

Dickinson College



Electrical Safety Program

September 10, 2010

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I. Introduction and Purpose

Electricity is capable of causing injury to persons and damage to property if not handled safely. Dickinson College has established this safety program to protect its employees from the dangers of electricity. Where feasible, employees will be protected first through the use of engineering and administrative controls. Where these controls are not possible or are insufficient to reduce the hazards to acceptable levels, personal protective equipment will be provided.

This document serves as the written guide for Dickinson College compliance to 29 CFR 1910.331--335, titled, "Electrical Safety—Related Work Practices" and NFPA 70E, titled, "Standard for Electrical Safety in the Workplace". These documents are available for review in the Department of Environmental Health & Safety.

II. Scope and Application

All employees at Dickinson College whose job duties expose them to energized electrical work are required to comply with this document.

This program is predicated on the principle that employees will use Lockout Tagout procedures as outlined in the Dickinson College Lockout Tagout Program to avoid energized electrical work. Live parts will be deenergized before an employee works on or near them unless one of the following conditions applies:

1. **Deenergizing introduces additional or increased hazards.** Examples of "additional or increased" hazards would include the interruption of life support equipment, deactivation of emergency alarm systems, or shutdown of hazardous location ventilation systems.
2. **Deenergizing is not possible due to equipment design or operational limitations.** Examples include, testing of electrical circuits that can only be performed with the circuit energized and work on circuits that form an integral part of a continuous process that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment.
3. **Live parts are operating at less than 50 volts to ground and there is no increased exposure to electrical burns or to explosion due to electrical arcs.**

III. Responsibilities

- A. The **President of Dickinson College** has ultimate responsibility for occupational safety within the institution. General oversight responsibility is assigned to the **Vice President of Campus Operations**.
- B. The **Director of Environmental Health & Safety** will be responsible for administering the Dickinson College Electrical Safety Program. This includes:
 - 1. working with administrators and other employees to develop and implement electrical safety procedures.
 - 2. assisting supervisors in assessing workplace hazards, including hiring outside consultants to perform arc flash analyses.
 - 3. assisting supervisors in their periodic inspections
 - 4. scheduling training/retraining and maintaining training records
- C. The **Supervisor** has a primary responsibility for implementing the Dickinson College Electrical Safety Program in the workplace. This includes:
 - 1. notifying employees of the Dickinson College Electrical Safety Program, and making the policy readily available to them
 - 2. identifying all employees who require training or retraining on Electrical Safety
 - 3. controlling electrical hazards through engineering and administrative controls where feasible
 - 4. ensuring that electrical equipment is labeled with appropriate arc flash warning labels.
 - 5. Ensuring employees receive training appropriate to their assigned electrical work
 - 6. Ensuring employees are provided with appropriate protective equipment and enforcing the use of that equipment.
- D. The **Employee** will be responsible for maintaining a thorough understanding of the Dickinson College Electrical Safety Program and conducting each operation in accordance with the program. This includes:
 - 1. attending required training/retraining
 - 2. following procedures as outlined in this program
 - 3. reporting changes in the workplace that prevent employees from following these procedures to their supervisor

IV. Definitions

The following help clarify terms used in the electrical safety program:

- Arc Rating – the maximum incident energy resistance rating assigned to electrical protective clothing. This rating is normally expressed in calories per square centimeter (cal/cm^2)
- Electrically safe work condition – a state in which the conductor or circuit part to be worked on or near has been disconnected from energized parts, locked/tagged in accordance with the Dickinson Lockout/Tagout program, tested to ensure the absence of voltage, and grounded if determined necessary (e.g. – if emergency generators are connected to the circuit).
- Energized – electrically connected to or having a source of voltage
- Exposed Live Parts – energized conductive components which are not properly grounded, isolated, or insulated that are capable of being inadvertently touched or approached from closer than a safe distance by a person.
- 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 along with appropriate levels of PPE.
- Flash Protection Boundary – an approach limit at a distance from exposed live parts within which a person could receive a second degree burn if an electrical arc flash were to occur.
- Flash Suit – a complete arc flash rated body covering consisting of bib overalls, jacket, and a hood with face shield.
- Incident Energy – the amount of energy impressed on a surface, a certain distance from the source, generated during an electrical arc event, typically measured in calories per square centimeter (cal/cm^2)
- Limited approach boundary – an approach limit at a distance from an exposed live part within which a shock hazard exists.
- Prohibited approach boundary – an approach limit at a distance from an exposed live part within which work is considered the same as making contact with the live part.
- Qualified Person – one familiar with the construction and operation of the equipment and the hazards involved.
- Restricted approach boundary – an approach limit at a distance from an exposed live part within which there is an increased risk of shock due to electrical arc-over combined with inadvertent movement.
- Testing and Troubleshooting – process of analyzing the operation of a faulty piece of equipment/circuit in order to determine why it is not functioning normally. The multimeter is a commonly used piece of testing equipment used to measure voltage and resistance. As soon as tools such as a screwdriver, wrench, pliers, etc. . . are used on or near a

live circuit, the task is no longer considered testing and troubleshooting.

