or safer.
	Arc Rating. Informational Note No. 1: ...Flame-Resistant (FR) clothing without an arc rating has not been tested for exposure to an electric arc. <u>Arc Rating. Informational Note No. 1: ...Flame resistant clothing without an arc rating has not been tested for exposure to an electric arc. All arc-rated clothing is also flame-resistant</u>	Change: Revised informational note to explain that all arc-rated clothing is also flame resistant. Safety Impact: As safe or safer.
	Bare-Hand Work. A technique of performing work on energized electrical conductors or circuit parts, after the employee has been raised to the potential of the conductor or circuit part.	Change: Deleted the term since bare hand work is not referenced in the document. Safety Impact: As safe or safer

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	<p>Barricade. A physical obstruction such as tapes, cones, or A-frame-type wood or metal structures intended to provide a warning about and to limit access to a hazardous area.</p>	<p>Change: Deleted the phrase <i>to a hazardous area</i> from the end of the definition.</p> <p>Safety Impact: As safe or safer</p>
	<p>Boundary, Prohibited Approach. An approach limit at a distance from an exposed energized electrical conductor or circuit part within which work is considered the same as making contact with the electrical conductor or circuit part.</p>	<p>Change: Eliminated the term since the requirement for using shock protective equipment typically begins at the restricted approach boundary. No additional protective equipment is required when crossing the prohibited approach boundary. Previous changes that used the limited approach boundary or arc flash boundary for "triggering" requirements have made the use of this term unnecessary.</p> <p>Safety Impact: As safe or safer</p>
	<p>Device. A unit of an electrical system, <u>other than a conductor</u>, that carries or controls electric energy as its principal function.</p>	<p>Change: Revised to correlate with the definition in the 2014 <i>NEC</i>.</p> <p>Safety Impact: As safe or safer</p>
	<p>Enclosure. The case or housing of apparatus, or the fence or walls surrounding an installation to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage.</p> <p>Enclosure. The case or housing of <u>apparatus</u> — or the fence or walls <u>surrounding an installation to prevent personnel from accidentally contacting energized electrical conductors or circuit parts or to protect the equipment from physical damage.</u></p>	<p>Change: Revised to correlate with the definition in the 2014 <i>NEC</i>.</p> <p>Safety Impact: As safe or safer</p>
	<p>Equipment. A general term, including material, fittings, devices, appliances, luminaires, apparatus, machinery, and the like, used as a part of, or in connection with, an electrical installation.</p> <p>Equipment. A general term, <u>including fittings, devices, appliances, luminaires, apparatus, machinery, and the like, used as a</u></p>	<p>Change: Revised to correlate with the definition in the 2014 <i>NEC</i>.</p> <p>Safety Impact: As safe or safer</p>

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	<u>part of, or in connection with, an electrical installation.</u>	
	<p>Grounding Conductor, Equipment (EGC). The conductive path installed to connect normally non-current-carrying metal parts of equipment together and to the system grounded conductor or to the grounding electrode conductor, or both.</p> <p><u>Grounding Conductor, Equipment (EGC).</u> The conductive path(s) that provides a ground fault current path and connects normally non-current-carrying metal parts of equipment together and to the system grounded conductor or to the grounding electrode conductor, or both.</p>	<p>Change: Revised to correlate with the definition in the 2014 <i>NEC</i>.</p> <p>Safety Impact: As safe or safer</p>
	<u>Hazard.</u> A source of possible injury or damage to health.	<p>Change: Added new term to provide clarity and consistent use throughout the standard.</p> <p>Safety Impact: As safe or safer</p>
	<u>Hazardous.</u> Involving exposure to at least one hazard.	<p>Change: Added new term to provide clarity and consistent use throughout the standard.</p> <p>Safety Impact: As safe or safer</p>
	<u>Incident Energy.</u> The amount of thermal energy impressed on a surface, a certain distance from the source generated during an electrical arc event. One of the units used to measure Incident energy is typically expressed in calories per square centimeter (cal/cm ²).	<p>Change: Revised to include the term <i>thermal</i>.</p> <p>Safety Impact: As safe or safer</p>
	<u>Incident Energy Analysis.</u> A component of an arc flash hazard analysis <u>risk assessment</u> used to predict the incident energy of an arc flash for a specified set of conditions.	<p>Change: Replaced the phrase <i>arc flash hazard analysis</i> with <i>arc flash risk assessment</i> to provide clarity.</p> <p>Safety Impact: As safe or safer</p>
	<u>Luminaire.</u> A complete lighting unit consisting of a light source, such as a lamp or lamps, together with the parts designed to distribute the light position and protect the lamps and ballast (where applicable) the light source, and to connect the lamps <u>it</u> to the power supply... It may also include parts to protect the light	<p>Change: Revised to correlate with the definition in the 2014 <i>NEC</i>.</p> <p>Safety Impact: As safe or safer</p>

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	source or the ballast or to distribute the light. A lampholder is not a luminaire.	
	Premises Wiring. <u>Informational Note: Power sources include, but are not limited to, interconnected or standalone batteries, solar photovoltaic systems, other distributed generation systems, or generators.</u>	Change: Added informational note to correlate with the definition in the 2014 <i>NEC</i> . Safety Impact: As safe or safer
	Qualified Person. One who has <u>demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to recognize identify and avoid the hazards involved.</u>	Change: Revised for consistency with the OSHA definition. Safety Impact: As safe or safer
	Raceway. An enclosed channel of metal or nonmetallic materials designed expressly for holding wires, cables, or busbars, with additional functions as permitted in this standard. Raceways include, but are not limited to, rigid metal conduit, rigid nonmetallic conduit, intermediate metal conduit, liquidtight flexible conduit, flexible metallic tubing, flexible metal conduit, electrical metallic tubing, electrical nonmetallic tubing, underfloor raceways, cellular concrete floor raceways, cellular metal floor raceways, surface raceways, wireways, and busways. Raceway. <u>An enclosed channel of metal or nonmetallic materials designed expressly for holding wires, cables, or busbars, with additional functions as permitted in this standard.</u>	Change: Revised to correlate with the definition in the 2014 <i>NEC</i> . Safety Impact: As safe or safer
	Risk. <u>A combination of the likelihood of occurrence of injury or damage to health and the severity of injury or damage to health that results from a hazard</u>	Change: Added new definition to provide clarity and consistent use throughout the standard. Safety Impact: As safe or safer
	Risk Assessment. <u>An overall process that identifies hazards, estimates the potential severity of injury or damage to health, estimates the likelihood of occurrence of injury or damage to</u>	Change: Added definition and informational note to provide clarity and consistent use throughout the standard. Safety Impact: As safe or safer

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	<u>health and determines if protective measures are required.</u> <u>Informational Note: As used in this standard, <i>arc flash risk assessment</i> and <i>shock risk assessment</i> are types of risk assessments.</u>	
	<u>Service Point.</u> <u>Informational Note: The service point can be described as the point of demarcation between where the serving utility ends and the premises wiring begins. The serving utility generally specifies the location of the service point based on the conditions of service.</u>	Change: Added informational note to correlate with the definition in the 2014 <i>NEC</i> . Safety Impact: As safe or safer
	<u>Switchboard.</u> A large single panel, frame, or assembly of panels on which are mounted on the face, back, or both, switches, overcurrent and other protective devices, buses, and usually instruments. Switchboards-These assemblies are generally accessible from the rear as well as from the front and are not intended to be installed in cabinets.	Change: Revised to correlate with the definition in the 2014 <i>NEC</i> . Safety Impact: As safe or safer
	<u>Voltage, Nominal.</u> A nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class (e.g., 120/240 volts, 480Y/277 volts, 600 volts). The actual voltage at which a circuit operates can vary from the nominal within a range that permits satisfactory operation of equipment. <u>Informational Note No. 1: The actual voltage at which a circuit operates can vary from the nominal within a range that permits satisfactory operation of equipment.</u> <u>Informational Note 2: See ANSI/IEEE C84.1-2006, <i>Electric Power Systems and Equipment — Voltage Ratings (60 Hz)</i>.</u>	Change: Moved non-mandatory information to a new informational note about voltage varying within a range. Safety Impact: As safe or safer
Article 105 – Application of Safety-Related Work Practices		
Sections 105.1 thru 105.4	No changes noted.	
Article 110 – General Requirements for Electrical Safety-Related Work Practices		
Section 110.1	110.1 Relationships with Contractors (Outside Service Personnel, and So Forth). 110.2 Training Requirements. 110.3 Electrical Safety Program.	Change: Relocated former 110.3 to 110.1 and relocated former 110.1 to 110.3 for improved usability. Safety Impact: As safe or safer (Editorial)

2015 NFPA 70E Article or Section	Added or Deleted Text <u>Underlined</u> text is added. Strikethrough indicates deleted text.	Change Description Impact to Worker Safety
	<u>110.1 Electrical Safety Program.</u> <u>110.2 Training Requirements.</u> <u>110.3 Relationships with Contractors (Outside Service Personnel, and So Forth).</u>	
Section 110.1(A)	<p>(A) General. The employer shall implement and document an overall electrical safety program that directs activity appropriate for the electrical hazards, voltage, energy level, and circuit conditions to the risk associated with electrical hazards. <u>The electrical safety program shall be implemented as part of the employer's overall occupational health and safety management system, when one exists.</u></p> <p>Informational Note No. 1: Safety-related work practices such as <u>verification of proper maintenance and installation, alerting techniques, auditing requirements, and training requirements provided in this standard are administrative controls and part of just one component of an overall electrical safety program.</u></p> <p>Informational Note No. 2: ANSI/AIHA Z10-2005, <i>American National Standard for Occupational Health and Safety Management Systems</i> provides a framework for establishing a comprehensive electrical safety program as a component of an employer's occupational safety and health program.</p> <p>Informational Note No. 3: IEEE 3007.1, <i>Recommended Practice for the Operation and Management of Industrial and Commercial Power Systems</i>, provides additional guidance for the implementation of the electrical safety program.</p> <p>Informational Note No. 4: IEEE 3007.3, <i>Recommended Practice for Electrical safety in Industrial and Commercial Power Systems</i>.</p>	<p>Change: Added sentence to reinforce that electrical safety is part of an overall safety management system.</p> <p>Added informational notes to former 110.3(A) to provide references and valuable information on electrical safety in the workplace and the implementation of an electrical safety program. Added examples of safety related work practices in informational note.</p> <p>Safety Impact: As safe or safer</p>

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	<u>provides additional guidance for electrical safety in the workplace.</u>	
Section 110.1(B)	<u>(B) Maintenance. The electrical safety program shall include elements that consider condition of maintenance of electrical equipment and systems.</u>	Change: Added subsection on the conditions of maintenance. Maintenance must be part of an overall electrical safety program to ensure proper condition and operation of electrical equipment and installations required for employee safety. Employers must demonstrate the maintenance program as part of the overall electrical safety program. Safety Impact: As safe or safer
Section 110.1(F)	110.3(E) Electrical Safety Program Procedures. An electrical safety program shall identify the procedures for working within the limited approach boundary and for working within the arc flash boundary before work is started. <u>110.1(F) Electrical Safety Program Procedures. An electrical safety program shall identify the procedures to be utilized before work is started by employees exposed to an electrical hazard.</u>	Change: Revised former 110.3(E) for usability and clarity by replacing <i>working within the limited approach boundary and for working within the arc flash boundary</i> with <i>electrical hazard</i> . This change broadens scope of electrical safety program. Safety Impact: As safe or safer.
Section 110.1(G)	Hazard Identification and Risk Assessment Procedure. An electrical safety program shall include a hazard identification and risk assessment procedure that addresses employee exposure to electrical hazards. The procedure 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 <u>Informational Note No. 1: The hierarchy of risk control methods specified in ANSI/AIHA Z10, <i>American National Standard for Occupational Health and Safety Management Systems</i>, is as follows: (1) Elimination (2) Substitution</u>	Change: Revised former 110.3(F) into a list format. Added new Informational Note No.1 and deleted No. 2 in the 2012 edition. Safety Impact: As safe or safer

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	<p><u>(3) Engineering controls</u> <u>(4) Awareness</u> <u>(5) Administrative controls</u> <u>(6) PPE</u></p> <p>Informational Note No. 4 2: The hazard identification and risk assessment procedure may include identifying when a second person could be required and the training and equipment that person should have.</p> <p>Informational Note No 2: For an example of a hazard identification and risk assessment procedure flow chart, see Annex F.</p> <p>Informational Note No 3: For an example of a hazard identification and risk assessment procedure, see Informative Annex F.</p>	
Section 110.1(H)	<p>(G) (H) Job Briefing. (1) General. Before starting each job, the employee in charge shall 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, personal protective equipment <u>PPE</u> 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.</p> <p><u>Informational Note: For an example of a job briefing form and planning checklist, see Figure I.1.</u></p> <p>(2) Repetitive or Similar Tasks. If the work or operations to be performed during the work day or shift are repetitive and similar, at least one job briefing shall be conducted before the start of the first job of the day or shift.</p> <p>(3) Routine Work. Prior to starting work, a brief discussion shall be satisfactory if the work involved is routine and if the employee is</p>	<p>Change: Revised former 110.3(G) to introduce job briefing requirements for more complex tasks and to delete former 110.3(G)(2) and (G)(3).</p> <p>Added informational note to reference a job briefing form.</p> <p>Safety Impact: As safe or safer.</p>

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	<p>qualified for the task. A more extensive discussion shall be conducted if either of the following apply:</p> <p>(1) The work is complicated or particularly hazardous.</p> <p>(2) The employee cannot be expected to recognize and avoid the hazards involved in the job.</p>	
Section 110.1(I)(1)	<p>(1) Electrical Safety Program. 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. The frequency of the audit shall not exceed <u>Audits shall be performed at intervals not to exceed 3 years.</u></p>	<p>Change: Revised former 110.3(H)(1) to improve usability.</p> <p>Safety Impact: As safe or safer.</p>
Section 110.1(I)(2)	<p>(2) Field Work. 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.</p> <p><u>Audits shall be performed at intervals not to exceed 1 year.</u></p>	<p>Change: Revised former 110.3(H)(2) to improve usability and added requirement for audit not to exceed 1 year.</p> <p>Safety Impact: As safe or safer.</p>
Section 110.2(A)	<p>(A) Safety Training. The training requirements contained in this section shall apply to employees who face a risk of exposed to an electrical hazard when the risk associated with electrical hazard that hazard is not reduced to a safe level by the applicable electrical installation requirements.</p>	<p>Change: Replaced the phrase <i>who face a risk of</i> with <i>exposed to</i> and added the phrase <i>when the risk associated with that hazard.</i></p> <p>Safety Impact: As safe or safer.</p>
Section 110.2(B)	<p>(B) Type of Training. The training required by this section shall be classroom or on-the-job type, or a combination of the two. The degree <u>type and extent</u> of training provided shall be determined by the risk to the employee.</p>	<p>Change: Replaced the phrase <i>degree of training</i> with <i>type and extent of training</i> to link necessary training to employee risk.</p> <p>Safety Impact: As safe or safer.</p>
Section 110.2(C)	<p>(C) Emergency <u>Response Training Procedures.</u> Employees exposed to shock hazards and those employees</p>	<p>Change: Reorganized paragraph into subsection format for release, first aid, training, and documentation for usability.</p>

