

Dickinson

Electrical Safety Program

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Table of Contents

INTRODUCTION AND PURPOSE..... 2

SCOPE AND APPLICATION 2

RESPONSIBILITIES 2

DEFINITIONS 3

TRAINING..... 4

 INITIAL TRAINING4

 RETRAINING.....5

PROCEDURES FOR WORK NEAR/ON LIVE PARTS 5

 GENERAL WORK PROCEDURES5

 ENERGIZED ELECTRICAL WORK5

 TESTING, TROUBLESHOOTING, AND VOLTAGE MEASURING6

 APPROACH BOUNDARIES TO LIVE PARTS.....6

PERSONAL PROTECTIVE EQUIPMENT 7

ARC FLASH PROTECTION 7

 ARC FLASH BOUNDARIES8

 ARC FLASH PERSONAL PROTECTIVE EQUIPMENT SELECTION8

 ARC FLASH PERSONAL PROTECTIVE EQUIPMENT (PPE) CARE AND USE8

INSULATED EQUIPMENT AND TOOLS 9

 RUBBER INSULATING EQUIPMENT (E.G., RUBBER GLOVES, SLEEVES, BLANKETS, OR MATS)9

 INSULATED TOOLS & EQUIPMENT9

HAZARD COMMUNICATION 10

 ARC FLASH HAZARD LABELS10

 SIGNS AND BARRICADES10

 CONTRACTORS10

ELECTRICAL EMERGENCIES..... 10

 ELECTRICAL SHOCK.....10

 ELECTRICAL FIRE10

RECORD KEEPING..... 11

 ENERGIZED ELECTRICAL WORK PERMIT11

 TRAINING RECORDS.....11

APPENDIX A: ENERGIZED ELECTRICAL WORK PERMIT 12

APPENDIX B: APPROACH BOUNDARIES TO LIVE PARTS FOR SHOCK PROTECTION..... 15

APPENDIX C: HAZARD/RISK CATEGORY CLASSIFICATIONS 17

APPENDIX D: PROTECTIVE CLOTHING AND PERSONAL PROTECTIVE EQUIPMENT MATRIX..... 23

APPENDIX E: INSPECTION SCHEDULE FOR RUBBER INSULATING EQUIPMENT..... 26

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" and NFPA 70E, titled, "Standard for Electrical Safety in the Workplace".

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:

- **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.
- **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.
- **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.**

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 Finance & Administration**.
- B. The **Director of Compliance & Enterprise Risk Management** will be responsible for administering the Dickinson College Electrical Safety Program. This includes:

- working with administrators and other employees to develop and implement electrical safety procedures
 - assisting supervisors in assessing workplace hazards, including hiring outside consultants to perform arc flash analyses at least every 5 years
 - assisting supervisors in their periodic inspections
 - scheduling training/retraining and maintaining training records
 - reviewing the Electrical Safety Program at least every 3 years
- C. The **Supervisor** has a primary responsibility for implementing the Dickinson College Electrical Safety Program in the workplace. This includes:
- notifying employees of the Dickinson College Electrical Safety Program, and making the policy readily available to them
 - identifying all employees who require training or retraining on Electrical Safety
 - controlling electrical hazards through engineering and administrative controls where feasible
 - ensuring that electrical equipment is labeled with appropriate arc flash warning labels
 - ensuring employees receive training appropriate to their assigned electrical work
 - ensuring employees are provided with appropriate protective equipment and enforcing the use of that equipment
 - ensuring through regular supervision or through inspections conducted at least annually that each employee is complying with the safety-related work practices
- 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:
- attending required training/retraining
 - following procedures as outlined in this program
 - reporting changes in the workplace that prevent employees from following these procedures to their supervisor

Definitions

The following (found in NFPA 70E—2015 Article 100) help clarify terms used in the electrical safety program:

- **Arc Rating** – the value attributed to materials that describe their performance to exposure to an electrical arc discharge. The arc rating is expressed in calories per square centimeter (cal/cm^2)
- **Electrically Safe Work Condition** – a state in which an electrical conductor or circuit 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 is, a source of voltage
- **Exposed** (as applied to energized electrical conductors or circuit parts) – Capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to electrical conductors or circuit parts that are not suitably guarded, isolated, or insulated
- **Incident Energy** – the amount of thermal energy impressed on a surface, a certain distance from the source, generated during an electrical arc event, typically expressed in calories per square centimeter (cal/cm^2)
- **Qualified Person** – one who has demonstrated skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to identify and avoid the hazards involved
- **Risk Assessment** – 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 health, and determines if protective measures are required

Training

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 Compliance & Enterprise Risk Management.