- Working near/on live parts – any activity within the limited approach boundary

V. Training

A. Initial Training

Dickinson College shall provide training to ensure employees exposed to an electrical hazard that is not reduced to a safe level by the installation (panel cover, outlet cover, etc. . .) understand the purpose and function of the electrical safety program and that employees have acquired the knowledge and skills required to work safely. Training records must be sent to the Director of Environmental Health & Safety.

Qualified Employees will receive training including, but not limited to the following:

- Construction and operation of equipment on which work is assigned.
- Ability to distinguish between exposed energized and non-energized parts
- Ability to determine the nominal voltage of exposed live parts
- Approach distances specified in this document and the corresponding voltages to which the qualified worker will be exposed.
- Process necessary to determine the degree and extent of electrical hazards along with the PPE and job planning necessary to perform the task safely

Unqualified Employees will receive training on the inherent hazards of electricity and any related work practices necessary for their safety.

Note: A person can be considered qualified with respect to certain equipment and methods but unqualified for others.

B. Retraining

Qualified and Unqualified Employees will be retrained whenever:

- changes in their job assignment presents a new hazard
- a change in machines, equipment, or processes presents a new hazard
- inadequacies in the employee's knowledge or use of electrical safety procedures indicates the employee has not retained the requisite understanding and skill

VI. Procedures for Work Near/On Live Parts

NOTE: These procedures are for protection from electrical shock, not for arc flash protection. Arc flash procedures and boundaries (typically larger) are discussed in Section VIII.

A. General Work Procedures

The following safe work practices shall be followed when performing electrical work:

1. Do not reach blindly into areas that might contain exposed live parts.
2. Do not enter spaces containing live parts unless illumination is provided that allows the work to be performed safely. Additional illumination may be required when using tinted face shields.
3. Do not wear conductive articles of jewelry and clothing, including, but not limited to: watchbands, bracelets, rings, key chains, necklaces, or metal frame glasses.
4. When working in a confined space that contains live parts, employees shall use protective shields, barriers, or insulating materials as necessary to avoid contact with these parts.
5. When working on/near uninsulated overhead lines, the minimum approach distance is 10 feet for 50 kV plus 4 inches for each 10 kV above 50kV.

B. Energized Electrical Work

REMEMBER: Every electrical conductor or circuit path is considered energized until proven otherwise.

The following safe work practices shall be followed when working on energized parts:

1. If live parts are not placed in an electrically safe condition, work to be performed shall be considered energized and require an energized work permit (see Appendix A);
2. Section 1 of the energized work permit must be completed by a supervisor; Section 2 must be completed by the qualified persons completing the work; Section 3 must be signed by the Director of Facilities Management and the Director of Environmental Health & Safety.
3. The energized work permit must be on site during the work;

4. A pre-job briefing shall take place between the supervisor and the qualified persons and must include, at a minimum, the following:
 - Associated electrical hazards
 - Work procedures
 - Special precautions
 - Energy source controls (isolation points and procedures)
 - Emergency response
 - PPE requirements
 - Other work in the area
5. At least two qualified persons must be present for all energized work requiring a permit;
6. If both qualified employees are working on the circuit, an attendant is required to control any unqualified person from entering the limited approach boundary. The attendant can be an unqualified person as long as he or she remains outside the limited approach boundary;

C. Testing, Troubleshooting, and Voltage Measuring

Testing, troubleshooting, and voltage measuring may be completed without an energized electrical permit provided appropriate safe work practices and PPE are used.

Remember: You must wear PPE after disconnecting the conductor or circuit from the energy source in order to verify it is deenergized. Once verification of deenergizing is made, PPE can be removed.

D. Approach Boundaries to Live Parts

1. Safe approach distances to fixed live parts can be determined by referring to Appendix B, "Approach Boundaries to Live Parts for Shock Protection."
2. Unqualified persons may only cross the Limited Approach Boundary when they are under the direct supervision of a qualified person.
3. Qualified persons may not cross or take any conductive object closer than the Restricted Approach Boundary unless one of the following conditions applies:
 - The qualified person is insulated or guarded from the live parts and no uninsulated part of the qualified person's body crosses the Prohibited Approach Boundary.
 - The live parts are insulated from the qualified person and from any other conductive object at a different potential.