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	<p>responsible for taking action in case of emergency shall be trained in methods of release of victims from contact with exposed energized electrical conductors or circuit parts. Employees shall be regularly instructed in methods of first aid and emergency procedures, such as approved methods of resuscitation, if their duties warrant such training. Training of employees in approved methods of resuscitation, including cardiopulmonary resuscitation and automatic external defibrillator (AED) use, shall be certified by the employer annually.</p> <p>(1) <u>Contact Release. 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.</u></p> <p>(2) <u>First Aid, Emergency Response, and Resuscitation.</u></p> <p style="padding-left: 40px;">a) <u>Employees responsible for responding to medical emergencies shall be trained in first aid and emergency procedures.</u></p> <p style="padding-left: 40px;">b) <u>Employees responsible for responding to medical emergencies shall be trained in cardiopulmonary resuscitation (CPR). Refresher training shall occur annually.</u></p> <p style="padding-left: 40px;">c) <u>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. Refresher training shall occur annually.</u></p> <p>(3) <u>Training Verification. Employers shall verify at least annually that</u></p>	<p>Revised responsibility from <i>certify</i> training to <i>verify</i> training.</p> <p>Safety Impact: As safe or safer</p>

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	<p><u>employee training required by this section is current</u></p> <p>(4) <u>Documentation. The employer shall document that the training required by this section has occurred.</u></p>	
Section 110.2(D)(1)	<p>(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.</p> <p>(a) Such persons shall also be familiar with the proper use of the special precautionary techniques, <u>applicable electrical policies and procedures,</u> personal protective equipment including arc flash suit PPE, insulating and shielding materials, and insulated tools and test equipment. A person can be considered qualified with respect to certain equipment and methods but still be unqualified for others.</p> <p>(b) Such persons permitted to work within the limited approach boundary of exposed energized electrical conductors and circuit parts operating at 50 volts or more shall, at a minimum, be additionally trained in all of the following:</p> <p>(1) Skills and techniques necessary to distinguish exposed energized electrical conductors and circuit parts from other parts of electrical equipment</p> <p>(2) Skills and techniques necessary to determine the nominal voltage of exposed energized electrical conductors and circuit parts</p>	<p>Change: Removed reference to <i>50 volts or more</i> in (D)(1)(b) and replaced <i>voltage detector</i> with <i>test instrument</i> in (D)(1)(d). Other modifications were made to correct inconsistencies and increase clarity and usability.</p> <p>Safety Impact: As safe or safer.</p>

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	<p>(3) Approach distances specified in Table 130.4(D) and Table 130.4(D)(b) and the corresponding voltages to which the qualified person will be exposed</p> <p>(4) Decision-making process necessary to determine the degree and extent of the hazard and the personnel protective equipment and job planning necessary to perform the task safely be able to do the following:</p> <ol style="list-style-type: none"> i. <u>Perform the job safety planning</u> ii. <u>Identify electrical hazards</u> iii. <u>Assess the associated risk</u> iv. <u>Select the appropriate risk control methods from the hierarchy of control identified in 110.1(F), including personal protective equipment.</u> <p>(c) 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 <u>training demonstrates</u> 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.</p> <p>(d) Tasks that are performed less often than once per year shall require retraining before the performance of the work practices involved.</p> <p>(e) Employees shall be trained to select an appropriate voltage detector <u>test instrument</u> 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</p>	

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	enables the employee to understand all limitations of each specific voltage detector <u>test instrument</u> that might be used.	
Section 110.2(D)(3)	<p>(3) Retraining. <u>Retraining in safety-related work practices and applicable changes in this standard shall be performed at intervals not to exceed three years.</u> An employee shall receive additional training (or retraining) if any of the following conditions exists:</p> <p>(1) If The supervision or annual inspections indicate that the employee is not complying with the safety-related work practices.</p> <p>(2) If New technology, new types of equipment, or changes in procedures necessitate the use of safety-related work practices that are different from those that the employee would normally use.</p> <p>(3) If he or she The employee must employ safety-related work practices that are not normally used during his or her regular job duties.</p> <p>Retraining shall be performed at intervals not to exceed 3 years.</p>	<p>Change: Clarified wording only.</p> <p>Safety Impact: As safe or safer (Editorial)</p>
Section 110.2(E) Informational Note 1	<u>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.</u>	<p>Change: Added informational note to clarify the content of the training required by 110.2(E).</p> <p>Safety Impact: As safe or safer.</p>
Section 110.3	<u>110.3 Relationships with Contractors (Outside Service Personnel, and So Forth)- Host and Contractors Employers Responsibilities</u>	<p>Change: Relocated former 110.1 to 110.3 as well as 110.3 to 110.1 for improved usability.</p> <p>Changed former 110.1 title from <i>Relationships with Contractors (Outside Service Personnel, and So Forth)</i> to <i>Host and Contract Employers' Responsibilities</i>.</p> <p>Safety Impact: As safe or safer (Editorial)</p>

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Section 110.3(B)(3)(b)	Contract Employer Responsibilities. (B)(3)(b)(2) Any unanticipated hazards found during the contract employer's work that the host employer did not mention <u>Hazards identified during the course of work by the contract employer that were not communicated by the host employer.</u>	Change: Replaced the phrase <i>any unanticipated hazards found</i> with <i>hazards identified</i> and revised for clarity. Safety Impact: As safe or safer.
Section 110.3(C)	(C) Documentation. Where the host employer has knowledge of hazards <u>covered by this standard that are related to the contract employer's work,</u> there shall be a documented meeting between the host employer and the contract employer.	Change: Revised former 110.1(C) requirement for a documented meeting between the host employer(s) and the contract employer when host employer has knowledge of hazards. Safety Impact: As safe or safer.
Section 110.4	110.4 Use of <u>Electrical</u> Equipment.	Change: Changed title from <i>Use of Equipment</i> to <i>Use of Electrical Equipment</i> to clarify the intent of the section. Safety Impact: As safe or safer.
Section 110.4(A)(2)	(2) Rating. Test instruments, equipment, and their accessories shall be rated for circuits and equipment to which they will be connected <u>where they are utilized.</u>	Change: Replaced the phrase <i>to which they will be connected</i> with <i>where they are utilized</i> for clarity. Safety Impact: As safe or safer.
Section 110.4(A)(3)	(3) 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 used <u>utilized.</u>	Change: Replaced the term <i>used</i> with <i>utilized</i> for clarity. Safety Impact: As safe or safer (Editorial)
Section 110.4(A)(4)	(4) Visual Inspection and Repair. Test instruments and equipment and all associated test leads, cables, power cords, probes, and connectors shall be visually inspected for external defects and damage before each use. If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service. No employee shall use it until <u>a person(s) qualified to perform the repairs and tests that are necessary to render the equipment safe has done so.</u>	Change: Added the term <i>repair</i> to the title and <i>qualified person</i> to the text. Safety Impact: As safe or safer.
Section 110.4(A)(5)	(5) Operation Verification. When test instruments are used for testing the absence of voltage on conductors or circuit parts operating	Change: Added the phrase <i>on a known voltage source</i> to provide guidance and clarification on test instrument verification.

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	at 50 volts or more, the operation of the test instrument shall be verified <u>on a known voltage source</u> before and after an absence of voltage testis performed.	Safety Impact: As safe or safer.
Section 110.4(B)(1)	(1) Handling and Storage. Portable equipment shall be handled <u>and stored</u> 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.	Change: Added the term <i>storage</i> to the title and <i>stored</i> to the text to enhance safety by addressing the handling and storage of portable equipment and their connected flexible electric cords. Safety Impact: As safe or safer.
Section 110.4(B)(3)	(3) Visual Inspection and Repair of Portable Cord- and Plug-Connected Equipment and Flexible Cord Sets. (b) Defective Equipment. If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service. No employee shall use it until <u>a person(s) qualified to perform the repairs and tests necessary to render the equipment safe has done so</u> have been made. (4) 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.	Change: Added the term <i>repair</i> to the title. Added <i>person qualified to perform</i> to (b) Relocated Conductive Work Location 110.4(B)(3)(d) to 110.4(B)(4). Safety Impact: As safe or safer
Section 110.4(B)(4)	(4) Conductive Work Locations. <u>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.</u>	Change: Relocated former 110.4(B)(3)(d) to 110.4(B)(4). Safety Impact: As safe or safer (Editorial)
Section 110.4(B)(6)	(6) Manufacturer's Instructions. <u>Portable equipment shall be used in</u>	Change: Added (B)(6) to ensure users read, understand, and comply with the

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	<u>accordance with the manufacturer's instructions and safety warnings.</u>	manufacturer's operating and safety instructions. Safety Impact: As safe or safer.
Section 110.4(C)(2) and (C)(3)	<p>(C)(2) Maintenance and Construction. GFCI protection shall be provided where an employee is operating or using cord- and plug-connected <u>tools related to maintenance and construction activity</u> supplied by 125-volt, 15-, 20-, or 30-ampere circuits. Where employees working outdoors operate or use equipment supplied by other <u>greater</u> than 125-volt, 15-, 20-, or 30-ampere circuits, <u>GFCI protection</u> or an assured equipment grounding conductor program shall be implemented.</p> <p>(C)(2)(3) Outdoors. GFCI protection shall be provided when an employee is outdoors and operating or using 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 other <u>greater</u> than 125-volt, 15-, 20-, or 30-ampere circuits, <u>GFCI protection</u> or an assured equipment grounding conductor program shall be implemented.</p>	<p>Change: Revised former 110.4(C)(2) into two sections: (C)(2) for construction and maintenance work, and (C)(3) for outdoor work.</p> <p>Clarified that either GFCI protection or an assured equipment grounding conductor program is applicable to cord and plug connected equipment supplied by greater than 125 volts.</p> <p>Safety Impact: As safe or safer.</p>
Section 110.4(E)	(E) Overcurrent Protection Modification. Overcurrent protection of circuits and conductors shall not be modified, even on a temporary basis, beyond that <u>what is</u> permitted by applicable portions of electrical codes and standards dealing with overcurrent protection.	<p>Change: Replaced the term <i>that</i> with <i>what is</i> for editorial purposes.</p> <p>Safety Impact: As safe or safer (Editorial)</p>
Article 120 – Establishing an Electrically Safe Work Condition		
Section 120.1	120.1 Process of Achieving Verification of an Electrically Safe Work Condition.	<p>Change: Replaced the phrase <i>Process of Achieving</i> with <i>Verification of</i> in the title for clarity.</p> <p>Safety Impact: As safe or safer.</p>
Section 120.1(5)	(5) Use an adequately rated <u>voltage detector test instrument</u> to test each phase conductor or circuit part to verify it is de-energized. Test each phase conductor or circuit part both	Change: Replaced the phrase <i>voltage detector</i> with <i>test instrument</i> to clarify the verification requirements of all test instruments. Clarified to test on a <i>known voltage source</i> .

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	phase-to-phase and phase-to-ground. Before and after each test, determine that the voltage detector <u>test instrument</u> is operating satisfactorily <u>through verification on a known voltage source.</u>	Safety Impact: As safe or safer.
Section 120.2	120.2 De-energized Electrical Conductors or Circuit Parts Equipment That Have Has Lockout/Tagout Devices Applied.	Change: Replaced the phrase <i>Conductors or Circuit Parts</i> in the title with <i>Equipment</i> to clarify lockout devices are placed on equipment (disconnecting means), not on the conductors or circuit parts. Safety Impact: As safe or safer.
Section 120.2(B)(2)	<p>(2) Training. All persons who could be exposed or affected by the lockout/tagout shall be trained to understand the established procedure to control the energy and their responsibility in executing the procedure <u>the procedure and its execution.</u> New or reassigned employees shall be trained (or retrained) to understand the lockout/tagout procedure as it relates to their new assignments. Retraining shall be required as the established procedure is revised.</p> <p>(3) Retraining. Retraining shall be performed: <u>(a) When the established procedure is revised</u> <u>(b) At intervals not to exceed 3 years</u></p> <p>(4) Training Documentation. <u>(a) The employer shall document that each employee has received the training required by this section.</u> <u>(b) The documentation shall be made when the employee demonstrates proficiency in the work practices involved.</u> <u>(c) The documentation shall contain the content of the training, each employee's name, and the dates of the training.</u></p> <p><u>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.</u></p>	<p>Change: Revised former (B)(2) into three sections: (B)(2) Training, (B)(3) Retraining, and (B)(4) Training Documentation, to more accurately reflect who is to be trained and retrained.</p> <p>Adds text to require retraining on LOTO at least every 3 years to match 110.2(D)(3) and to maintain the same type of documentation required by 110.2(E).</p> <p>Safety Impact: As safe or safer.</p>

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Section 120.2(D)(3)(c)	(c) The electrical lockout/tagout procedure shall always include voltage testing requirements where there might be direct exposure to electrical energy hazards.	Change: Deleted the term <i>energy</i> from the phrase <i>electrical energy hazards</i> to promote consistent use of terminology associated with hazard and risk. Safety Impact: As safe or safer.
Section 120.2(D)(4)	(4) Training and Retraining. Each employer shall provide training as required to ensure employees' understanding of the lockout/tagout procedure content and their duty in executing such procedures.	Change: Deleted entire section. The training requirements are already covered in) 120.2(B)(2). Safety Impact: As safe or safer (Editorial)
Section 120.2(E)(2)	(2) Lockout/Tagout Device. Each employer shall supply, and employees shall use, lockout/tagout devices and equipment necessary to execute the requirements of 120.2(E). Locks and tags used for control of exposure to electrical energy hazards shall be unique, shall be readily identifiable as lockout/tagout devices, and shall be used for no other purpose.	Change: Deleted the term <i>energy</i> from the phrase <i>electrical energy hazards</i> to promote consistent use of terminology associated with hazard and risk. Safety Impact: As safe or safer.
Section 120.2 (E)(4)(e)	(e) A hold card tagging tool on an overhead conductor in conjunction with a hotline tool to install the tagout device safely on a disconnect that is isolated from the work(s) shall be permitted. <u>Where a hold card is used, the tagout procedure shall include the method of accounting for personnel who are working under the protection of the hold card.</u>	Change: Added a sentence to address the method of accounting for personnel who are working under the protection of the hold card. Safety Impact: As safe or safer.
Section 120.3(A)	(A) Placement. Temporary protective grounding equipment shall be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to a hazardous differences in electric potential <u>shock hazard (hazardous differences in electrical potential).</u>	Change: Replaced the phrase <i>hazardous differences in electrical potential</i> with <i>shock hazard (hazardous differences in electrical potential)</i> . Added a sentence to address the application of temporary protective grounding. Safety Impact: As safe or safer.