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
- Ability to select an appropriate test instrument and demonstrate how to use a device to verify the absence of voltage, including interpreting indications provided by the device.

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.

Retraining

Qualified and Unqualified Employees will be retrained at least every three years, and 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
- annually on emergency response including contact release, first aid, CPR/AED
- Tasks that are performed less often than once per year shall require retraining before the performance of the work practices involved

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.

General Work Procedures

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

- Do not reach blindly into areas that might contain exposed live parts.
- 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.
- Do not wear conductive articles of jewelry and clothing, including, but not limited to: watchbands, bracelets, rings, key chains, necklaces, or metal frame glasses.
- 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.
- 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.

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); the need for energized work shall be evaluated as part of the annual program review.
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 AVP Facilities Management and the Director of Compliance & Enterprise Risk Management.
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.

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.

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.

- The live parts are insulated from the qualified person and from any other conductive object at a different potential.

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.

Arc Flash Protection

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

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 risk assessment using Annex D of NFPA 70E—2015.
2. For systems that are above 600 V, the Flash Protection Boundary shall be calculated through an arc flash risk assessment.

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

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 risk assessment using Annex D of NFPA 70E—2015, 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)(15), “Arc Flash PPE Categories” (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)(16) “Personal Protective Equipment” (see Appendix D of this Plan).

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.

Insulated Equipment and Tools

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

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 Compliance & Enterprise Risk Management.
7. Insulating equipment must be tested according to the schedule in Appendix E.

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.

Hazard Communication

Arc Flash Hazard Labels

After completing a detailed arc flash risk assessment using Annex D of NFPA 70E—2015, the calculated exposure level shall be clearly identified on all switchboards, panel boards, industrial panels, motor control centers, and meter socket enclosures.

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.

Contractors

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

Electrical Emergencies

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.

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.

Record Keeping

Energized Electrical Work Permit

Energized electrical work permits shall be provided to the Director of Compliance & Enterprise Risk Management upon completion of work, where they will be maintained for not less than 3 years.

Training Records

Training records shall be maintained by the Director of Compliance & Enterprise Risk Management 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:	
<hr style="width: 60%; margin: 0 auto;"/> <div style="display: flex; justify-content: space-between; width: 80%; margin: 0 auto;"> Supervisor Signature Date </div>	
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) Restricted Boundaries for Shock Hazard, based on Appendix B of this program or Table 130.4(D)(a) in NFPA 70E – 2015.	
Restricted 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 the available bolted fault current of 50 kA or any combination not exceeding 100 kA cycles (1667 ampere seconds). <input type="checkbox"/> Higher voltages as determined by Arc Flash Analyses Calculated Boundary : ____ Ft ____ inches	
(11) Arc Flash PPE (see Appendix C of this program)	
(12) Personal Protective Equipment required to safely perform the task (see Appendix D of this program (check all that apply)	
<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:
(13) Means employed to restrict the access of unqualified persons from the work area:	
<input type="checkbox"/> barricade and signs	<input type="checkbox"/> attendant
(14) Will a job briefing be completed that covers all of the following? <input type="checkbox"/> Yes	
<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:
Do you agree the above work can be done safely? <input type="checkbox"/> Yes <input type="checkbox"/> No	
Qualified Person Performing Work: _____ Date: _____	
Qualified Person Performing Work: _____ Date: _____	
Attendant: _____ Date: _____	
Part III: Approval(s) to perform the work while electrically energized:	

_____	_____
AVP Facilities Management	Date
_____	_____
Director of Compliance & Enterprise Risk Management	Date

Appendix B: Approach Boundaries to Live Parts for Shock Protection

Table 130.4(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.)