4. Crossing the Prohibited Approach Boundary is considered the same as making contact with energized parts. Qualified persons may only cross this boundary when all of the following precautions have been taken:
 - The qualified person has specific training to work on energized parts
 - The qualified person has obtained an energized electrical work permit.
 - The qualified person uses PPE appropriate for working on energized parts which is rated for the voltage and energy level involved.

VII. Personal Protective Equipment

The following shall be required to ensure proper selection of personal protective equipment:

1. All personal protective equipment shall be maintained in a safe, reliable condition by the employee to whom it was issued.
2. Employees shall wear nonconductive head protection whenever there is a danger of head injury from electric shock or burns due to contact with live parts or from flying objects resulting from an electrical explosion.
3. Employees shall wear nonconductive protection for the face, eyes, neck, and chin whenever there is danger of injury from exposure to electric arcs or flashes or from flying objects resulting from an electrical explosion. Face shields must be rated for electrical work. Safety glasses must always be worn underneath face shields.
4. Employees shall wear rubber insulating gloves where there is danger of hand and arm injury due to contact with live parts or possible exposure to arc flash burn. The following ratings can be found on voltage rated gloves:
 - Class 00 = protect against voltage up to 500 volts
 - Class 0 = protect against voltage up to 1000 volts
 - Class 1 = protect against voltage up to 7500 volts
 - Class 2 = protect against voltage up to 17,000 volts
 - Class 3 = protect against voltage up to 26,500 volts
 - Class 4 = protect against voltage up to 36,000 volts
5. Where insulated footwear is used as protection against step and touch potential, dielectric overshoes shall be required. Insulated footwear shall not be used as the primary protection. The integrity of the insulating quality of such footwear cannot be established easily after the worker has been wearing them in the working environment.

6. Employees shall wear ear plugs whenever there is a danger of noise overexposure resulting from an electrical explosion.

VIII. Arc Flash Protection

The following safe work practices shall be followed to protect employees from arc flash hazards:

A. Arc Flash Boundaries

1. For systems that are 600 V or less, the Flash Protection Boundary shall be a minimum of four feet, based on the product of clearing time of 2 cycles (0.033 sec) and the available bolted fault current of 50 kA or any combination not exceeding 100 kA cycles (1667 ampere seconds). The Flash Protection Boundary for systems under 600 V may also be calculated through an arc flash analysis using Annex D of NFPA 70E—2009.
2. For systems that are above 600 V, the Flash Protection Boundary shall be calculated through an arc flash analysis.

Note: Only qualified personnel may cross the flash protection boundary.

B. Arc Flash Personal Protective Equipment Selection

The specific protective equipment to be worn within the Flash Protection Boundary can be determined by one of the following, in order of preference:

1. Complete a detailed arc flash analysis using Annex D of NFPA 70E—2009, then select the appropriate PPE based on the calculated exposure level.
2. Determine the hazard level of the task by referring to NFPA 70E Table 130.7(C)(9), “Hazard/Risk Category Classifications” (see Appendix C of this plan). This table also indicates whether voltage-rated gloves and/or voltage-rated tools need to be used. Once the hazard level of the task has been determined, the required PPE can be determined from NFPA 70E Table 130.7(C)(10) “Protective Clothing and PPE Matrix” (see Appendix D of this plan)

C. Arc Flash Personal Protective Equipment (PPE) Care and Use

1. PPE shall be visibly inspected before each use. PPE that is contaminated (with flammable or combustible liquids) or damaged shall not be used.
2. PPE shall be cared for and maintained according to the manufacturer's instructions.
3. PPE shall cover all ignitable clothing and allow for movement and visibility.
4. PPE shall be worn according to manufacturer's instructions (e.g. – shirt sleeves must be fastened and shirts/jackets must be closed at the neck)
5. Non-melting, flammable garments (e.g. – cotton, wool, rayon, silk, or blends of these materials) may be used as underlayers beneath PPE.
6. Meltable fibers such as acetate, nylon, polyester, polypropylene, and spandex shall not be permitted in fabric underlayers next to the skin. (An incidental amount of elastic used on non-melting fabric underwear or socks shall be permitted).
7. When arc flash rated PPE is worn, outer layers (eg. jackets or rainwear) must also be arc flash rated.
8. Flash suits must permit easy and rapid removal by the user.

IX. Insulated Equipment and Tools

The following safe work practices shall be followed to protect employees from electrical hazards:

A. Rubber Insulating Equipment (e.g. – rubber gloves, sleeves, blankets, or mats)

1. Insulating equipment must be inspected for damage before each day's use and immediately following any incident that could have caused damage.
2. An air test must be performed on rubber insulating gloves before each use. To complete an air test, manually fill the glove with air. Fold over the cuff to seal the air inside the glove. Detect any leaking air by either listening for escaping air or feeling the escaping air by holding the glove near the face.
3. Insulating equipment found to have defects that might affect its insulating properties must be removed from service until testing indicates that it is acceptable for continued use.