2015 NFPA 70E Article or Section	Added or Deleted Text <u>Underlined</u> text is added. Strikethrough indicates deleted text.	Change Description Impact to Worker Safety
	<u>The location, sizing, and application of temporary protective grounding equipment shall be identified as part of the employer's job planning.</u>	
Article 130 – Work Involving Electrical Hazards		
Section 130.1	<p>General. Article 130 covers the following:</p> <p><u>(1) When an electrically safe work condition must be established</u></p> <p><u>(2) The electrical safety-related work practices when an electrically safe work condition cannot be established</u></p> <p>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)(b), and Table 130.7(C)(16) are used in lieu of an incident energy analysis in accordance with 130.5.</p>	<p>Change: Revised to clarify the scope of Article 130.</p> <p>Safety Impact: As safe or safer.</p>
Section 130.2	<p>Electrically Safe Working Condition. Energized electrical conductors and circuit parts to which an employee might be exposed shall be put into an electrically safe work condition before an employee performs work if either any of the following conditions exist:</p> <p>(1) The employee is within the limited approach boundary.</p> <p>(2) The employee interacts with equipment where conductors or circuit parts are not exposed but an increased risk of injury <u>likelihood of injury</u> from an exposure to an arc flash hazard exists.</p>	<p>Change: Changed <i>risk of injury</i> to <i>likelihood of injury</i>.</p> <p>Safety Impact: As safe or safer</p>
Section 130.2(A)(1)	<p>(A) Energized Work.</p> <p>(1) Greater Additional Hazards or Increased Risk. Energized work shall be permitted where the employer can demonstrate that de-energizing introduces additional hazards or increased risk.</p>	<p>Change: Changed the title from <i>Greater Hazard</i> to <i>Additional Hazards or Increased Risk</i> to clarify and promote the consistent use of terminology associated with hazard and risk.</p> <p>Safety Impact: As safe or safer</p>
Section 130.2(A)(4)	<p>(4) <u>Normal Operation.</u> <u>Normal operation of electric equipment shall</u></p>	<p>Change: Added description of requirements where normal operation of electric equipment is permitted.</p>

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	<u>be permitted where all of the following conditions are satisfied:</u> <u>(1) The equipment is properly installed.</u> <u>(2) The equipment is properly maintained.</u> <u>(3) The equipment doors are closed and secured.</u> <u>(4) All equipment covers are in place and secured.</u> <u>(5) There is no evidence of impending failure.</u>	<p>Safety Impact: As safe or safer.</p>
Section 130.2(A)(4) Informational Note	<p>(4) Normal Operation. Informational Note: The phrase <u>properly installed</u> means that the equipment is installed in accordance with applicable industry codes and standards and the manufacturer's recommendations. The phrase <u>properly maintained</u> means that the equipment has been maintained in accordance with the manufacturer's recommendations and applicable industry codes and standards. The phrase <u>evidence of impending failure</u> means that there is evidence such as arcing, overheating, loose or bound equipment parts, visible damage, or deterioration.</p>	<p>Change: Added to explain the meaning of the phrases <i>properly installed</i>, <i>properly maintained</i>, and <i>evidence of impending failure</i>.</p> <p>Safety Impact: As safe or safer.</p>
Section 130.2(B)(1)	<p>(1) When Required. When working within the limited approach boundary or the arc flash boundary of exposed energized electrical conductors or circuit parts that are not placed in an electrically safe work condition [that is, for the reasons of increased or additional hazards or infeasibility per 130.2(A)], work to be performed shall be considered energized electrical work and shall be performed by written permit only.</p> <p>(1) When Required. When energized work is permitted in accordance with 130.2(A), an energized electrical work permit shall be required under the following conditions:</p> <p><u>(1) When work is performed within the restricted approach boundary</u></p>	<p>Change: Changed <i>limited approach boundary</i> to <i>restricted approach boundary</i>.</p> <p>Revised to simplify and clarify the requirement for an energized work permit.</p> <p>Safety Impact: As safe or safer.</p> <p>The language retains the new criteria of "arc flash boundary of exposed electrical conductors or circuit parts", but changes "limited approach boundary" to "restricted approach boundary" to recognize the intended use of the energized electrical work permit in previous editions of the Standard. During the 2009 revision cycle of the NFPA 70E Standard, a chair-appointed task group carefully selected the term "working on" to require an energized electrical work permit when employees were in direct contact with exposed energized parts (either with their body or with tools). It is this direct contact work that poses an elevated risk that should require a higher level of authorization provided by the</p>

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	<u>(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</u>	energized electrical work permit. The energized electrical work permit, which requires upper level management approval, should be used as a deterrent for what may be considered the most hazardous work – when physically coming in contact with exposed, energized conductors and circuit parts.
Section 130.2(B)(2)(4)	(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) Justification for why the work must be performed in an energized condition [see 130.2(A)] (3) Description of the safe work practices to be employed [see 130.3(B)] (4) Results of the shock hazard analysis <u>risk assessment</u> [see 130.4(A)] <u>a. Voltage to which personnel will be exposed</u> b. Limited approach boundary [see 130.4(B), Table 130.4(D)(a), and Table 130.4(D)(b)] c. Restricted approach boundary [see 130.4(B) and Table 130.4(D)(a) and Table 130.4(D)(b)] c. Prohibited approach boundary (see 130.4(B) and Table 130.4(C)(a) and Table 130.4(C)(b)) d. Necessary shock personal and other protective equipment to safely perform the assigned task [see 130.4(C), 130.7(C)(1) through (C)(16), Table 130.7(C)(15)(A)(a), Table 130.7(C)(16), and 130.7(D)]	Change: Replaced the phrase <i>shock hazard analysis</i> with <i>shock risk assessment</i> and deleted reference to <i>prohibited approach boundary</i> as it no longer appears throughout this standard. Safety Impact: As safe or safer See Safety Impact note for 130.4(B).
Section 130.2 (B)(2)(5)	(2) Elements of Work Permit. (5) Results of the arc flash hazard analysis <u>risk assessment</u> [see 130.5] a. Available incident energy <u>at the working distance</u> or <u>arc flash hazard/risk PPE</u> category [see 130.5] b. Necessary personal protective equipment PPE to safely perform the assigned task <u>protect against</u>	Change: Replaced the phrase <i>arc flash hazard analysis</i> with <i>arc flash risk assessment</i> . Safety Impact: As safe or safer

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	<p>the hazard [see 130.5(C), 130.7(C)(1) through (C)(16), Table 130.7(C)(15)(a) and 130.7(C)(15)(b) 130.7(C)(15)(A)(a), Table 130.7(C)(16), and 130.7(D)] c. Arc flash boundary [see 130.5(A)(B)]</p>	
Section 130.2 (B)(3)	<p>(3) Exemptions to Work Permit. Work performed within the limited approach boundary of energized electrical conductors or circuit parts by qualified persons related to tasks such as testing, troubleshooting, and voltage measuring shall be permitted to be performed without an energized electrical work permit, if appropriate safe work practices and personal protective equipment in accordance with Chapter 1 are provided and used. If the purpose of crossing the limited approach boundary is only for visual inspection and the restricted approach boundary will not be crossed, then an energized electrical work permit shall not be required.</p> <p>(3) Exemptions to Work Permit. <u>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:</u> <u>(1) Testing, troubleshooting, and voltage measuring</u> <u>(2) Thermography and visual inspections if the restricted approach boundary is not crossed</u> <u>(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</u> <u>(4) General housekeeping and miscellaneous non-electrical tasks if the restricted approach boundary is not crossed</u></p>	<p>Change: Revised into a list format and added item referencing general housekeeping and miscellaneous non-electrical tasks.</p> <p>Safety Impact: As safe or safer</p>
Section 130.3	<p>Working While Exposed to Electrical Hazards. (A) General. Working While Exposed to Electrical Hazards Safety-related work</p>	<p>Change: Clarified that only qualified persons are permitted to work on electric conductors that are not in an electrically safe work condition.</p>

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	<p>practices shall be used to safeguard employees from injury while they are exposed to electrical hazards from electrical conductors or circuit parts that are or can become energized. The specific safety-related work practices shall be consistent with the nature and extent of the associated <u>the electrical hazards and the associated risk. Appropriate safety-related work practices shall be determined before any person is exposed to the electrical hazards involved by using both shock risk assessment and arc flash risk assessment. Only qualified persons shall be permitted to work on electrical conductors or circuit parts that have not been put into an electrically safe work condition.</u></p> <p>(1) Energized Electrical Conductors and Circuit Parts — Safe Work Condition. Before an employee works within the limited approach boundary, energized electrical conductors and circuit parts to which an employee might be exposed shall be put into an electrically safe work condition, unless work on energized components can be justified according to 130.2(A).</p> <p>(2) Energized Electrical Conductors and Circuit Parts — Unsafe Work Condition. Only qualified persons shall be permitted to work on electrical conductors or circuit parts that have not been put into an electrically safe work condition.</p> <p>(B) Working Within the Limited Approach Boundary of Exposed Electrical Conductors or Circuit Parts That Are or Might Become Energized.</p> <p>(1) Electrical Hazard Analysis. If the energized electrical conductors or circuit parts operating at 50 volts or more are not placed in an electrically safe work condition, other safety-related work practices</p>	<p>Safety Interlocks relocated to Section 130.6(N)</p> <p>Deleted Sections 130.3(A) (1) and (2) and 130.3(B) since 130.4 and 130.5 repeat the same basic requirement for work within the shock approach and arc flash boundary.</p> <p>Safety Impact: As safe or safer</p>

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	<p>shall be used to protect employees who might be exposed to the electrical hazards involved. Such work practices shall protect each employee from arc flash and from contact with energized electrical conductors or circuit parts operating at 50 volts or more directly with any part of the body or indirectly through some other conductive object. Work practices that are used shall be suitable for the conditions under which the work is to be performed and for the voltage level of the energized electrical conductors or circuit parts. Appropriate safety related work practices shall be determined before any person is exposed to the electrical hazards involved by using both shock hazard analysis and arc flash hazard analysis.</p> <p>(2) Safety Interlocks. Only qualified persons following the requirements for working inside the restricted approach boundary as covered by 130.4(C) shall be permitted to defeat or bypass an electrical safety interlock over which the person has sole control, and then only temporarily while the qualified person is working on the equipment. The safety interlock system shall be returned to its operable condition when the work is completed.</p>	
Section 130.4	130.4 Approach Boundaries to Energized Electrical Conductors or Circuit Parts <u>for Shock Protection.</u>	Change: Added the phrase <i>for Shock Protection</i> to the title. Safety Impact: As safe or safer.
Section 130.4(A)	(A) Shock Hazard Analysis Risk Assessment. A shock hazard analysis <u>risk assessment</u> shall determine the voltage to which personnel will be exposed, the boundary requirements, and the personal protective equipment PPE <u>PPE</u> necessary in order to minimize the possibility of electric shock to personnel.	Change: Changed the phrase <i>hazard analysis</i> to <i>risk assessment</i> and <i>personal protective equipment</i> to <i>PPE</i> to promote consistent use of terminology. Safety Impact: As safe or safer.
Section 130.4(B)	(B) Shock Protection Boundaries. The shock protection boundaries identified as limited approach	130.4(B): Deleted the phrase <i>prohibited approach boundary</i> , as it no longer appears throughout this standard.

2015 NFPA 70E Article or Section	Added or Deleted Text <u>Underlined</u> text is added. Strikethrough indicates deleted text.	Change Description Impact to Worker Safety
	<p><u>boundary and</u> restricted approach and boundary and prohibited approach boundaries shall be applicable where approaching personnel are exposed to energized electrical conductors or circuit parts. Table 130.4(C)(D)(a) shall be used for the distances associated with various ac system voltages. Table 130.4(C)(D)(b) shall be used for the distances associated with various dc system voltages.</p>	<p>Safety Impact: As safe or safer.</p> <p>The requirement for using personal protective equipment begins at the restricted approach boundary. No additional protective equipment is required when crossing the prohibited approach boundary, rendering the use of the term as unnecessary and thus is the basis for deleting it from the NFPA 70E. The prohibited approach boundary was intended to represent “making contact with exposed energized conductors or circuit parts” and this has been revised to indicate these words in other sections of 70E, such as 130.4(D)(1).</p>
Section 130.4(C)	<p><u>(C) Limited Approach Boundary.</u></p> <p>(D) (1) Approach by Unqualified Persons. Unless permitted by 130.4(D)(2)(C)(3), no unqualified person shall be permitted to approach nearer than the limited approach boundary of energized conductors and circuit parts.</p> <p>(1) (2) Working at or Close to the Limited Approach Boundary. Where one or more unqualified persons are working at or close to the limited approach boundary, the 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.</p> <p>(2) (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 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.</p>	<p>Change: Relocated former 130.4(C) to 130.4(D) and former 130.4(D) to 130.4(C).</p> <p>Revised former 130.4(D) into three sections regarding limited approach boundary: (C)(1) Approach by Unqualified Persons, (C)(2) Working at or Close to the Limited Approach Boundary, and (C)(3) Entering the Limited Approach Boundary.</p> <p>Safety Impact: As safe or safer.</p>
Section 130.4(D)(1)	<p><u>(C) (D) Restricted Approach Boundary Approach to Exposed</u></p>	<p>Change: Relocated former 130.4(D) to 130.4(C) and former 130.4(C) to 130.4(D).</p>

2015 NFPA 70E Article or Section	Added or Deleted Text <u>Underlined</u> text is added. Strikethrough indicates deleted text.	Change Description Impact to Worker Safety
	<p><u>Energized Electrical Conductors or Circuit Parts Operating at 50 Volts or More.</u></p> <p>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(C)(D)(a) and Table 130.4(C)(D)(b), unless any <u>one of the following conditions applies:</u></p> <p>(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 cross the prohibited approach boundary <u>contact exposed energized electrical conductors or circuit parts</u>, a combination of 130.4(C)(D)(1), 130.4 (C)(D)(2), and 130.4 (C)(D)(3) shall be used to protect the uninsulated body parts.</p> <p>(2) The energized electrical conductors or circuit part operating at 50 volts or more are insulated from the qualified person and from any other conductive object at a different potential.</p> <p>(3) The qualified person is insulated from any other conductive object as during live-line bare-hand work.</p>	<p>Revised former 130.4(C)(1) to replace the phrase <i>cross the prohibited approach boundary</i> with <i>contact exposed energized conductors or circuit parts</i>, and updated the table references.</p> <p>Revised former 130.4(C)(2) to delete the phrase <i>bare-hand work</i>.</p> <p>Safety Impact: As safe or safer.</p>
Table 130.4(C)(D)(b)	<p>Approach Boundaries to Energized Electrical Conductors or Circuit Parts for Shock Protection, Direct Current Voltage System.</p> <p><u>Note:</u> All dimensions are distance from exposed energized electrical conductors or circuit parts to worker.</p>	<p>Change: Renumbered table from (C) to (D)</p> <p>Eliminated the Prohibited Approach Boundary from table</p> <p>Replaced "the terms" with "Exposed movable conductor" to clarify definition.</p>