(1) Nominal System Voltage Range, Phase to Phase ^a	(2) Limited Approach Boundary ^b		(4) Restricted Approach Boundary ^b ; Includes Inadvertent Movement Adder
	Exposed Movable Conductor ^c	Exposed Fixed Circuit Part	
<50 V	Not specified	Not specified	Not specified
50 V–150 V ^d	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	Avoid contact
151 V–750 V	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	0.3 m (1 ft 0 in.)
751 V–15 kV	3.0 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	0.7 m (2 ft 2 in.)
15.1 kV–36 kV	3.0 m (10 ft 0 in.)	1.8 m (6 ft 0 in.)	0.8 m (2 ft 7 in.)
36.1 kV–46 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	0.8 m (2 ft 9 in.)
46.1 kV–72.5 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 3 in.)
72.6 kV–121 kV	3.3 m (10 ft 8 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 4 in.)
138 kV–145 kV	3.4 m (11 ft 0 in.)	3.0 m (10 ft 0 in.)	1.2 m (3 ft 10 in.)
161 kV–169 kV	3.6 m (11 ft 8 in.)	3.6 m (11 ft 8 in.)	1.3 m (4 ft 3 in.)
230 kV–242 kV	4.0 m (13 ft 0 in.)	4.0 m (13 ft 0 in.)	1.7 m (5 ft 8 in.)
345 kV–362 kV	4.7 m (15 ft 4 in.)	4.7 m (15 ft 4 in.)	2.8 m (9 ft 2 in.)
500 kV–550 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)	3.6 m (11 ft 10 in.)
765 kV–800 kV	7.2 m (23 ft 9 in.)	7.2 m (23 ft 9 in.)	4.9 m (15 ft 11 in.)

Note (1): For arc flash boundary, see 130.5(A).

Note (2): All dimensions are distance from exposed energized electrical conductors or circuit part to employee.

^a For single-phase systems above 250V, select the range that is equal to the system's maximum phase-to-ground voltage multiplied by 1.732.

^b See definition in Article 100 and text in 130.4(D)(2) and Informative Annex C for elaboration.

^c *Exposed movable conductors* describes a condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.

^d This includes circuits where the exposure does not exceed 120V.

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

(1)	(2)	(3)	(4)
Nominal Potential Difference	Limited Approach Boundary		Restricted Approach Boundary; Includes Inadvertent Movement Adder
	Exposed Movable Conductor*	Exposed Fixed Circuit Part	
<100 V	Not specified	Not specified	Not specified
100 V–300 V	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	Avoid contact
301 V–1 kV	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	0.3 m (1 ft 0 in.)
1.1 kV–5 kV	3.0 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	0.5 m (1 ft 5 in.)
5 kV–15 kV	3.0 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	0.7 m (2 ft 2 in.)
15.1 kV–45 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	0.8 m (2 ft 9 in.)
45.1 kV– 75 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 2 in.)
75.1 kV–150 kV	3.3 m (10 ft 8 in.)	3.0 m (10 ft 0 in.)	1.2 m (4 ft 0 in.)
150.1 kV–250 kV	3.6 m (11 ft 8 in.)	3.6 m (11 ft 8 in.)	1.6 m (5 ft 3 in.)
250.1 kV–500 kV	6.0 m (20 ft 0 in.)	6.0 m (20 ft 0 in.)	3.5 m (11 ft 6 in.)
500.1 kV–800 kV	8.0 m (26 ft 0 in.)	8.0 m (26 ft 0 in.)	5.0 m (16 ft 5 in.)

Note: All dimensions are distance from exposed energized electrical conductors or circuit parts to worker.
 * *Exposed movable conductor* describes a condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.

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 likelihood of electrical shock due to electrical arc-over combined with inadvertent movement, for personnel working in close proximity to the energized electrical conductor or circuit part. This boundary may be crossed only by a qualified person who is safely insulated or guarded from the live parts.

Appendix C: Hazard/Risk Category Classifications

Table 130.7(C)(15)(A)(a) Arc Flash Hazard Identification for Alternating Current (ac) and Direct Current (dc) Systems

Task	Equipment Condition*	Arc Flash PPE Required
Reading a panel meter while operating a meter switch	Any	No
Normal operation of a circuit breaker (CB), switch, contactor, or starter	All of the following: The equipment is properly installed The equipment is properly maintained All equipment doors are closed and secured All equipment covers are in place and secured There is no evidence of impending failure	No
	One or more of the following: The equipment is not properly installed The equipment is not properly maintained Equipment doors are open or not secured Equipment covers are off or not secured There is evidence of impending failure	Yes
For ac systems: Work on energized electrical conductors and circuit parts, including voltage testing	Any	Yes
For dc systems: Work on energized electrical conductors and circuit parts of series-connected battery cells, including voltage testing	Any	Yes
Voltage testing on individual battery cells or individual multi-cell units	All of the following: The equipment is properly installed The equipment is properly maintained Covers for all other equipment are in place and secured There is no evidence of impending failure	No
	One or more of the following: The equipment is not properly installed The equipment is not properly maintained Equipment doors are open or not secured Equipment covers are off or not secured There is evidence of impending failure	Yes
Removal or installation of CBs or switches	Any	Yes
Removal or installation of covers for equipment such as wireways, junction boxes, and cable trays that does not expose bare energized electrical conductors and circuit parts	All of the following: The equipment is properly installed The equipment is properly maintained There is no evidence of impending failure	No
	Any of the following: The equipment is not properly installed The equipment is not properly maintained There is evidence of impending failure	Yes
Removal of bolted covers (to expose bare energized electrical conductors and circuit parts). For dc systems, this includes bolted covers, such as battery terminal covers.	Any	Yes