4. Where the insulating capabilities of protective equipment is subject to damage during use, the insulating material shall be protected by an outer covering of leather or other appropriate material.
5. Insulating equipment must be stored in an area protected from light, temperature extremes, excessive humidity, ozone, and other substances or conditions that may cause damage.
6. Repairs to insulating equipment are not permitted without approval from the Director of Environmental Health & Safety.
7. Insulating equipment must be tested according to the schedule in Appendix E.

B. Insulated Tools & Equipment

1. Only insulated tools and equipment shall be used within the Limited Approach Boundary of exposed electrical parts.
2. Insulated tools shall be rated for the voltages on which they are used.
3. Fuse or fuse holder handling equipment, insulated for the circuit voltage, shall be used to remove or install a fuse if the fuse terminals are energized.
4. Ropes and handlines used near exposed energized parts shall be nonconductive.
5. Portable ladders used for electrical work shall have nonconductive side rails.

X. Hazard Communication

A. Arc Flash Hazard Labels

After completing a detailed arc flash analysis using Annex D of NFPA 70E—2009, the calculated exposure level shall be clearly identified on all switchboards, panel boards, industrial panels, motor control centers, and meter socket enclosures.

B. Signs and Barricades

Barricades shall be used in conjunction with safety signs to prevent or limit access to work areas containing live parts or where arc flash hazards exist. If signs or barricades do not provide sufficient protection, an attendant shall be assigned to warn and protect pedestrians.

C. Contractors

Dickinson College shall inform contractors engaged in electrical work of any known hazards applicable to the work being performed. Contractors are required to follow all federal, state, and local regulations including the OSHA Electrical Standard and NFPA 70E.

XI. Electrical Emergencies

A. Electrical Shock

If an electrical shock occurs, Do Not touch the person, follow these procedures:

1. Call 911 and Public Safety at 245-1111.
2. Shut off the power, fuse, or circuit-breaker or pull the plug
3. Be aware of secondary sources of electricity
4. Remove the person from the contact point using a non-conductive object (eg. fiberglass pole)
5. Provide first aid and CPR if you are trained, treating the victim for shock.
6. Always have the victim checked by medical personnel, regardless of severity.

B. Electrical Fire

1. Pull the Fire Alarm to Warn Others
2. Evacuate the Building
3. Call 911 and Public Safety at 245-1111.
4. Extinguish the fire using a Class C fire extinguisher only if you are trained to do so and you have first warned others.

XII. Record Keeping

A. Energized Electrical Work Permit

Energized electrical work permits shall be provided to the Director of Environmental Health & Safety upon completion of work, where they will be maintained for not less than 3 years.

B. Training Records

Training records shall be maintained by the Director of Environmental Health & Safety for a period of not less than 3 years.

Appendix A: Energized Electrical Work Permit

Part I: To be completed by Supervisor	
(1) Description of job location:	
(2) Description of work to be done:	
(3) Justification of why the circuit/equipment cannot be de-energized or the work deferred until the next scheduled outage:	
<p align="center">_____</p>	
Supervisor Signature	Date
Part II: To be completed by the electrically qualified persons doing the work:	
(4) Description of the circuit and equipment:	
(5) Detailed description of the procedure to be used in performing the work:	
(6) Safe work practices to be used (check all that apply)	
<input type="checkbox"/> Barricades/Boundaries	<input type="checkbox"/> Non-conductive covers/blankets
<input type="checkbox"/> Voltage rated tools	<input type="checkbox"/> Attendant
<input type="checkbox"/> PPE (list type)	<input type="checkbox"/> LOTO (other circuits/tools)
	<input type="checkbox"/> Other (describe)
(7) What is the Maximum Voltage that will be exposed:	
(8) What is the amperage rating is the upstream protective device:	
(9) Limited, Restricted, and Prohibited Boundaries for Shock Hazard, based on Appendix B of this program or Table 130.2(c) in NFPA 70E – 2009.	
Limited Boundary = _____ Restricted Boundary = _____ Prohibited Boundary = _____	
(10) Determination of the Arc Flash Protection Boundary:	
<input type="checkbox"/> 4 ft for 600V or less, based on the product of clearing time of 2 cycles (0.033sec) and	