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	<p>* <u>Exposed movable conductor</u> The terms describes a condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.</p>	
Table 130.4(C)(D)(a)	<p><i>Table 130.4 (C)(D)(a) Approach Boundaries to 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.)</i></p> <p>Note (1): For arc flash boundary, see 130.5(A).</p> <p><u>Note (2): All dimensions are distance from exposed energized electrical conductors or circuit part to employee.</u></p> <p>^a For single-phase systems <u>above 250V</u>, select the range that is equal to the system's maximum phase-to-ground voltage multiplied by 1.732.</p> <p>^b See definition in Article 100 and text in 130.4(D)(2) and Informative Annex C for elaboration.</p> <p>^c <u>Exposed movable conductors</u> This term describes a condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.</p> <p>^d <u>This includes circuits where the exposure does not exceed 120V.</u></p>	<p>Change: Several revisions were made to this table:</p> <ul style="list-style-type: none"> • Voltage range in the second row was adjusted from 50 V–300 V to 50 V–150 V • Voltage range in the third row was adjusted from 300 V–750 V to 151 V–750 V. • Revised Footnote “a” to specify single-phase systems above 250 V. <p>Added a new Footnote “d” to clarify that the voltage range includes circuits where the exposure does not exceed 120 V.</p> <p>Safety Impact: As safe or safer.</p>
Section 130.5	<p>130.5 Arc Flash Hazard Analysis. An arc flash hazard analysis shall determine the arc flash boundary, the incident energy at the working distance, and the personal protective equipment that people within the arc flash boundary shall use.</p> <p>The arc flash hazard analysis shall be updated when a major modification or renovation takes place. It shall be reviewed periodically, not to exceed 5 years, to account for changes in the electrical distribution system that could affect the results of the arc flash hazard analysis.</p>	<p>Deleted first paragraph and exception.</p> <p>Replaced the phrase <i>arc flash hazard analysis</i> with <i>arc flash risk assessment</i>.</p> <p>Revised paragraphs into list format for usability.</p> <p>Added requirement to update label when risk assessment indicates a change in the calculation.</p> <p>Added requirement that the owner of the equipment is responsible for the installation and maintenance of labels.</p> <p>Updated subsections for (A) Documentation, (B) Arc Flash Boundary, (C) Arc Flash PPE, and (D) Equipment Labeling.</p>

2015 NFPA 70E Article or Section	Added or Deleted Text <u>Underlined</u> text is added. Strikethrough indicates deleted text.	Change Description Impact to Worker Safety
	<p>The arc flash hazard analysis shall take into consideration the design of the overcurrent protective device and its opening time, including its condition of maintenance.</p> <p><i>Exception: The requirements of 130.7(C)(15) and 130.7(C)(16) shall be permitted to be used in lieu of determining the incident energy at the working distance.</i></p> <p>(A) Arc Flash Boundary. The arc flash boundary for systems 50 volts and greater shall be the distance at which the incident energy equals 5 J/cm² (1.2 cal/cm²).</p> <p>(B) Protective Clothing and Other Personal Protective Equipment (PPE) for Application with an Arc Flash Hazard Analysis. Where it has been determined that work will be performed within the arc flash boundary, one of the following methods shall be used for the selection of protective clothing and other personal protective equipment (PPE): (1) Incident Energy Analysis. The incident energy analysis shall determine, and the employer shall document, the incident energy exposure of the worker (in calories per square centimeter). The incident energy exposure level shall be based on the working distance of the employee's face and chest areas from a prospective arc source for the specific task to be performed. Arc-rated clothing and other PPE shall be used by the employee based on the incident energy exposure associated with the specific task. Recognizing that incident energy increases as the distance from the arc flash decreases, additional PPE shall be used for any parts of the body that are closer than the distance at which the incident energy was determined.</p>	<p>Safety Impact: As safe or safer.</p>

2015 NFPA 70E Article or Section	Added or Deleted Text <u>Underlined</u> text is added. Strikethrough indicates deleted text.	Change Description Impact to Worker Safety
	<p>(2) Hazard/Risk Categories. The requirements of 130.7(C)(15) and 130.7(C)(16) shall be permitted to be used for the selection and use of personal and other protective equipment.</p> <p>(C) 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 are likely to require examination, adjustment, servicing, or maintenance while energized, shall be field marked with a label containing all the following information:</p> <p>(1) At least one of the following:</p> <p>a. Available incident energy and the corresponding working distance</p> <p>b. Minimum arc rating of clothing</p> <p>c. Required level of PPE</p> <p>d. Highest Hazard/Risk Category (HRC) for the equipment</p> <p>(2) Nominal system voltage</p> <p>(3) Arc flash boundary</p> <p><u>130.5 Arc Flash Risk Assessment.</u> <u>An arc flash risk assessment shall be performed and shall:</u></p> <p><u>(1) Determine if an arc flash hazard exists. If an arc flash hazard exists, the risk assessment shall determine:</u></p> <p><u>a. Appropriate safety-related work practices</u></p> <p><u>b. The arc flash boundary</u></p> <p><u>c. The PPE to be used within the arc flash boundary</u></p> <p><u>(2) 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.</u></p> <p><u>(3) Take into consideration the design of the overcurrent protective</u></p>	

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	<p><u>device and its opening time, including its condition of maintenance.</u></p> <p><u>(A) Documentation.</u> <u>The results of the arc flash risk assessment shall be documented.</u></p> <p><u>(B) Arc Flash Boundary.</u></p> <p><u>(1)</u> <u>The arc flash boundary shall be the distance at which the incident energy equals 5 J/cm² (1.2 cal/cm²).</u></p> <p><u>(2)</u> <u>The arc flash boundary shall be permitted to be determined by Table 130.7(C)(15)(A)(b) or Table 130.7(C)(15)(B), when the requirements of these tables apply.</u></p> <p><u>(C) Arc Flash PPE.</u> <u>One of the following methods shall be used for the selection of PPE. 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) shall not be permitted.</u></p> <p><u>(1) Incident Energy Analysis Method.</u> <u>The incident energy exposure level shall be based on the working distance of the employee's face and chest areas from a prospective arc source for the specific task to be performed. Arc-rated clothing and other PPE shall be used by the employee based on the incident energy exposure associated with the specific task. Recognizing that incident energy increases as the distance from the arc flash decreases, additional PPE shall be used for any parts of the body that are closer than the distance at which the incident energy was determined.</u></p> <p><u>(2) Arc Flash PPE Categories Method.</u> <u>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.</u></p>	

2015 NFPA 70E Article or Section	Added or Deleted Text <u>Underlined</u> text is added. Strikethrough indicates deleted text.	Change Description Impact to Worker Safety
	<p><u>(D) Equipment Labeling.</u> <u>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:</u></p> <ul style="list-style-type: none"> <u>(1) Nominal system voltage</u> <u>(2) Arc flash boundary</u> <u>(3) At least one of the following:</u> <ul style="list-style-type: none"> <u>a. Available incident energy and the corresponding working distance, or the arc flash PPE category in Table 130.7(C)(15)(A)(b) or 130.7(C)(15)(B) for the equipment, but not both</u> <u>b. Minimum arc rating of clothing</u> <u>c. Site-specific level of PPE</u> <p>The method of calculating and the data to support the information for the label shall be documented. <u>Where the review of the arc flash hazard risk assessment identifies a change that renders the label inaccurate, the label shall be updated.</u></p> <p><u>The owner of the electrical equipment shall be responsible for the documentation, installation, and maintenance of the field-marked label.</u></p>	
Section 130.5 Informational Notes	<p>Informational Note No. 1: Improper or inadequate maintenance can result in increased opening time of the overcurrent protective device, thus increasing the incident energy. <u>Where equipment is not properly installed or maintained, PPE selection based on incident energy analysis or the PPE category method may not provide adequate protection from arc flash hazards.</u></p>	<p>Change: Added note that PPE may not be adequate if equipment not properly installed or maintained.</p> <p>Referenced Annex O for safety related design.</p> <p>Safety Impact: As safe or safer</p>

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	<p>Informational Note No. 2: Both larger and smaller available short-circuit currents could result in higher available arc flash energies. If the available short-circuit current increases without a decrease in the opening time of the overcurrent protective device, the arc flash energy will increase. If the available short-circuit current decreases, resulting in a longer opening time for the overcurrent protective device, arc flash energies could also increase.</p> <p>Informational Note No. 3: 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 at-risk procedures that <u>could expose</u> require an employee to be exposed to high levels of <u>incident</u> energy sources. 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 -kV (nominal) systems, current limitation, and specification of covered bus or covered conductors within equipment are techniques available to reduce the hazard of the system <u>risk associated with an arc flash incident</u>. See Informative Annex O for <u>Safety Related Design Requirements</u>.</p> <p>Informational Note No. 4: For additional direction for performing maintenance on overcurrent protective devices, see Chapter 2, Safety-Related Maintenance Requirements.</p> <p>Informational Note No. 5: See IEEE 1584 <u>Guide for Performing Arc</u></p>	

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	<u>Flash Calculations</u> for more information regarding arc flash hazards for three-phase systems rated less than 240 volts.	
Section 130.6(A)(1)	(1) When Hazardous Electrical Hazards Might Exist. Employees shall be instructed to be alert at all times when they are working within the limited approach boundary of energized electrical conductors or circuit parts operating at 50 volts or more and in work situations where <u>when</u> electrical hazards might exist.	Change: Replaced the term <i>Hazardous</i> with the phrase <i>Electrical Hazards Might Exist</i> in the title to promote the consistent use of terminology. Safety Impact: As safe or safer.
Section 130.6(C)(1)	(C) Illumination. (1) General. Employees shall not enter spaces containing where electrical hazards <u>exist</u> unless illumination is provided that enables the employees to perform the work safely.	Change: Replaced the term <i>containing</i> with <i>where</i> to promote the consistent use of terminology associated with hazard and risk. Safety Impact: As safe or safer (Editorial)
Section 130.6(D)	(D) Conductive Articles Being Worn. Conductive articles of jewelry and clothing (such as watchbands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, metal headgear, or metal frame glasses) shall not be worn <u>within the restricted approach boundary or</u> where they present an electrical contact hazard with exposed energized electrical conductors or circuit parts.	Change: Added the phrase <i>within the restricted approach boundary</i> to correlate with the standard and to clarify the restricted approach boundary is considered the closest approach for a qualified worker without precautionary techniques. Safety Impact: As safe or safer.
Section 130.6(H)	(H) Clear Spaces. <u>Working space required by other codes and standards shall not be used for storage. This space shall be kept clear to permit safe operation and maintenance of electrical equipment.</u>	Change: Added new section <i>Clear Spaces</i> to clarify that working space requirements are found in other codes and standards and to provide information on maintaining clear working space in front of electrical equipment. Safety Impact: As safe or safer.
Section 130.6(M)	(L) (M) Reclosing Circuits After Protective Device Operation. After a circuit is de-energized by the automatic operation of a circuit protective device, the circuit shall not be manually reenergized until it has been determined that the equipment and circuit can be safely energized. The repetitive manual reclosing of circuit breakers or reenergizing circuits through replaced fuses shall be prohibited. When it is determined <u>from the design of the circuit and the</u>	Change: Added the phrase <i>from the design of the circuit and the overcurrent devices involved</i> to the second sentence. This change returns the requirement to the 2009 edition text. This language requires someone knowledgeable of circuit devices to determine whether it is safe to re-energize circuit. Safety Impact: As safe or safer.

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	<u>overcurrent devices involved</u> that the automatic operation of a device was caused by an overload rather than a fault condition, examination of the circuit or connected equipment shall not be required before the circuit is reenergized.	
Section 130.6(N)	(B) (2) (N) Safety Interlocks. Only qualified persons following the requirements for working inside the restricted approach boundary as covered by 130.4(C) shall be permitted to defeat or bypass an electrical safety interlock over which the person has sole control, and then only temporarily while the qualified person is working on the equipment. The safety interlock system shall be returned to its operable condition when the work is completed.	Change: Relocated former 130.3(B)(2) to new 130.6(N). Safety Impact: As safe or safer (Editorial)
Section 130.7(A) Informational Note 3	Informational Note No. 3: When incident energy exceeds 40 cal/cm ² at the working distance, greater emphasis may be necessary with respect to de-energizing before working within the limited approach boundary of the exposed electrical conductors or circuit parts when exposed to electrical hazards.	Change: Revised to address electrical hazards is not just shock but also includes arc flash. Safety Impact: As safe or safer.
Section 130.7(C)(8) Informational Note	(8) Foot Protection. Where insulated footwear is used as protection against step and touch potential, dielectric overshoes <u>footwear</u> shall be required. Insulated soles shall not be used as primary electrical protection. Informational Note: Electrical hazard shoes footwear meeting ASTM F2413, <u>Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear</u> , can provide a secondary source of electric shock protection under dry conditions.	Change: Replaced the term <i>shoes</i> with <i>footwear</i> to align with the ASTM family of standards. Safety Impact: As safe or safer.
Section 130.7(C)(9)(a)	(a) Layering. Nonmelting, flammable fiber garments shall be permitted to be used as underlayers in conjunction with arc-rated garments in a layered system for added protection. If nonmelting, flammable fiber garments are used as underlayers, the system arc rating shall be sufficient to prevent breakopen of the innermost arc-rated layer at the expected arc	Change: Revised to clarify that nonmelting, flammable fiber garments used as underlayers do not contribute to the overall arc rating of the layering system. Safety Impact: As safe or safer.

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	exposure incident energy level to prevent ignition of flammable underlayers. Garments that are not arc rated shall not be permitted to be used to increase the arc rating of a garment or of a clothing system.	
Section 130.7(C)(9)(a)	Factors in Selection of Protective Clothing. (d) Coverage. Clothing shall cover potentially exposed areas as completely as possible. Shirt and coverall sleeves shall be fastened at the wrists, <u>shirts shall be tucked into pants</u> , and shirts, <u>coveralls</u> , and jackets shall be closed at the neck.	Change: Added the term <i>coverall</i> and the phrase <i>shirts shall be tucked into pants</i> . Safety Impact: As safe or safer.
Section 130.7(C)(11) Exception	Clothing Material Characteristics. <i>Exception: Fiber blends that contain materials that melt, such as acetate, acrylic, nylon, polyester, polyethylene, polypropylene, and spandex, shall be permitted if such blends in fabrics meet the requirements of ASTM F1506, Standard Performance Specification for Flame Resistant and Arc Rated Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards, and if such blends in fabrics do not exhibit evidence of a melting and sticking hazard during arc testing according to ASTM F1959/F1959M, Standard Test Method for Determining the Arc Thermal Performance Value Rating of Materials for Clothing.</i>	Change: Updated ASTM standards to reflect current titles. Safety Impact: As safe or safer.
Section 130.7(C)(12) Exception	Clothing and Other Apparel Not Permitted. <i>Exception No. 1: Nonmelting, flammable (non-arc-rated) materials shall be permitted to be used as underlayers to arc-rated clothing, as described in 130.7(C)(11) and also shall be permitted to be used for Hazard/Risk Category 0 as described in Table 130.7(C)(16).</i> <i>Exception No. 2: Where the work to be performed inside the arc flash boundary exposes the worker to multiple hazards, such as airborne contaminants, and under special permission by the authority having jurisdiction and where it can be</i>	Change: Deleted the use of <i>Hazard/Risk Category 0</i> to clarify and promote the consistent use of terminology associated with hazard and risk. Change: Removed the requirement in Exception 2 for permission by the AHJ and added requirement for a risk assessment to determine adequacy of protection. Safety Impact: As safe or safer.