(continues)

Table 130.7(C)(15)(A)(a) *Continued*

Task	Equipment Condition*	Arc Flash PPE Required
Removal of battery intercell connector covers	All of the following: The equipment is properly installed. The equipment is properly maintained Covers for all other equipment are in place and secured There is no evidence of impending failure	No
	One or more of the following: The equipment is not properly installed The equipment is not properly maintained Equipment doors are open or not secured Equipment covers are off or not secured There is evidence of impending failure	Yes
Opening hinged door(s) or cover(s) (to expose bare energized electrical conductors and circuit parts)	Any	Yes
Perform infrared thermography and other noncontact inspections outside the restricted approach boundary. This activity does not include opening of doors or covers.	Any	No
Application of temporary protective grounding equipment after voltage test	Any	Yes
Work on control circuits with exposed energized electrical conductors and circuit parts, 120 volts or below without any other exposed energized equipment over 120 V including opening of hinged covers to gain access	Any	No
Work on control circuits with exposed energized electrical conductors and circuit parts, greater than 120 V	Any	Yes
Insertion or removal of individual starter buckets from motor control center (MCC)	Any	Yes
Insertion or removal (racking) of CBs or starters from cubicles, doors open or closed	Any	Yes
Insertion or removal of plug-in devices into or from busways	Any	Yes
Insulated cable examination with no manipulation of cable	Any	No
Insulated cable examination with manipulation of cable	Any	Yes
Work on exposed energized electrical conductors and circuit parts of equipment directly supplied by a panelboard or motor control center	Any	Yes
Insertion and removal of revenue meters (kW-hour, at primary voltage and current)	Any	Yes
For dc systems, insertion or removal of individual cells or multi-cell units of a battery system in an enclosure	Any	Yes
For dc systems, insertion or removal of individual cells or multi-cell units of a battery system in an open rack	Any	No

Table 130.7(C)(15)(A)(a) Continued

Task	Equipment Condition*	Arc Flash PPE Required
For dc systems, maintenance on a single cell of a battery system or multi-cell units in an open rack	Any	No
For dc systems, work on exposed energized electrical conductors and circuit parts of utilization equipment directly supplied by a dc source	Any	Yes
Arc-resistant switchgear Type 1 or 2 (for clearing times of <0.5 sec with a prospective fault current not to exceed the arc-resistant rating of the equipment) and metal enclosed interrupter switchgear, fused or unfused of arc resistant type construction, tested in accordance with IEEE C37.20.7: *Insertion or removal (racking) of CBs from cubicles *Insertion or removal (racking) of ground and test device *Insertion or removal (racking) of voltage transformers on or off the bus	All of the following: The equipment is properly installed The equipment is properly maintained All equipment doors are closed and secured All equipment covers are in place and secured There is no evidence of impending failure	No
	One or more of the following: The equipment is not properly installed The equipment is not properly maintained Equipment doors are open or not secured Equipment covers are off or not secured There is evidence of impending failure	Yes
Opening voltage transformer or control power transformer compartments	Any	Yes
Outdoor disconnect switch operation (hookstick operated) at 1 kV through 15 kV	Any	Yes
Outdoor disconnect switch operation (gang-operated, from grade) at 1 kV through 15 kV	Any	Yes

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.

*The phrase *properly installed*, 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 *properly maintained*, 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 *evidence of impending failure*, as used in this table, means that there is evidence of arcing, overheating, loose or bound equipment parts, visible damage, deterioration, or other damage.