<p>the available bolted fault current of 50 kA or any combination not exceeding 100 kA cycles (1667 ampere seconds).</p> <p><input type="checkbox"/> Higher voltages as determined by Arc Flash Analyses</p> <p style="text-align: center;">Calculated Boundary : _____ Ft _____ inches</p>	
<p>(11) Hazard/Risk Category (see Appendix C of this program)</p>	
<p>(12) Personal Protective Equipment required to safely perform the task (see Appendix D of this program (check all that apply))</p>	
<input type="checkbox"/> voltage rated gloves – class 00, 0, 1, 2, 3, 4	<input type="checkbox"/> long sleeve shirt (non-melting)
<input type="checkbox"/> voltage rated tools	<input type="checkbox"/> long pants (non-melting)
<input type="checkbox"/> safety glasses or goggles	<input type="checkbox"/> long sleeve FR shirt -- Calorie rating ____
<input type="checkbox"/> earplugs	<input type="checkbox"/> long FR pants – Calorie rating ____
<input type="checkbox"/> hard hat (Class G up to 2200V, Class E up to 20,000 V)	<input type="checkbox"/> FR jacket or rainwear – Calorie Rating _____
<input type="checkbox"/> leather boots/shoes	<input type="checkbox"/> FR hood– Calorie rating _____
<input type="checkbox"/> dielectric over-boots/shoes	<input type="checkbox"/> Balaclava – Category 2 only
<input type="checkbox"/> Arc rated face shield – Calorie rating _____	<input type="checkbox"/> Other:
<p>(13) Means employed to restrict the access of unqualified persons from the work area:</p>	
<input type="checkbox"/> barricade and signs	<input type="checkbox"/> attendant
<p>(14) Will a job briefing be completed that covers all of the following? <input type="checkbox"/> Yes</p>	
<input type="checkbox"/> Hazards associated with the job	<input type="checkbox"/> Energy source controls
<input type="checkbox"/> Work procedures involved	<input type="checkbox"/> Personal Protective Equipment
<input type="checkbox"/> Special precautions	<input type="checkbox"/> Other:
<p>Do you agree the above work can be done safely? <input type="checkbox"/> Yes <input type="checkbox"/> No</p>	
<p>Qualified Person Performing Work: _____ Date: _____</p>	
<p>Qualified Person Performing Work: _____ Date: _____</p>	
<p>Attendant: _____ Date: _____</p>	
<p>Part III: Approval(s) to perform the work while electrically energized:</p>	
<div style="display: flex; justify-content: space-between; align-items: flex-end;"> <div style="width: 60%; border-top: 1px solid black; border-bottom: 1px solid black; height: 80px;"></div> <div style="width: 35%; border-top: 1px solid black; border-bottom: 1px solid black; height: 80px;"></div> </div>	
<p>Director of Facilities Management</p>	<p>Date</p>
<p>Director of Environmental Health & Safety</p>	<p>Date</p>

Appendix B: Approach Boundaries to Live Parts for Shock Protection

TABLE 130.2(C) Approach Boundaries to Energized Electrical Conductors or Circuit Parts for Shock Protection (All dimensions are distance from energized electrical conductor or circuit part to employee.)

(1)	(2) <i>Limited Approach Boundary¹</i>		(3)	(4)	(5)
<i>Nominal System Voltage Range, Phase to Phase²</i>	<i>Exposed Movable Conductor³</i>	<i>Exposed Fixed Circuit Part</i>	<i>Restricted Approach Boundary¹; Includes Inadvertent Movement Adder</i>	<i>Prohibited Approach Boundary¹</i>	
Less than 50	Not specified	Not specified	Not specified	Not specified	Not specified
50 to 300	3.05 m (10 ft 0 in.)	1.07 m (3 ft 6 in.)	Avoid contact	Avoid contact	
301 to 750	3.05 m (10 ft 0 in.)	1.07 m (3 ft 6 in.)	304.8 mm (1 ft 0 in.)	25.4 mm (0 ft 1 in.)	
751 to 15 kV	3.05 m (10 ft 0 in.)	1.53 m (5 ft 0 in.)	660.4 mm (2 ft 2 in.)	177.8 mm (0 ft 7 in.)	
15.1 kV to 36 kV	3.05 m (10 ft 0 in.)	1.83 m (6 ft 0 in.)	787.4 mm (2 ft 7 in.)	254 mm (0 ft 10 in.)	
36.1 kV to 46 kV	3.05 m (10 ft 0 in.)	2.44 m (8 ft 0 in.)	838.2 mm (2 ft 9 in.)	431.8 mm (1 ft 5 in.)	
46.1 kV to 72.5 kV	3.05 m (10 ft 0 in.)	2.44 m (8 ft 0 in.)	.990 m (3 ft 3 in.)	660 mm (2 ft 2 in.)	
72.6 kV to 121 kV	3.25 m (10 ft 8 in.)	2.44 m (8 ft 0 in.)	1.016 m (3 ft 4 in.)	838 mm (2 ft 9 in.)	
138 kV to 145 kV	3.36 m (11 ft 0 in.)	3.05 m (10 ft 0 in.)	1.168 m (3 ft 10 in.)	.965 m (3 ft 4 in.)	
161 kV to 169 kV	3.56 m (11 ft 8 in.)	3.56 m (11 ft 8 in.)	1.29 m (4 ft 3 in.)	1.14 m (3 ft 9 in.)	
230 kV to 242 kV	3.97 m (13 ft 0 in.)	3.97 m (13 ft 0 in.)	1.721 m (5 ft 8 in.)	1.57 m (5 ft 2 in.)	
345 kV to 362 kV	4.68 m (15 ft 4 in.)	4.68 m (15 ft 4 in.)	2.794 m (9 ft 2 in.)	2.641 m (8 ft 8 in.)	
500 kV to 550 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)	3.61 m (11 ft 10 in.)	3.45 m (11 ft 4 in.)	
765 kV to 800 kV	7.24 m (23 ft 9 in.)	7.24 m (23 ft 9 in.)	4.851 m (15 ft 11 in.)	4.7 m (15 ft 5 in.)	