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	<i>shown and the risk assessment identifies that the level of protection is adequate to address the arc flash hazard, non-arc-rated PPE shall be permitted.</i>	
Section 130.7(C)(13)	<p>Care and Maintenance of Arc Rated Clothing. (d) Cleaning, Repairing, and Affixing Items. When arc rated clothing is cleaned, manufacturer's instructions shall be followed to avoid loss of protection. When arc-rated clothing is repaired, the same arc-rated materials used to manufacture the arc-rated clothing shall be used to provide repairs. When trim, name tags, or logos, or any combination thereof, are affixed to arc-rated clothing, guidance in ASTM F 1506, <i>Standard Performance Specification for Textile Material for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards</i>, shall be followed. [See Table 130.7(C)(14).]</p> <p><u>Informational Note No. 1: Additional guidance is provided in ASTM F1506, <i>Standard Performance Specification for Flame Resistant and Arc Rated Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards</i>, when trim, name tags, logos, or any combination thereof are affixed to arc-rated clothing.</u></p> <p><u>Informational Note No. 2: Additional guidance is provided in ASTM F1449, <i>Standard Guide for Industrial Laundering of Flame, Thermal, and Arc Resistant Clothing</i>, and ASTM F2757, <i>Standard Guide for Home Laundering Care and Maintenance of Flame, Thermal, and Arc Resistant Clothing</i>.</u></p>	<p>Change: Revised to move reference to ASTM F1506 to the informational note, and added second informational note for both ASTM F2757 and ASTM F1449. Referencing these standards provides useful information on laundering flame, thermal, and arc resistant clothing.</p> <p>Safety Impact: As safe or safer.</p>
Section 130.7(C)(14)	<p>(14) Standards for Personal Protective Equipment (PPE). Personal protective equipment PPE shall conform to the standards listed in Table 130.7(C)(14).</p>	<p>Change: Deleted the use of <i>personal protective equipment</i> and replaced with <i>PPE</i> to promote the consistent use of terminology.</p> <p>Safety Impact: As safe or safer (Editorial)</p>
Section 130.7(C)(15)	<p>(15) Selection of Personal Protective Equipment (PPE) When Required for Various Tasks.</p>	<p>Change: Rewrote section to separate AC from DC</p>

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	<p>Where selected in lieu of the incident energy analysis of 130.5(B)(1), Table 130.7(C)(15)(a) and Table 130.7(C)(15)(b) shall be used to determine the hazard/risk category and requirements for use of rubber insulating gloves and insulated and insulating hand tools for a task. The assumed maximum short-circuit current capacities and maximum fault clearing times for various tasks are listed in Table 130.7(C)(15)(a). For tasks not listed, or for power systems with greater than the assumed maximum short-circuit current capacity or with longer than the assumed maximum fault clearing times, an incident energy analysis shall be required in accordance with 130.5.</p> <p><u>(A) Alternating Current (ac) Equipment.</u> <u>When selected in lieu of the incident energy analysis of 130.5(B)(1), Table 130.7(C)(15)(A)(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). An incident energy analysis shall be required in accordance with 130.5 for the following:</u></p> <p><u>(1) Tasks not listed in Table 130.7(C)(15)(A)(a)</u></p> <p><u>(2) Power systems with greater than the estimated maximum available short-circuit current</u></p> <p><u>(3) Power systems with longer than the maximum fault clearing times</u></p> <p><u>(4) Tasks with less than the minimum working distance</u></p> <p><u>(B) Direct Current (dc) Equipment.</u> <u>When selected in lieu of the incident energy analysis of 130.5(C)(1), Table 130.7(C)(15)(A)(a) shall be used to identify when arc flash PPE</u></p>	<p>Clarified Note 1 to reflect new tables and clarified that table is not used if a task distance is less than the minimum working distance specified in table.</p> <p>Safety Impact: As safe or safer</p>

2015 NFPA 70E Article or Section	Added or Deleted Text <u>Underlined</u> text is added. Strikethrough indicates deleted text.	Change Description Impact to Worker Safety
	<p><u>is required. 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). An incident energy analysis shall be required in accordance with 130.5 for the following:</u></p> <p><u>(1) Tasks not listed in Table 130.7(C)(15)(A)(a)</u></p> <p><u>(2) Power systems with greater than the estimated maximum available short circuit current</u></p> <p><u>(3) Power systems with longer than the maximum fault clearing times</u></p> <p><u>(4) Tasks with less than the minimum working distance</u></p> <p>Informational Note No. 1: The hazard risk category <u>arc flash PPE category</u>, work tasks, and protective equipment provided in <u>Table 130.7(C)(15)(A)(a), Table 130.7(C)(15)(A)(b), and Table 130.7(C)(15)(B)</u> were identified by a task group and selected the hazard risk category, protective clothing and equipment were, based on the collective experience of the NFPA 70E Technical Committee. The hazard risk category <u>arc flash PPE category</u> of the protective clothing and equipment is generally based on determination of the estimated exposure levels.</p> <p>Informational Note No. 2: The collective experience of the task group <u>NFPA 70E Technical Committee</u> is that, in most cases, closed doors do not provide enough protection to eliminate the need for PPE for instances where in <u>situations</u> in which the state of the equipment is known to readily change (e.g., doors open or closed, rack in or rack out).</p> <p>Informational Note No. 3: The premise used by the task group <u>NFPA 70E Technical Committee</u> in developing the criteria discussed in</p>	

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	Informational Note No. 1 and Informational Note No. 2 is considered to be reasonable, based on the consensus judgment of the full NFPA 70E Technical committee.	
Table 130.7(C)(15)(A)(a)	<p>Arc Flash Hazard Identification for Alternating Current (ac) and Direct Current (dc) Systems</p> <p>Table Columns Include: 1) Task 2) Equipment Condition* 3) Arc Flash PPE Required (Yes or No)</p> <p>Note: Hazard identification is one component of risk assessment. Risk assessment involves a determination of the likelihood of occurrence of an incident, resulting from a hazard that could cause injury or damage to health. The assessment of the likelihood of occurrence contained in this table does not cover every possible condition or situation. Where this table indicates that arc flash PPE is not required, an arc flash is not likely to occur.</p> <p>*The phrase <i>properly installed</i>, as used in this table, means that the equipment is installed in accordance with applicable industry codes and standards and the manufacturer's recommendations. The phrase <i>properly maintained</i>, as used in this table, means that the equipment has been maintained in accordance with the manufacturer's recommendations and applicable industry codes and standards. The phrase <i>evidence of impending failure</i>, as used in this table, means that there is evidence of arcing, overheating, loose or bound equipment parts, visible damage, deterioration, or other damage.</p>	<p>Change: Added a new task based table to help user determine when arc flash PPE is required. The new table lists the task, equipment condition and provides guidance on whether arc flash PPE is required (i.e. Yes or No)</p> <p>Safety Impact: As safe or safer.</p> <p>Note: Although this new task table may indicate that arc flash PPE is not required for normal operation of a circuit breaker, switch, contactor or starter when all equipment conditions are met, the EFCOG working group consensus concluded that some level of arc rated clothing and non-melting underlayment should be used when energy is ≥ 1.2 calories (Reference: 2016 EFCOG Workshop Task Group 5 presentation)</p>
Tables 130.7(C)(15)(A)(b) and 130.7(C)(15)(B) and Notes	<p>(1) Rubber insulating gloves are gloves rated for the maximum line-to-line voltage upon which work will be done.</p> <p>(2) Insulated and insulating hand tools are tools rated and tested for the maximum line-to-line voltage</p>	<p>Change: Previous Hazard/Risk Classification tables were revised to reflect a single PPE category for the type of equipment. All references pertaining to rubber insulating gloves and insulating hand tools were deleted from tables and notes. Removed Notes 1,2,3,5 and 6. Expanded existing Note 4 to limit</p>

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	<p>upon which work will be done, and are manufactured and tested in accordance with ASTM F 1505, Standard Specification for Insulated and Insulating Hand Tools.</p> <p>(3) The use of "N" does not indicate that rubber insulating gloves and insulated and insulating hand tools are not required in all cases. Rubber insulating gloves and insulated and insulating hand tools may be required by 130.4, 130.8 (C) (7), and 130.8(D).</p> <p>(4) For equipment protected by upstream current limiting fuses with arcing fault current in their current limiting range (1/2 cycle fault clearing time or less), the hazard/risk category required may be reduced by one number.</p> <p>(5) For power systems up to 600 V the arc flash boundary was determined by using the following information: When 0.03 second trip time was used, that indicated MCC or panelboard equipment protected by a molded-case circuit breaker. Working distance used was 18 in. (455 mm). Arc gap used was 32 mm for switchgear and 25 mm for MCC and protective device type 0 for all. When 0.33 or 0.5 second trip time was used, that indicated a LVPCB (drawout circuit breaker) in switchgear. Working distance was 24 in. (610 mm). Arc gap used was 32 mm and protective device type 0 for all. All numbers were rounded up or down depending on closest multiple of 5.</p> <p>(6) For power systems from 1 kV to 38 kV the arc flash boundary was determined by using the following information: No maximum values were given in the 2009 edition of NFPA 70E for short-circuit current or operating time. Two sets of equations were performed: 35 kA AIC and 0.2 second operating time and 26 kA AIC and 0.2 second operating time. 0.2 seconds was used by adding the typical maximum total clearing time of the circuit</p>	<p>reduction to no less than PPE Category 1 and include information on current-limiting circuit breakers. Revised arc flash boundary distances to be in conformance with the <i>NEC Manual of Style</i>. Additional text and other editorial revisions were made for clarity.</p> <p>Safety Impact: As safe or safer.</p>

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	<p>breaker to an estimated value for relay operation. This coincides with the IEEE 1584 values of 0.18 second operating time and 0.08 tripping time rounded off. A short-circuit current of 35 kA was used as a maximum (HRC-4 @ 40 cal/cm²) and 26 kA was used to compare the effects of lowering the short circuit current (HRC-4 @ 30 cal/cm²). Working distance used was 36 in. (909 mm), arc gap was 6 in. (155 mm), and protective device type 0 for all.</p> <p><u>(AC Table) Note: For equipment rated 600 volts and below, and protected by upstream current-limiting fuses or current limiting circuit breakers sized at 200 amperes or less, the hazard/risk arc flash PPE category can be reduced by one number but not below arc flash PPE category 1.</u></p> <p><u>(DC Table) Note: Apparel that can be expected to be exposed to electrolyte must meet both of the following conditions:</u></p> <p><u>(1) Be evaluated for electrolyte protection in accordance with ASTM F1296, <i>Standard Guide for Evaluating Chemical Protective Clothing</i></u></p> <p><u>(2) Be arc-rated in accordance with ASTM F1891, <i>Standard Specification for Arc Rated and Flame Resistant Rainwear, or equivalent</i></u></p>	
Table 130.7(C)(16):	<p>Table 130.7(C)(16) Protective Clothing and Personal Protective Equipment (PPE)</p> <p><i>Hazard/Risk Category 0</i></p> <p><i>Hazard/Risk PPE Category</i></p> <p><u>(3) If rubber insulating gloves with leather protectors <u>are required by Table 130.7(C)(15)(a) and Table 130.7(C)(15) used</u>, additional leather or arc-rated gloves are not required. The combination of rubber</u></p>	<p>Change: Deleted the phrase <i>Protective Clothing and</i> from title and the reference to <i>hazard/risk category 0</i>. Additional editorial changes made for clarity.</p> <p>Safety Impact: As safe or safer.</p>

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	insulating gloves with leather protectors satisfies the arc flash protection requirement.	
Section 130.7(D)(1)	<p>(1) Insulated Tools and Equipment. Employees shall use insulated tools or handling equipment, or both, when working inside the limited-restricted approach boundary of exposed energized electrical conductors or circuit parts where tools or handling equipment might make accidental contact. Table 130.7(C)(15)(a) and Table 130.7(C)(15)(b) provide further information for tasks that require insulated and insulating hand tools. Insulated tools shall be protected from damage to the insulating material.</p> <p>(b) Fuse or <u>Fuseholder Fuse Holding Handling</u> Equipment. Fuse or fuseholder handling equipment, insulated for the circuit voltage, shall be used to remove or install a fuse if the fuse terminals are energized.</p>	<p>Change: Moved shock hazard for qualified worker to restricted boundary by changing the term <i>limited</i> to <i>restricted</i>. Changed the phrase <i>Fuse Holding</i> to <i>Fuseholder Handling</i>. Deleted references to Table 130.7(C)(15)(a) and Table 130.7(C)(15)(b) for tasks that require insulated and insulating hand tools.</p> <p>Safety Impact: As safe or safer</p> <p>Changing from the “limited” to “restricted” approach boundary aligns with the requirement in 130.4(D) that prohibits a qualified person from approaching or taking any conductive object closer to exposed energized electrical conductors or circuit parts operating at 50 volts or more closer than the restricted approach boundary.</p>
Section 130.7(E)(2)	<p>(2) Barricades. Barricades shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas containing energized conductors or circuit parts. Conductive barricades shall not be used where it might cause-increase the likelihood of exposure to an electrical hazard. Barricades shall be placed no closer than the limited approach boundary given in Table 130.4(D)(C)(a) and Table 130.4(D)(C)(b). <u>Where the arc flash boundary is greater than the limited approach boundary, barricades shall not be placed closer than the arc flash boundary.</u></p>	<p>Change: Replaced the term <i>cause</i> with the phrase <i>increase the likelihood of exposure to</i>. (Conductive objects do not cause injury or damage to health; rather, they increase the likelihood of exposure to injury or damage to health.) Clarified distance for barricade is greater of limited approach boundary or arc flash boundary.</p> <p>Safety Impact: As safe or safer.</p>
Section 130.7(F)	<p>Table 130.7(F) Standards for Other Protective Equipment Other protective equipment required in 130.7(D) shall conform to the standards given in Table 130.7(F).</p>	<p>Change: Revised to update edition dates and titles.</p> <p>Safety Impact: As safe or safer (Editorial)</p>
Section 130.8	<p>130.8 Work Within the Limited Approach Boundary or Arc Flash Boundary of Uninsulated Overhead Lines.</p>	<p>Change: Deleted the term <i>Uninsulated</i> from title.</p> <p>Safety Impact: As safe or safer.</p>

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Section 130.8(E) and (F)	(E) Approach Distances for Unqualified Persons. When unqualified persons are working on the ground or in an elevated position near overhead lines, the location shall be such that the employee and the longest conductive object the employee might contact do not come closer to any unguarded, energized overhead power line than the limited approach boundary in Table 130.4 (C) (D)(a), column 2 or Table 130.4 (C) (D)(b), column 2.	Change: Changed table references from Table 130.4(C)(a) to Table 130.4(D)(a) and Table 130.4(C)(b) to Table 130.4(D)(b). Safety Impact: As safe or safer (Editorial)
Section 130.9	110.5 130.9 Underground Electrical Lines and Equipment. Before excavation starts where there exists a reasonable possibility of contacting electrical lines or equipment, the employer shall take the necessary steps to contact the appropriate owners or authorities to identify and mark the location of the electrical lines or equipment. When it has been determined that a reasonable possibility of contacting electrical lines or equipment exists, a hazard analysis shall be performed to identify appropriate safe work practices <u>and PPE</u> shall be used during the excavation.	Change: Relocated former 110.5 to 130.9 for underground electrical lines. Deleted requirement to perform a hazard analysis to identify appropriate work practices. The phrase (<i>PPE</i>) was added. Safety Impact: As safe or safer. The 2012 70E requirement to perform a hazard analysis for this type of work is addressed in 2015 edition Section 130.3 which requires identification of electrical hazards and appropriate safety-related work practices based on shock and arc flash risk assessments.
Section 130.10	130.10 Cutting or Drilling. <u>Before cutting or drilling into equipment, floors, walls, or structural elements where a likelihood of contacting energized electrical lines or parts exists, the employer shall perform a risk assessment to:</u> (1) <u>Identify and mark the location of conductors, cables, raceways, or equipment</u> (2) <u>Create an electrically safe work condition</u> (3) <u>Identify safe work practices and PPE to be used</u>	Change: Added section <i>Cutting and Drilling</i> with new requirements regarding penetrating a floor, wall, or equipment to address penetration through walls or floors into a space that contains possible unknown electrical hazards. Safety Impact: As safe or safer.
Article 200 – Introduction		
Section 200.1 Informational Note:	Scope. Informational Note: Refer to NFPA 70B, <i>Recommended Practice for Electrical Equipment Maintenance</i> ; ANSI/NETA MTS, <i>Standard for Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems</i> ; and IEEE 3007.2, <i>IEEE</i>	Change: Added IEEE 3007.2, <i>Recommended Practice for the Maintenance of Industrial and Commercial Power Systems</i> , for a more complete list of applicable safety standards. Safety Impact: As safe or safer.