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

Equipment	Arc Flash PPE Category	Arc-Flash Boundary
Panelboards or other equipment rated 240 V and below Parameters: Maximum of 25 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	1	485 mm (19 in.)
Panelboards or other equipment rated >240 V and up to 600 V Parameters: Maximum of 25 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	2	900 mm (3 ft)
600-V class motor control centers (MCCs) Parameters: Maximum of 65 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	2	1.5 m (5 ft)
600-V class motor control centers (MCCs) Parameters: Maximum of 42 kA short-circuit current available; maximum of 0.33 sec (20 cycles) fault clearing time; working distance 455 mm (18 in.)	4	4.3 m (14 ft)
600-V class switchgear (with power circuit breakers or fused switches) and 600 V class switchboards Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.5 sec (30 cycles) fault clearing time; working distance 455 mm (18 in.)	4	6 m (20 ft)
Other 600-V class (277 V through 600 V, nominal) equipment Parameters: Maximum of 65 kA short circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	2	1.5 m (5 ft)
NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	4	12 m (40 ft)
Metal-clad switchgear, 1 kV through 15 kV Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	4	12 m (40 ft)
Arc-resistant switchgear Type 1 or 2 [for clearing times of < 0.5 sec (30 cycles) with a perspective fault current not to exceed the arc-resistant rating of the equipment], and metal-enclosed interrupter switchgear, fused or unfused of arc-resistant-type construction, tested in accordance with IEEE C37.20.7, 1 kV through 15 kV Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	N/A (doors closed)	N/A (doors closed)
	4 (doors open)	12 m (40 ft)
Other equipment 1 kV through 15 kV Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	4	12 m (40 ft)

Note: For equipment rated 600 volts and below, and protected by upstream current-limiting fuses or current-limiting circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below arc flash PPE category 1.

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

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

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

Appendix D: Protective Clothing and Personal Protective Equipment Matrix

Table 130.7(C)(16) Personal Protective Equipment (PPE)

PPE Category	PPE
1	<p>Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm² (see Note 1) Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated face shield (see Note 2) or arc flash suit hood Arc-rated jacket, parka, rainwear, or hard hat liner (AN)</p> <p style="text-align: center;">Protective Equipment</p> <p style="text-align: center;">Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy duty leather gloves (see Note 3) Leather footwear (AN)</p>
2	<p>Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm² (see Note 1) Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated flash suit hood or arc-rated face shield (see Note 2) and arc-rated balaclava Arc-rated jacket, parka, rainwear, or hard hat liner (AN)</p> <p style="text-align: center;">Protective Equipment</p> <p style="text-align: center;">Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy duty leather gloves (see Note 3) Leather footwear</p>
3	<p>Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm² (see Note 1) Arc-rated long-sleeve shirt (AR) Arc-rated pants (AR) Arc-rated coverall (AR) Arc-rated arc flash suit jacket (AR) Arc-rated arc flash suit pants (AR) Arc-rated arc flash suit hood Arc-rated gloves (see Note 1) Arc-rated jacket, parka, rainwear, or hard hat liner (AN)</p> <p style="text-align: center;">Protective Equipment</p> <p style="text-align: center;">Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather footwear</p>

Table 130.7(C)(16) *Continued*

PPE Category	PPE
4	<p>Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm² (see Note 1)</p> <p>Arc-rated long-sleeve shirt (AR) Arc-rated pants (AR) Arc-rated coverall (AR) Arc-rated arc flash suit jacket (AR) Arc-rated arc flash suit pants (AR) Arc-rated arc flash suit hood Arc-rated gloves (see Note 1) Arc-rated jacket, parka, rainwear, or hard hat liner (AN)</p> <p>Protective Equipment</p> <p>Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather footwear</p>

AN: as needed (optional). AR: as required. SR: selection required.

Notes:

(1) *Arc rating* is defined in Article 100.

(2) Face shields are to have wrap-around guarding to protect not only the face but also the forehead, ears, and neck, or, alternatively, an arc-rated arc flash suit hood is required to be worn.

(3) If rubber insulating gloves with leather protectors are used, additional leather or arc-rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement.

Appendix E: Inspection Schedule for Rubber Insulating Equipment

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

Rubber Insulating Equipment	When to Test	Governing Standard for Test Voltage*
Blankets	Before first issue; every 12 months thereafter [†]	ASTM F479
Covers	If insulating value is suspect	ASTM F478
Gloves	Before first issue; every 6 months thereafter [†]	ASTM F496
Line hose	If insulating value is suspect	ASTM F478
Sleeves	Before first issue; every 12 months thereafter [†]	ASTM F496

*ASTM F478, *Standard Specification for In-Service Care of Insulating Line Hose and Covers*; ASTM F479, *Standard Specification for In-Service Care of Insulating Blankets*; ASTM F496, *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 is not permitted to be placed into service unless it has been electrically tested within the previous 12 months.