Note: For Arc Flash Protection Boundary, see 130.3(A).

¹ See definition in Article 100 and text in 130.2(D)(2) and Annex C for elaboration.

² For single-phase systems, select the range that is equal to the system's maximum phase-to-ground voltage multiplied by 1.732.

³ 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.

Limited approach boundary – an approach limit at a distance from an exposed live part within which a shock hazard exists. Unqualified persons may not cross this boundary, unless escorted by a qualified person.

Restricted approach boundary – an approach limit at a distance from an exposed live part within which there is an increased risk of shock due to electrical arc-over combined with inadvertent movement. This boundary may be crossed only by a qualified person who is safely insulated or guarded from the live parts.

Prohibited approach boundary – an approach limit at a distance from an exposed live part within which work is considered the same as making contact with the live part. This boundary may be crossed only by a qualified person who has specific training to work on energized parts; has obtained an Energized Electrical Work Permit; and uses PPE appropriate for working on energized parts.

Appendix C: Hazard/Risk Category Classifications

TABLE 130.7(C)(9) Hazard/Risk Category Classifications and Use of Rubber Insulating Gloves and Insulated and Insulating Hand Tools

<i>Tasks Performed on Energized Equipment</i>	<i>Hazard/Risk Category</i>	<i>Rubber Insulating Gloves</i>	<i>Insulated and Insulating Hand Tools</i>
Panelboards or Other Equipment Rated 240 V and Below — Note 1			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	0	N	N
Circuit breaker (CB) or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	0	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	1	Y	Y
Remove/install CBs or fused switches	1	Y	Y
See Exhibit 130.5			
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	0	N	N
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard	1	Y	Y
Panelboards or Switchboards Rated >240 V and up to 600 V (with molded case or insulated case circuit breakers) — Note 1			
Perform infrared thermography and other non-contact inspections outside the Restricted Approach Boundary	1	N	N
CB or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	1	Y	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard or switchboard	2*	Y	Y
600 V Class Motor Control Centers (MCCs) — Note 2 (except as indicated)			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	1	N	N
CB or fused switch or starter operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N

TABLE 130.7(C)(9) Continued

<i>Tasks Performed on Energized Equipment</i>	<i>Hazard/Risk Category</i>	<i>Rubber Insulating Gloves</i>	<i>Insulated and Insulating Hand Tools</i>
CB or fused switch or starter operation with enclosure doors open	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
See Exhibits 130.6 and 130.7			
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	2*	Y	Y
Insertion or removal of individual starter "buckets" from MCC — Note 3	4	Y	N
Application of safety grounds, after voltage test	2*	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts) — Note 3	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts) — Note 3	1	N	N
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the motor control center	2*	Y	Y
600 V Class Switchgear (with power circuit breakers or fused switches) — Note 4			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	2	N	N
CB or fused switch operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch operation with enclosure doors open	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	2*	Y	Y
Insertion or removal (racking) of CBs from cubicles, doors open or closed	4	N	N
See Exhibit 130.8			

TABLE 130.7(C)(9) Continued

<i>Tasks Performed on Energized Equipment</i>	<i>Hazard/Risk Category</i>	<i>Rubber Insulating Gloves</i>	<i>Insulated and Insulating Hand Tools</i>
Application of safety grounds, after voltage test	2*	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	2	N	N
Other 600 V Class (277 V through 600 V, nominal) Equipment — Note 2 (except as indicated)			
Lighting or small power transformers (600 V, maximum)			
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	2*	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Application of safety grounds, after voltage test	2*	Y	N
Revenue meters (kW-hour, at primary voltage and current)	—	—	—
Insertion or removal	2*	Y	N
Cable trough or tray cover removal or installation	1	N	N
Miscellaneous equipment cover removal or installation	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Application of safety grounds, after voltage test	2*	Y	N
Insertion or removal of plug-in devices into or from busways	2*	Y	N
NEMA E2 (fused contactor) Motor Starters, 2.3 kV Through 7.2 kV			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	3	N	N
Contactors operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
Contactors operation with enclosure doors open	2*	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	4	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	3	Y	Y