2015 NFPA 70E Article or Section	Added or Deleted Text <u>Underlined</u> text is added. Strikethrough indicates deleted text.	Change Description Impact to Worker Safety
	<u>Recommended Practice for the Maintenance of Industrial and Commercial Power Systems</u> , for guidance on maintenance frequency, methods, and tests.	
Article 205 – General Maintenance Requirements		
Section 205.3	<p>205.3 General Maintenance Requirements. Electrical equipment shall be maintained in accordance with manufacturers' instructions or industry consensus standards to reduce the risk associated with of failure and the subsequent exposure of employees to electrical hazards. <u>The equipment owner or the owner's designated representative shall be responsible for maintenance of the electrical equipment and documentation.</u></p> <p><u>Informational Note: Common industry practice is to apply test or calibration decals to equipment to indicate the test or calibration date and overall condition of equipment that has been tested and maintained in the field. These decals provide the employee immediate indication of last maintenance date and if the tested device or system was found acceptable on the date of test. This local information can assist the employee in the assessment of overall electrical equipment maintenance status.</u></p>	<p>Change: Replaced the phrase <i>risk of failure and the subsequent exposure of employees</i> with <i>risk associated with failure</i>. Added language to indicate that the <i>equipment owner or the owners designated representative</i> is responsible for maintenance of the electrical equipment and documentation for consistency with other NFPA standards such as <i>NFPA 72®</i>, <i>National Fire Alarm and Signaling Code</i>.</p> <p>Safety Impact: As safe or safer</p>
Section 205.7	<p>205.7 Guarding of Energized Conductors and Circuit Parts. Enclosures shall be maintained to guard against accidental contact with energized conductors and circuit parts and other electrical hazards. <u>Covers and doors shall be in place with all associated fasteners and latches secured.</u></p>	<p>Change: Added new text regarding covers and doors.</p> <p>Safety Impact: As safe or safer.</p> <p>Proper maintenance of electrical equipment may improve safety of workers and reduce fire hazards in facilities.</p>
Section 205.13	<p>205.13 Single and Multiple Conductors and Cables. Electrical cables and single and multiple conductors shall be maintained free of damage, shorts, and ground that would present a hazard to <u>expose employees to an electrical hazard.</u></p>	<p>Change: Replaced the phrase <i>present a hazard to employees</i> with <i>expose employees to an electrical hazard</i> to provide clarity and consistency with other safety standards that address hazard, risk, and risk assessment.</p> <p>Safety Impact: As safe or safer</p>
Section 205.14	<p>205.14 Flexible Cords and Cables. Flexible cords and cables shall be maintained to avoid strain and</p>	<p>Change: Replaced the phrase <i>that to avoid strain and damage</i> with <i>preserve insulation Integrity</i> to clarify the intent that insulation</p>

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	damage <u>preserve insulation integrity.</u>	integrity be maintained regardless of the source of potential harm or physical damage. Safety Impact: As safe or safer
Section 205.14(1)	(1) Damaged Cords and Cables. Cords and cables shall not have worn, frayed, or damaged areas that present an electrical hazard to employees would expose <u>employees to an electrical hazard.</u>	Change: Replaced the phrase <i>that present an electrical hazard to employees</i> with <i>that would expose employees to an electrical hazard</i> to provide clarity and consistency with other safety standards that address hazard, risk, and risk assessment. Damages to the items listed do not present a source of harm; rather, they expose the person to a source of harm. Safety Impact: As safe or safer.
Section 205.14(3)	(3) Repair and Replacement. <u>Cords and cord caps for portable electrical equipment shall be repaired and replaced by qualified personnel and checked for proper polarity, grounding, and continuity prior to returning to service.</u>	Change: Added a requirement to clarify that cord replacements and cord repairs to electrical equipment be performed by a knowledgeable qualified person and tested to ensure proper configuration. Safety Impact: As safe or safer
Section 205.15	205.15 Overhead Line Clearances. <u>For overhead electric lines under the employer's control, grade elevation shall be maintained to preserve no less than the minimum designed vertical and horizontal clearances necessary to minimize risk of unintentional contact.</u>	Change: Added a requirement to clarify that maintaining proper clearance of overhead conductors is critical to the prevention of unintentional contact. Safety Impact: As safe or safer This may improve safety of workers.
Article 210 – Substation, Switchgear Assemblies, Switchboards, Panelboards, Motor Control Centers, and Disconnect Switches		
Section 210.1	210.1 Enclosures. Enclosures shall be kept free of material that would create a hazard <u>expose employees to an electrical hazard.</u>	Change: Replaced the phrase “ <i>create an electrical hazard</i> ” with “ <i>expose employees to an electrical hazard</i> ” to provide clarity and consistency with other safety standards that address hazard. (Material in enclosures does not create a source of injury or damage to health; rather, it exposes the person to a source of harm.)
Section 210.5 Informational Note	Informational Note: Failure to properly maintain protective devices can have an adverse effect on the <u>arc flash hazard analysis incident energy values. Improper or inadequate maintenance can result in increased opening time of the overcurrent protective device, thus increasing the incident energy.</u>	Change: Revised to provide clarity and consistency with other Safety standards that address hazard, risk, and risk assessment. Safety Impact: As safe or safer
Article 225 – Fuses and Circuit Breakers		
Section 225.1	225.1 Fuses. Fuses shall be maintained free of breaks or cracks in fuse cases, ferrules, and insulators. Fuse clips	Change: Added a new last sentence: <i>Non-current limiting fuses shall not be modified to allow their insertion into current-limiting fuseholders.</i>

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	shall be maintained to provide adequate contact with fuses. Fuseholders for current-limiting fuses shall not be modified to allow the insertion of fuses that are not current-limiting. <u>Non-current limiting fuses shall not be modified to allow their insertion into current-limiting fuseholders.</u>	Safety Impact: As safe or safer
Article 250 – Personal Safety and Protective Equipment		
Section 250.1	<p>250.1 Maintenance Requirements for Personal Safety and Protective Equipment.</p> <p>Personal safety and protective equipment such as the following shall be maintained in a safe working condition:</p> <ul style="list-style-type: none"> (1) Grounding equipment (2) Hot sticks (3) Rubber gloves, sleeves, and leather protectors (4) Voltage Test indicators <u>instruments</u> (5) Blanket and similar insulating equipment (6) Insulating mats and similar insulating equipment (7) Protective barriers (8) External circuit breaker rack-out devices (9) Portable lighting units (10) <u>Temporary protective</u> Safety grounding equipment (11) Dielectric footwear (12) Protective clothing (13) Bypass jumpers (14) Insulated and insulating hand tools 	<p>Change: Replaced item (4) <i>voltage test indicators</i> with <i>test instruments</i> and item (10) <i>safety grounding equipment</i> with <i>temporary protective grounding equipment</i>.</p> <p>Safety Impact: As safe or safer</p>
Section 250.2(B)	<p>(B) Testing. The insulation of protective equipment and protective tools, such as items specified in 250.1(1) through 250.1 (14), <u>that is used as primary protection from shock hazards and requires an insulation system to ensure protection of personnel,</u> shall be verified by the appropriate test and visual inspection to ascertain that insulating capability has been retained before initial use, and at intervals thereafter, as service conditions and applicable standards and instructions require, but in no case shall the interval exceed 3</p>	<p>Change: Added the phrase <i>that is used as primary protection from shock hazards and requires an insulation system to ensure protection of personnel</i> to the first sentence.</p> <p>Deleted the reference to ASTM standards.</p> <p>Safety Impact: As safe or safer</p>

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	years, unless specified otherwise by the respective ASTM standards.	
Section 250.4	<u>250.4 Test Instruments.</u> <u>Test instruments and associated test leads used to verify the absence or presence of voltage shall be maintained to assure functional integrity. The maintenance program shall include functional verification as described in 110.4(A)(5).</u>	Change: Added a new requirement for the maintenance of test instruments used for the verification of the absence or presence of voltage. Safety Impact: As safe or safer
Article 310 – Safety-Related Work Practices for Electrolytic Cells		
Article 310 – Safety-Related Work Practices for Electrolytic Cells	Note: The changes in this section are not evaluated.	
Article 320 – Safety Requirements Related to Batteries and Battery Rooms		
Section 320.2 Definitions	<u>Prospective Fault Current Short-Circuit Current.</u> The highest level of fault current that can occur <u>could theoretically occur</u> 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.	Change: Changed the name of the term from <i>Prospective Fault Current</i> to <i>Prospective Short-Circuit Current</i> to promote consistent use of terminology throughout the standard. Replaced the phrase <i>that can occur</i> with <i>that could theoretically occur</i> Safety Impact: As safe or safer
Section 320.3(A)(1)	<u>(1) Battery Risk Assessment.</u> Prior to any work on a battery system, a risk assessment shall be performed to identify the chemical, electrical, shock, and arc flash hazards and assess the risks associated with the type of tasks to be performed. <u>(1) (2) Battery Room or Enclosure Requirement</u>	Change: Added a new requirement for a risk assessment associated with battery work. Safety Impact: As safe or safer
Section 320.3(A)(4)	<u>(3) (4) Abnormal Battery Conditions.</u> Instrumentation that provides alarms for early warning of the following abnormal conditions of battery operation, if present, shall be tested yearly <u>annually</u> : For vented cells: a. Overvoltage b. Undervoltage c. Overcurrent d. Ground fault For VRLA a. Overvoltage b. Undervoltage c. Overcurrent d. Ground current	Change: Revised previous 320.3(A)(3) to simplify the requirement for annual testing of battery alarm functionality. Add new informational note to provide source of guidance on battery monitoring systems. Safety Impact: As safe or safer

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	<p>e. Overtemperature, as measured at the pilot cell</p> <p><u>Informational Note: Battery monitoring systems typically include alarms for such conditions as overvoltage, undervoltage, overcurrent, ground fault, and over-temperature. The type of conditions monitored will vary depending upon the battery technology. One source of guidance on monitoring battery systems is IEEE 1491, <i>Guide for the Selection and Use of Battery Monitoring Equipment in Stationary Applications.</i></u></p>	
Section 320.3(A)(5)	<p>Warning Signs. (4) (5) (1) Electrical hazard warnings indicating the shock hazard due to the battery voltage and the arc flash hazard due to the prospective short-circuit current, <u>and the thermal hazard.</u></p> <p><u>Informational Note No. 2: See 130.5(D) for requirements for equipment labeling.</u></p>	<p>Change: Revised former 320.3(A)(4)(1) by adding <i>flash hazard</i>. Added the phrase <i>and thermal hazards</i> to the end of the sentence.</p> <p>Added Informational Note 2 for labeling guidance.</p> <p>Safety Impact: As safe or safer</p>
Section 320.3(B)(1)	<p>(1) Batteries with Liquid Electrolyte <u>Battery Activities That Include Handling of Liquid Electrolyte.</u> The following protective equipment shall be available to employees performing any type of service on a battery with liquid electrolyte:</p> <p>(1) Goggles and face shield appropriate for the electrical hazard and the chemical hazard</p> <p>(2) Gloves and aprons appropriate for the chemical hazards</p> <p>(3) Portable or stationary water facilities <u>eye wash facilities within the work area that are capable of drenching or flushing of the eyes and body for the duration necessary to the hazard within the work area.</u></p> <p><u>Informational Note: Guidelines for the use and maintenance of eye wash facilities for vented batteries in non-telecom environments can be found in ANSI/ISEA Z358.1, <i>American National Standard for Emergency Eye Wash and Shower Equipment.</i></u></p>	<p>Change: Changed title from <i>Batteries with Liquid Electrolyte</i> to <i>Battery Activities That Include Handling of Liquid Electrolyte</i>. Provided requirements for capacity of eye wash facilities by introducing the concept that the duration of the flushing should be specified by the electrolyte or battery manufacturer.</p> <p>Safety Impact: As safe or safer</p>
Section 320.3(B)(2)	<p>(2) Batteries with Solid or Immobilized Electrolyte <u>Activities That Do Not Include Handling of</u></p>	<p>Change: Changed the title from <i>Batteries with Solid or Immobilized Electrolyte</i> to <i>Activities That Do Not Include Handling of Electrolyte</i>.</p>

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	<p><u>Electrolyte.</u> <u>Employees performing any activity not involving the handling of electrolyte shall wear safety glasses.</u> The following protective equipment shall be available to employees performing any type of service on a nonspillable battery with solid or immobilized electrolyte:</p> <ul style="list-style-type: none"> (1) Goggles or face shield appropriate for the electrical hazard (2) Gloves appropriate for the electrical and chemicals hazards (3) Protective clothing appropriate for electrical hazard <p><u>Informational Note: Battery maintenance activities usually do not involve handling electrolyte. Batteries with solid electrolyte (such as most lithium batteries) or immobilized electrolyte (such as valve-regulated lead acid batteries) present little or no electrolyte hazard. Most modern density meters expose a worker to a quantity of electrolyte too minute to be considered hazardous, if at all. Such work would not be considered handling electrolyte. However, if specific gravity readings are taken using a bulb hydrometer, the risk of exposure is higher — this could be considered to be handling electrolyte, and the requirements of 320.3(B)(1) would apply.</u></p>	<p>Added informational note to clarify when PPE should be considered.</p> <p>Safety Impact: As safe or safer</p>
Section 320.3(C)	<p>Testing, Maintenance and Operation. (1) Battery Short-Circuit Current. The battery manufacturer shall be consulted regarding the sizing of the battery short-circuit protection and for battery short-circuit current values.</p>	<p>Change: Deleted former subdivision (1) for being redundant with 320.3(A).</p> <p>Safety Impact: As safe or safer (Editorial)</p>
Section 320.3(C)(2)(c)	<p>(3) (2) Tools and Equipment. (a) Tools and equipment for work on batteries shall be equipped with handles listed as insulated for the maximum working voltage. (b) Battery terminals and all electrical conductors shall be kept clear of unintended contact with</p>	<p>Change: Replaced the phrase <i>hazard identification and risk assessment</i> with <i>risk assessment</i>.</p> <p>Safety Impact: As safe or safer</p>

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	tools, test equipment, liquid containers, and other foreign objects. (c) Non-sparking tools shall be required when the hazard identification and risk assessment required by 110.17(F) justifies their use.	
Section 320.3(D)	(D) Cell Flame Arresters and Cell Ventilation. <u>When present, battery cell ventilation openings shall be unobstructed, and cell flame arresters shall be maintained.</u> (E) Battery Cell flame arresters shall be inspected for proper installation and unobstructed ventilation and <u>shall be replaced when necessary in accordance with the manufacturer's instructions.</u>	Change: Combined former sections 320.3(D) and 320.3(E). Added requirement for cell flame arresters to be replaced when necessary. Safety Impact: As safe or safer
Article 330 – Safety Related Work Practices for use of Lasers		
Section 330.2 – Definitions	Fail Safe. The design consideration in which failure of a component does not <u>create additional hazards or increased risk.</u> In the failure mode, the system is rendered inoperative or nonhazardous.	Change: Replaced the phrase <i>increase the hazard with create additional hazards or increased risk</i> to clarify and promote the consistent use of terminology associated with hazard and risk. Safety Impact: As safe or safer.
Section 330.3(B)(2)(b)	Scope of Training. (B)(2) Laser safety, including the following: a. System operating procedures b. Hazard control procedures <u>Risk assessment and risk control procedures</u> c. Need for personnel protection...	Change: Replaced the phrase <i>hazard control procedures</i> with <i>risk assessment, and risk control procedures</i> to provide clarity and consistency with the definitions of hazard, risk, and risk assessment and with risk management principles. (Hazards are identified, whereas risk is assessed and controlled.) Safety Impact: As safe or safer.
Section 330.3(C)	(C) Proof of Qualification. Proof of qualification of the laser equipment operator shall be available and in possession of the operator at all times <u>readily available.</u>	Change: Replaced the phrase <i>available and in possession of the operator at all times</i> with <i>readily available</i> to clarify that the operator need only provide proof of qualification while outside the zone where the risk of hazard could exist. Safety Impact: As safe or safer.
Article 340 – Safety-Related Work Practices: Power Electronic Equipment		

2015 NFPA 70E Article or Section	Added or Deleted Text <u>Underlined</u> text is added. Strikethrough indicates deleted text.	Change Description Impact to Worker Safety
Section 340.5	<p>340.5 Hazardous Effects of Electricity on the Human Body.</p> <p>(1) b At 10 mA, a person may not be able to voluntarily let go of the hazard <u>an energized electrical conductor or circuit part.</u></p> <p>(1) c. At about 40 mA, the shock, if lasting for 1 second or longer, may <u>can</u> be fatal due to ventricular fibrillation.</p> <p>(2) b. A dc current of 40 <u>40</u> mA is considered the threshold of the let-go current.</p> <p>(7) Effects of Capacitive Discharge:</p> <p>a. A circuit of capacitance of 1 <u>μF</u> microfarad having a 10 kV capacitor charge may <u>can</u> cause ventricular fibrillation.</p> <p>b. A circuit of capacitance of 20 <u>μF</u> microfarad having a 10 kV capacitor charge may <u>can</u> be dangerous and probably will cause ventricular fibrillation.</p>	<p>Change: Deleted the term <i>Hazardous</i> from the title. Replaced <i>10 mA</i> with <i>40 mA</i>, <i>may</i> with <i>can</i>, and <i>microfarad</i> with μF</p> <p>Safety Impact: As safe or safer</p> <p>The 40mA threshold for let-go current is consistent with the DC shock hazard threshold established in the DOE Electrical Safety Handbook DOE-HDBK-1092-2013, Appendix D, Table D-1.</p>
Section 340.5	<p>Effects of DC Current. (1) Results <u>Effects</u> of Power Frequency Current (2) Results <u>Effects</u> of Direct Current: (3) Results <u>Effects</u> of Voltage (4) Results <u>Effects</u> of Short Contact (5) Results <u>Effects</u> of Alternating Current in Frequencies Above 100 Hz.</p>	<p>Change: Replaced the term <i>result</i> with <i>effects</i> in the title to help clarify the main title from the subsection titles and to provide consistency with the rest of the standard and risk assessment principles.</p> <p>Safety Impact: As safe or safer</p>
Section 340.7(A)	<p>(A) Employer Responsibility. The employer shall be responsible for the following:</p> <p>(1) Proper training and supervision by properly qualified personnel, including the following:</p> <p>a. Nature <u>Identification</u> of associated hazards</p> <p>b. Strategies to minimize <u>reduce the risk associated with</u> the hazards</p> <p>c. Methods of avoiding or protecting against the hazard</p> <p>d. Necessity of reporting any hazardous incident that resulted in, <u>or could have resulted in, injury or damage to health</u></p>	<p>Change: Replaced <i>nature</i> with <i>identification</i>; <i>hazard</i> with <i>hazards</i>; <i>minimize the hazard</i> with <i>reduce the risk associated with the hazards</i>; and <i>hazardous incident</i> with <i>incident that resulted in, or could have resulted in, injury or damage to health</i>. These changes clarify and promote the consistent use of terminology associated with hazard and risk.</p> <p>Safety Impact: As safe or safer</p>

2015 NFPA 70E Article or Section	Added or Deleted Text <u>Underlined</u> text is added. Strikethrough indicates deleted text.	Change Description Impact to Worker Safety
Section 340.7(B)	<p>(B) Employee Responsibility. The employee is <u>shall be</u> responsible for the following:</p> <p>(1) Understanding the hazards associated with the work</p> <p>(2) Being continuously alert and aware of the possible hazards</p> <p>(3) Using the proper tools and procedures for the work</p> <p>(4) Informing the employer of malfunctioning protective measures, such as faulty or inoperable enclosures and locking schemes</p> <p>(5) Examining all documents provided by the employer relevant to the work, especially those documents indicating the hazardous components <u>location of components that present an electrical hazard</u></p> <p>(6) Maintaining good housekeeping around the equipment and work space</p> <p>(7) Reporting any hazardous incident that resulted in, or could <u>have resulted in, injury or damage to health</u></p> <p>(8) Using and appropriately maintaining the PPE and tools required to perform the work safely</p>	<p>Change: Replaced <i>is</i> with <i>shall be</i>; <i>hazardous components location</i> with <i>location of components that present an electrical hazard</i>; and <i>hazardous incident</i> with <i>incident that resulted in, or could have resulted in, injury or damage to health</i>. These changes clarify and promote the consistent use of terminology associated with hazard and risk.</p> <p>Safety Impact: As safe or safer</p>
Article 350 – Safety-Related Work Requirements: Research and Development Laboratories		
Sections 350.2	<p>Competent Person. A person meeting who meets <u>meeting who meets</u> all the requirements of <i>qualified person</i>, as defined in Article 100 in Chapter 1 of this document standard <u>and who</u>, in addition, is responsible for all work activities or safety procedures related to custom or special equipment and has detailed knowledge regarding the electrical hazard exposure to electrical hazards, the appropriate control for mitigating methods to reduce the risk associated with those hazards, and the implementation of those controls <u>methods</u>.</p>	<p>Change: Replaced <i>meeting</i> with <i>who meets</i>; <i>electrical hazard exposure</i> with <i>exposure to electrical hazards</i>; and <i>controls for mitigating those hazards</i> with <i>control methods to reduce the risk associated with</i>. These changes clarify and promote the consistent use of terminology associated with hazard and risk and risk assessment, and with risk management principles. (Hazards are identified, whereas risk is assessed and controlled by following a hierarchy of risk control methods.)</p> <p>Safety Impact: As safe or safer</p>
Informative Annexes		
<p>Informative Annex A – Referenced Publications</p> <p>Informative Annex B –</p>	<p>(Annex material is not mandatory. Only major changes in the Annex are listed in this evaluation.)</p> <p>A.1 General. The documents or portions thereof listed in</p>	<p>A.1: Replaced the phrase <i>shall be</i> with <i>are to be</i> to remove a requirement from the annex. Updated all references to reflect the current revision dates.</p> <p>A.2: Updated <i>NFPA 70®</i>, <i>National Electrical Code®</i>, reference to the current edition.</p>

2015 NFPA 70E Article or Section	Added or Deleted Text <u>Underlined</u> text is added. Strikethrough indicates deleted text.	Change Description Impact to Worker Safety
<p>Informational References</p> <p>Informative Annex C – Limits of Approach</p> <p>Informative Annex D – Incident Energy and Arc Flash Boundary Calculation Methods</p> <p>Informative Annex E – Electrical Safety Program</p> <p>Informative Annex F – Hazard Analysis, Risk Estimation, and Risk Evaluation Procedure</p> <p>Informative Annex G – Sample Lockout/Tagout Procedure</p> <p>Informative Annex H – Guidance on Selection of Protective Clothing and other Personal Protective Equipment</p> <p>Informative Annex I – Job Briefing and Planning Checklist</p> <p>Informative Annex J – Energized Electrical Work Permit</p>	<p>this annex are referenced within this standard and shall be considered part of the requirements of this document. <u>This informative annex is not part of the requirements of this document and is included for information only. To the extent the documents or portions thereof listed in this informative annex are referenced within this standard, those documents are to be considered part of the requirements of this document in the section and manner in which they are referenced.</u></p> <p>A.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471. <i>NFPA 70®</i>, <i>National Electrical Code®</i>, 2014 <u>2014</u> edition.</p> <p>A.3.5 IEEE Publications. Institute of Electrical and Electronics Engineers, IEEE Operations Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331.</p> <p>IEEE C37.20.7, <i>Guide for Testing Metal-Enclosed Switchgear Rated up to 38 kV for Internal Arcing Faults</i>, 2007/Corrigendum 1, 2010.</p> <p>IEEE 1584, <i>Guide for Performing Arc Flash Calculations</i>, 2002.</p> <p>A.4 References for Extracts in Mandatory Sections.</p> <p><i>NFPA 70®</i>, <i>National Electrical Code®</i>, 2011 edition.</p> <p>NFPA 101®, <i>Life Safety Code®</i>, 2012 edition.</p> <p>B.1.2 <u>ANSI C84.1, <i>Electric Power Systems and Equipment – Voltage Ratings (60 Hz)</i>, 2011.</u></p> <p>B.1.3 <u>ASTM F1449, <i>Standard Guide for Industrial Laundering of Flame, Thermal, and Arc Resistant</i></u></p>	<p>A.3.2: Updated references to the most current editions.</p> <p>Added ASTM F1449, <i>Standard Guide for Industrial Laundering of Flame, Thermal, and Arc Resistant Clothing</i>, 2008.</p> <p>Added ASTM F2412/F2320, <i>Standard Specification for Rubber Insulating Sheeting</i>, 2011.</p> <p>Added ASTM F2757, <i>Standard Guide for Home Laundering Care and Maintenance of Flame, Thermal and Arc Resistant Clothing</i>, 2009.</p> <p>A.3.5: Deleted the reference to IEEE 1584, <i>Guide for Performing Arc Flash Calculations</i>, because it is no longer referenced in the requirements.</p> <p>A.4: Deleted the reference to NFPA 101®, <i>Life Safety Code®</i>, because it is not included within <i>NFPA 70E®</i>, <i>Standard for Electrical Safety in the Workplace®</i>.</p> <p>B.1: Updated all references to the most current editions.</p> <p>B.1.2 ANSI Publications</p> <p>Added ANSI C84.1, <i>Electric Power Systems and Equipment – Voltage Ratings (60 Hz)</i>, 2011.</p> <p>B.1.3 ASTM Publications</p> <p>Added ASTM F1449, <i>Standard Guide for Industrial Laundering of Flame, Thermal, and Arc Resistant Clothing</i>, 2008.</p> <p>Added ASTM F1959/F1959M, <i>Standard Test Method for Determining the Arc Rating of Materials for Clothing</i>, 2012.</p> <p>Added ASTM F2757, <i>Standard Guide for Home Laundering Care and Maintenance of Flame, Thermal and Arc Resistant Clothing</i>, 2009.</p> <p>B.1.5 CSA Publications</p>

2015 NFPA 70E Article or Section	Added or Deleted Text Underlined text is added. Strikethrough indicates deleted text.	Change Description Impact to Worker Safety
<p>Informative Annex K – General Categories of Electrical Hazards</p>	<p><u>Clothing, 2008.</u></p> <p><u>ASTM F1959/F1959M, Standard Test Method for Determining the Arc Rating of Materials for Clothing, 2012.</u></p>	<p>Added CAN/CSA Z462, <i>Workplace Electrical Safety, 2012.</i> and CAN/CSA Z1000, <i>Occupational Health and Safety Management, 2006 (R 2011).</i></p> <p>B.1.7: Added new IEEE standards supporting the implementation of <i>NFPA 70E</i>, <i>Standard for Electrical Safety in the Workplace</i>, requirements.</p>
<p>Informative Annex L –Typical Application of Safeguards in the Cell Line Working Zone</p>	<p><u>ASTM F2757, Standard Guide for Home Laundering Care and Maintenance of Flame, Thermal and Arc Resistant Clothing, 2009.</u></p> <p>B.1.5 CAN/CSA Z462, <i>Workplace Electrical Safety, 2012.</i></p>	<p>Moved IEEE papers that were previously located in the Other Publications subsection to a more appropriate location, the <i>IEEE Publications</i> subsection.</p>
<p>Informative Annex M – Layering of Protective Clothing and Total System Arc Rating</p>	<p>CAN/CSA Z1000, <i>Occupational Health and Safety Management, 2006 (R 2011).</i></p> <p>B.1.7</p>	<p>Added IEEE 946, <i>IEEE Recommended Practice for the Design of DC Auxiliary Power Systems for Generating Systems, 2004.</i></p> <p>Added IEEE 1491, <i>IEEE Guide for Selection and Use of Battery Monitoring Equipment in Stationary Applications, 2012.</i></p>
<p>Informative Annex N – Example Industrial Procedures and Policies for Working Near Overhead Electrical Lines and Equipment</p>	<p><u>IEEE 946, IEEE Recommended Practice for the Design of DC Auxiliary Power Systems for Generating Systems, 2004.</u></p> <p><u>IEEE 1491, IEEE Guide for Selection and Use of Battery Monitoring Equipment in Stationary Applications, 2012.</u></p>	<p>Added IEEE 1584b™, <i>Guide for Performing Arc Flash Hazard Calculations — Amendment 2: Changes to Clause 4, 2011.</i></p> <p>Added IEEE 3007.1, <i>IEEE Recommended Practice for the Operation and Management of Industrial and Commercial Power Systems, 2010.</i></p>
<p>Informative Annex O – Safety-Related Design Requirements</p>	<p><u>IEEE 1584b™, Guide for Performing Arc Flash Hazard Calculations — Amendment 2: Changes to Clause 4, 2011.</u></p> <p><u>IEEE 3007.1, IEEE Recommended Practice for the Operation and Management of Industrial and Commercial Power Systems, 2010.</u></p>	<p>Added IEEE 3007.2, <i>IEEE Recommended Practice for the Maintenance of Industrial and Commercial Power Systems, 2010.</i></p> <p>Added IEEE 3007.3, <i>IEEE Recommended Practice for Electrical Safety in Industrial and Commercial Power Systems, 2012.</i></p>
<p>Informative Annex P – Aligning Implementation of This Standard with Occupational Health and Safety Management Standards</p>	<p><u>IEEE 3007.2, IEEE Recommended Practice for the Maintenance of Industrial and Commercial Power Systems, 2010.</u></p> <p><u>IEEE 3007.3, IEEE Recommended Practice for Electrical Safety in Industrial and Commercial Power Systems, 2012.</u></p>	<p>Added Ammerman, R. F., Gammon, T., Sen, P. K., and Nelson, J. P., “DC-Arc Models and Incident-Energy Calculations,” <i>IEEE Transactions on Industrial Applications</i>, Vol. 46, No. 5, 2010.</p> <p>Added Doan, D. R, “Arc Flash Calculations for Exposures to DC Systems,” <i>IEEE Transactions on Industrial Applications</i>, Vol 46, No. 6, 2010.</p>
	<p><u>Ammerman, R. F., Gammon, T., Sen, P. K., and Nelson, J. P., “DC-Arc Models and Incident- Energy</u></p>	<p>Informative Annex C: Revised text to correlate with the redefined hazard and risk terminology. Deleted C.1.2.4, since the</p>