(continues)

TABLE 130.7(C)(9) Continued

<i>Tasks Performed on Energized Equipment</i>	<i>Hazard/Risk Category</i>	<i>Rubber Insulating Gloves</i>	<i>Insulated and Insulating Hand Tools</i>
Insertion or removal (racking) of starters from cubicles, doors open or closed	4	N	N
Application of safety grounds, after voltage test	3	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
Insertion or removal (racking) of starters from cubicles of arc-resistant construction, tested in accordance with IEEE C37.20.7, doors closed only	0	N	N
Metal Clad Switchgear, 1 kV Through 38 kV			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	3	N	N
CB operation with enclosure doors closed	2	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB operation with enclosure doors open	4	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	4	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	2	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	4	Y	Y
Insertion or removal (racking) of CBs from cubicles, doors open or closed	4	N	N
Application of safety grounds, after voltage test	4	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
Opening voltage transformer or control power transformer compartments	4	N	N
Arc-Resistant Switchgear Type 1 or 2 (for clearing times of <0.5 sec with a perspective fault current not to exceed the arc resistant rating of the equipment)			
CB operation with enclosure door closed	0	N	N
Insertion or removal (racking) of CBs from cubicles, doors closed	0	N	N
Insertion or removal of CBs from cubicles with door open	4	N	N

TABLE 130.7(C)(9) Continued

<i>Tasks Performed on Energized Equipment</i>	<i>Hazard/Risk Category</i>	<i>Rubber Insulating Gloves</i>	<i>Insulated and Insulating Hand Tools</i>
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	2	Y	Y
Insertion or removal (racking) of ground and test device with door closed	0	N	N
Insertion or removal (racking) of voltage transformers on or off the bus door closed	0	N	N
Other Equipment 1 kV Through 38 kV			
Metal-enclosed interrupter switchgear, fused or unfused	—	—	—
Switch operation of arc-resistant-type construction, tested in accordance with IEEE C37.20.7, doors closed only	0	N	N
Switch operation, doors closed	2	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	4	Y	Y
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
Outdoor disconnect switch operation (hookstick operated)	3	Y	Y
Outdoor disconnect switch operation (gang-operated, from grade)	2	Y	N
Insulated cable examination, in manhole or other confined space	4	Y	N
Insulated cable examination, in open area	2	Y	N

General Notes (applicable to the entire table):

(a) Rubber insulating gloves are gloves rated for the maximum line-to-line voltage upon which work will be done.

(b) Insulated and insulating hand tools are tools rated and tested for the maximum line-to-line voltage 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*.

(c) Y = yes (required), N = no (not required).

(d) For systems rated less than 1000 volts, the fault currents and upstream protective device clearing times are based on an 18 in. working distance.

(e) For systems rated 1 kV and greater, the Hazard/Risk Categories are based on a 36 in. working distance.

(f) 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.

Specific Notes (as referenced in the table):

1. Maximum of 25 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time.
2. Maximum of 65 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time.
3. Maximum of 42 kA short circuit current available; maximum of 0.33 sec (20 cycle) fault clearing time.
4. Maximum of 35 kA short circuit current available; maximum of up to 0.5 sec (30 cycle) fault clearing time.

Appendix D: Protective Clothing and Personal Protective Equipment Matrix

TABLE 130.7(C)(10) Protective Clothing and Personal Protective Equipment (PPE)

<i>Hazard/Risk Category</i>	<i>Protective Clothing and PPE</i>
Hazard/Risk Category 0	
Protective Clothing, Nonmelting (according to ASTM F 1506-00) or Untreated Natural Fiber	Shirt (long sleeve) Pants (long)
FR Protective Equipment	Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (AN) (Note 2)
Hazard/Risk Category 1	
FR Clothing, Minimum Arc Rating of 4 (Note 1)	Arc-rated long-sleeve shirt (Note 3) Arc-rated pants (Note 3) Arc-rated coverall (Note 4) Arc-rated face shield or arc flash suit hood (Note 7) Arc-rated jacket, parka, or rainwear (AN)
FR Protective Equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (Note 2) Leather work shoes (AN)
Hazard/Risk Category 2	
FR Clothing, Minimum Arc Rating of 8 (Note 1)	Arc-rated long-sleeve shirt (Note 5) Arc-rated pants (Note 5) Arc-rated coverall (Note 6) Arc-rated face shield or arc flash suit hood (Note 7) Arc rated jacket, parka, or rainwear (AN)
FR Protective Equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (Note 2) Leather work shoes
Hazard/Risk Category 2*	
FR Clothing, Minimum Arc Rating of 8 (Note 1)	Arc-rated long-sleeve shirt (Note 5) Arc-rated pants (Note 5) Arc-rated coverall (Note 6) Arc-rated arc flash suit hood (Note 10) Arc-rated jacket, parka, or rainwear (AN)