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	<p><u>Calculations,” <i>IEEE Transactions on Industrial Applications</i>, Vol. 46, No. 5, 2010.</u></p> <p><u>Doan, D. R, “Arc Flash Calculations for Exposures to DC Systems,” <i>IEEE Transactions on Industrial Applications</i>, Vol 46, No. 6, 2010.</u></p> <p>B.1.9 ISEA Publications. <u>International Safety Equipment Association, 1901 North Moore Street, Arlington, VA 22209-1762.</u></p> <p>B.1.13 U.S. Government Publications. <u>Title 29, Code of Federal Regulations, Part 1910, Occupational Safety and Health Standards,</u> <u>Subpart S, Electrical, 1910.137, Personal Protective Equipment, and 1910.305(j)(7), Storage Batteries; and Part 1926, Safety and Health Regulations for Construction, Subpart K,</u> <u>Electrical, 1926.441, Batteries and Battery Charging.</u></p> <p>C.1.2.2 For a person to cross the limited approach boundary and enter the limited space, he or she must a person should meet the following criteria:</p> <p>(1) Be qualified to perform the job/task</p> <p><u>(2) Be able to identify the hazards and associated risks with the tasks to be performed</u></p> <p>C.1.2.3 To cross the restricted approach boundary and enter the restricted space, qualified persons must do the following should meet the following criteria:</p> <p>(1) Have a plan that is documented and approved by an energized electrical work permit authorized by management</p> <p>(2) Use personal protective equipment (PPE) that is appropriate</p>	<p>definition for <i>prohibited approach boundary</i> no longer exists. Corrected 1 kV to 10 kV.</p> <p>C.1.2.2: Revised into list form and replaced the phrase <i>have a plan that identifies</i> with <i>be able to identify</i> in item (2) to better align with 130.4.</p> <p>C.2.1.1: Replaced the reference to ANSI/IEEE C84.1 with ANSI C84.1 for consistency with Informative Annex B.</p> <p>D.1: Rearranged Table D.1 according to the calculation method. Replaced <i>Ralph Lee paper</i> with <i>Lee, “The Other Electrical Hazard: Electrical Arc Flash Burns”</i>; replaced <i>Doughty/Neal paper</i> with <i>Doughty, et al., “Predicting Incident Energy to Better Manage the Electrical Arc Hazard on 600 V Power Distribution Systems”</i>; replaced <i>IEEE Std. 1584</i> with <i>IEEE 1584, Guide for Performing Arc Flash Calculations</i>; and replaced <i>ANSI/IEEE C2 NESC, Section 410, Table 410-1 and Table 410-2</i> with <i>Doan, “Arc Flash Calculations for Exposure to DC Systems.”</i></p> <p>D.2, D.3, D.4, D.5: Sections D.2 through D.8 were renumbered and renamed to span from D.2 through D.5. Redundant text deleted to provide clarity and consistency with other safety standards that address hazard, risk, and risk assessment.</p> <p>D.5.3: Subsection added to assist in calculating short circuit currents for stationary battery systems.</p> <p>Informative Annex E: Updated to correlate with the redefined hazard and risk terminology for consistency with the definitions of <i>hazard</i>, <i>risk</i>, and <i>risk assessment</i>, and with risk management principles (hazards are identified; risk is assessed and controlled by following a hierarchy of risk control methods). Modifications were made in E.2 to provide a more logical sequence of safety program controls.</p> <p>Annex F: Replaced the term <i>probability</i> with <i>likelihood</i> to provide clarity and promote consistent use of the term. (<i>Likelihood</i> can refer to the chance of something happening and includes a probability or a frequency over a given time period.)</p>

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	<p>for working near exposed energized conductors or circuit parts and is rated for the voltage and energy level involved</p> <p>(3) Minimize the risk from inadvertent movement likelihood of bodily contact with exposed energized conductors and circuit parts from inadvertent movement by keeping as much of the body out of the restricted space as possible <u>and</u> using only protected body parts in the space as necessary to accomplish the work</p> <p>(3) Be certain that no part of the body enters the prohibited space</p> <p><u>(4) Use insulated tools and equipment</u></p> <p>D.2.4</p> <p><u>Calculation of Incident Energy Exposure Greater Than 600 V for an Arc Flash Hazard Analysis.</u> <u>The equation that follows can be used to predict the incident energy produced by a three-phase arc in open air on systems rated above 600 V. The parameters required to make the calculations follow.</u></p> <p><u>(1) The maximum bolted fault, three-phase short-circuit current available at the equipment.</u></p> <p><u>(2) The total protective device clearing time (upstream of the prospective arc location) at the maximum short-circuit current. If the total protective device clearing time is longer than 2 seconds, consider how long a person is likely to remain in the location of the arc flash. It is likely that a person exposed to an arc flash will move away quickly if it is physically possible, and 2 seconds is a reasonable maximum time for calculations.</u></p> <p><u>A person in a bucket truck or a person who has crawled into</u></p>	<p>Changed the title of Informative Annex F from <i>Hazard Analysis, Risk Estimation, and Risk Evaluation</i> to <i>Risk Assessment Procedure</i>. (Risk assessment includes hazard analysis, risk estimation, and risk evaluation.)</p> <p>Replaced the term <i>harm</i> with the phrase <i>injury or damage to health</i>.</p> <p>Informative Annex G: Changed text to be consistent with the redefined hazard and risk terminology. Replaced the phrase <i>use of tags and warning signs</i> with <i>alerting techniques</i>, and replaced <i>voltage-detecting instruments</i> with <i>test instruments</i> to clarify and promote the consistent use of terminology associated with hazard and risk.</p> <p>G.13: Deleted item (8) <i>Individual employee control of energy</i>.</p> <p>H.2: Replaced the term <i>hazard/risk category</i> with <i>arc flash PPE category</i>, <i>voltage rated gloves</i> and <i>voltage-rated tools</i> with <i>rubber insulating gloves</i>, assumed with <i>estimated available</i>, and <i>arc flash hazard analysis</i> with <i>arc flash risk assessment</i>. Revised Table H.2 notes to be consistent with terminology used in the rest of the standard and to reflect changes to the new hazard/risk terminology and the new terminology in the PPE Category Tables. Table designations have been revised in the text for correlation.</p> <p>H.3: Replaced the term <i>hazard analysis</i> with <i>risk assessment of electrical hazards</i>, <i>personal protective equipment (PPE)</i> with <i>PPE</i>, and <i>incident exposure</i> with <i>incident energy exposure</i>, to clarify and promote the consistent use of terminology associated with hazard and risk. Editorial changes were made to the table references.</p> <p>Figure J.1: Changed the following text in Part II: (3) <i>Results of the shock hazard analysis</i> to <i>Results of shock risk assessment</i>, previous item (3)(c) <i>Prohibited approach boundary</i> deleted and previous item (3)(d) renumbered as item (3)(c), (4) <i>Results of the arc flash hazard analysis</i> to <i>Results of arc flash risk assessment</i>, and (4)(a) <i>Available incident energy or hazard/risk category</i> to <i>Available incident energy or arc flash PPE category</i>.</p>

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	<p><u>equipment will need more time to move away. Sound engineering judgment must be used in applying the 2-second maximum clearing time, since there could be circumstances where an employee's egress is inhibited.</u></p> <p><u>(3) The distance from the arc source.</u></p> <p><u>(4) Rated phase-to-phase voltage of the system.</u> $E = (793 \times F \times V \times t) / D^2$ <u>where:</u> <u>E = incident energy, cal/cm²</u> <u>F = bolted fault short-circuit current, kA</u> <u>V = system phase-to-phase voltage, kV</u> <u>t = arc duration, sec</u> <u>D = distance from the arc source, in.</u></p> <p><u>D.5.3 Short Circuit Current.</u> <u>The determination of short circuit current is necessary in order to use Table 130.7(C)(15)(b). The arcing current is calculated at 50 percent of the dc short circuit value. The current that a battery will deliver depends on the total impedance of the short-circuit path. A conservative approach in determining the short-circuit current that the battery will deliver at 25°C is to assume that the maximum available short-circuit current is 10 times the 1 minute ampere rating (to 1.75 volts per cell at 25°C and the specific gravity of 1.215) of the battery. A more accurate value for the short-circuit current for the specific application can be obtained from the battery manufacturer.</u></p> <p><u>Reference</u> <u>1. IEEE 946, Recommended Practice for the Design of DC Auxiliary Powers Systems for Generating Stations.</u></p> <p><u>Annex G</u></p>	<p>K.4: Replaced 1600 km/hr with 1120 km/hr to correct a mathematical error from the previous edition.</p> <p>Informative Annex L: Replaced the phrase <i>hazardous condition(s)</i> with <i>electrical hazard(s)</i> throughout annex.</p> <p>L.1: Deleted the phrase <i>the hazardous electrical condition will be removed</i> from items (5) and (7) to promote the consistent use of terminology associated with hazard and risk.</p> <p>O.1.2: Replaced the phrase <i>eliminate or reduce exposure risks</i> with <i>eliminate hazards or reduce risk</i>, for consistency with other safety-related standards that address hazard, risk, and risk assessment. When a hazard is eliminated, the risk associated with that hazard is also eliminated. However, the elimination of all hazards may not be feasible and some risk may remain. Risk is reduced by applying the hierarchy of risk control methods.</p> <p>O.2.1: Deleted the reference to 130.3(B)(1) and replaced the phrase <i>electrical hazard analysis</i> with <i>that electrical hazards risk assessments are performed</i>, to align with the revisions to Article 130. Restructured text into a list format.</p> <p>O.2.2: Restructured text into a list format to clarify and promote the consistent use of terminology associated with hazard and risk.</p> <p>O.2.3: Changed title from <i>Arc Energy Reduction to Incident Energy Reduction Methods</i>. Replaced the phrase <i>potentially hazardous work</i> with <i>work</i>. Added description of the functionality of an energy-reducing maintenance switch. Added methods with definitions or descriptive text to provide a list of what can assist the user in reducing incident energy levels.</p> <p>Annex P: Updated references to most current editions.</p> <p>Safety Impact: As safe or safer</p>

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	<p><u>5.3</u> <u>Whenever possible, the blades of disconnecting devices should be visually verified to be fully opened, or draw-out type circuit breakers should be verified to be completely withdrawn to the fully disconnected position.</u></p> <p>13.0 Lockout/Tagout Training. Recommended training can include, but is not limited to, the following:</p> <ul style="list-style-type: none"> (1) Recognition of lockout/tagout devices (2) Installation of lockout/tagout devices (3) Duty of employer in writing procedures (4) Duty of employee in executing procedures (5) Duty of person in charge (6) Authorized and unauthorized removal of locks/tags (7) Enforcement of execution of lockout/tagout procedures (8) Individual employee control of energy (8) Simple lockout/tagout (9) Complex lockout/tagout (10) Use of single-line and diagrammatic drawings to identify sources of energy <u>(11) Alerting techniques</u> (12) Release of stored energy (13) Personnel accounting methods (14) Grounding <u>Temporary protective grounding equipment</u> needs and requirements (15) Safe use of test instruments <p>Annex O</p> <p><u>O.2.2 Design option decisions should facilitate the ability to eliminate hazards or reduce risk by doing the following:</u></p> <ul style="list-style-type: none"> <u>(1) Reducing the likelihood of exposure</u> <u>(2) Reducing the magnitude or severity of exposure</u> <u>(3) Enabling achievement of an electrically safe work condition</u> <p><u>O.2.3 Incident Energy Reduction Methods. The following methods have proved to be effective</u></p>	

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	<p><u>in reducing incident energy:</u></p> <p><u>(1) Zone-selective interlocking. A method that allows two or more circuit breakers to communicate with each other so that a short circuit or ground fault will be cleared by the breaker closest to the fault with no intentional delay. Clearing the fault in the shortest time aids in reducing the incident energy.</u></p> <p><u>(2) Differential relaying. The concept of this protection method is that current flowing into protected equipment must equal the current out of the equipment. If these two currents are not equal, a fault must exist within the equipment, and the relaying can be set to operate for a fast interruption. Differential relaying uses current transformers located on the line and load sides of the protected equipment and fast acting relay.</u></p> <p><u>(3) Energy-reducing maintenance switching with a local status indicator. An energy-reducing maintenance switch allows a worker to set a circuit breaker trip unit to operate faster while the worker is working within an arc flash boundary, as defined in NFPA 70E, and then to set the circuit breaker back to a normal setting after the work is complete.</u></p> <p><u>O.2.4 Other Methods.</u></p> <p><u>(1) Energy-reducing active arc flash mitigation system. This system can reduce the arcing duration by creating a low impedance current path, located within a controlled compartment, to cause the arcing fault to transfer to the new current path, while the upstream breaker clears the circuit. The system works without compromising existing selective coordination in the electrical distribution system.</u></p> <p><u>(2) Arc flash relay. An arc flash relay typically uses light sensors to detect the light produced by an arc flash event. Once a certain level of light is detected the relay will issue a trip</u></p>	

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	<p><u>signal to an upstream overcurrent device.</u></p> <p><u>(3) High-resistance grounding. A great majority of electrical faults are of the phase-to-ground type. High-resistance grounding will insert an impedance in the ground return path and will typically limit the fault current to 10 amperes and below (at 5 kV nominal or below), leaving insufficient fault energy and thereby helping reduce the arc flash hazard level. High-resistance grounding will not affect arc flash energy for line-to-line or line-to-line-to-line arcs.</u></p> <p><u>(4) Current-limiting devices. Current-limiting protective devices reduce incident energy by clearing the fault faster and by reducing the current seen at the arc source. The energy reduction becomes effective for current above the current-limiting threshold of the current limiting fuse or current limiting circuit breaker.</u></p>	