(continues)

TABLE 130.7(C)(10) Continued

<i>Hazard/Risk Category</i>	<i>Protective Clothing and PPE</i>
FR Protective Equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (Note 2) Leather work shoes
Hazard/Risk Category 3	
FR Clothing, Minimum Arc Rating of 25 (Note 1)	Arc-rated long-sleeve shirt (AR) (Note 8) Arc-rated pants (AR) (Note 8) Arc-rated coverall (AR) (Note 8) Arc-rated arc flash suit jacket (AR) (Note 8) Arc-rated arc flash suit pants (AR) (Note 8) Arc-rated arc flash suit hood (Note 8) Arc-rated jacket, parka, or rainwear (AN)
FR Protective Equipment	Hard hat FR hard hat liner (AR) Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Arc-rated gloves (Note 2) Leather work shoes
Hazard/Risk Category 4	
FR Clothing, Minimum Arc Rating of 40 (Note 1)	Arc-rated long-sleeve shirt (AR) (Note 9) Arc-rated pants (AR) (Note 9) Arc-rated coverall (AR) (Note 9) Arc-rated arc flash suit jacket (AR) (Note 9) Arc-rated arc flash suit pants (AR) (Note 9) Arc-rated arc flash suit hood (Note 9) Arc-rated jacket, parka, or rainwear (AN)
FR Protective Equipment	Hard hat FR hard hat liner (AR) Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Arc-rated gloves (Note 2) Leather work shoes

AN = As needed (optional)

AR = As required

SR = Selection required

Notes:

1. See Table 130.7(C)(11). Arc rating for a garment or system of garments is expressed in cal/cm².
2. If rubber insulating gloves with leather protectors are required by Table 130.7(C)(9), additional leather or arc-rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement.
3. The FR shirt and pants used for Hazard/ Risk Category 1 shall have a minimum arc rating of 4.
4. Alternate is to use FR coveralls (minimum arc rating of 4) instead of FR shirt and FR pants.
5. FR shirt and FR pants used for Hazard/ Risk Category 2 shall have a minimum arc rating of 8.
6. Alternate is to use FR coveralls (minimum arc rating of 8) instead of FR shirt and FR pants.
7. A face shield with a minimum arc rating of 4 for Hazard/Risk Category 1 or a minimum arc rating of 8 for Hazard/Risk Category 2, with wrap-around guarding to protect not only the face, but also the forehead, ears, and neck (or, alternatively, an arc-rated arc flash suit hood), is required.
8. An alternate is to use a total FR clothing system and hood, which shall have a minimum arc rating of 25 for Hazard/Risk Category 3.
9. The total clothing system consisting of FR shirt and pants and/or FR coveralls and/or arc flash coat and pants and hood shall have a minimum arc rating of 40 for Hazard/Risk Category 4.
10. Alternate is to use a face shield with a minimum arc rating of 8 and a balaclava (sock hood) with a minimum arc rating of 8 and which covers the face, head and neck except for the eye and nose areas

Appendix E: Inspection Schedule for Rubber Insulating Equipment

TABLE 130.7(C)(6)(c) Rubber Insulating Equipment, Maximum Test Intervals

<i>Rubber Insulating Equipment</i>	<i>When to Test</i>	<i>Governing Standard* for Test Voltage</i>
Blankets	Before first issue; every 12 months thereafter [†]	ASTM F 479
Covers	If insulating value is suspect	ASTM F 478
Gloves	Before first issue; every 6 months thereafter [†]	ASTM F 496
Line hose	If insulating value is suspect	ASTM F 478
Sleeves	Before first issue; every 12 months thereafter [†]	ASTM F 496

*ASTM F 478, *Standard Specification for In-Service Care of Insulating Line Hose and Covers*; ASTM F 479, *Standard Specification for In-Service Care of Insulating Blankets*; ASTM F 496, *Standard Specification for In-Service Care of Insulating Gloves and Sleeves*.

[†]If the insulating equipment has been electrically tested but not issued for service, it may not be placed into service unless it has been electrically tested within the previous 12 months.