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Procedure
for

Electrical Safety Program

REVISION

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Table of Contents

1. Purpose and Scope 3
2. Definitions 3
3. Responsibilities 4
4. Associated Documents 5
5. Program Requirements 5
6. General Electrical Safety Requirements 6
7. Requirements for Electrical Servicing Activities Up To 600V 8
8. De-Energized Electrical Work 10
9. Energized Hazardous Electrical Energy Work (above 50 Volts) 11
10. Generation, Transmission and Distribution (High Voltage) Activities Greater Than 600V 23
11. Maintenance of Electrical PPE and Periodic Inspection 27
12. Records 28

1. PURPOSE AND SCOPE

1.1 The purpose of this program is to provide the framework for assessing and controlling the hazards in the workplace associated with electrical energy.

1.2 This program applies to CNSE tenant, contractor, or vendor employees, professors and students operating and or servicing industrial equipment classified as building and or facilities or tool/die/model/machine shop or laboratory or Cleanroom or research equipment that constitutes work on or near hazardous electrical energy.

NOTE: De-energizing and performing Lockout/Tagout to all potential hazardous sources of energy is the preferred method of protecting people from serious injury. Although Lockout/Tagout will be identified in this document, the specific requirements for Lockout/Tagout are found in the Lockout/Tagout Procedure EHS-00008.

2. DEFINITIONS

2.1 **AFC** – Arc Fault Current, the calculated maximum incident amperage available as a result of an arc fault condition.

2.2 **Apparatus** - A term used in this document to denote tools, appliances, machines, equipment, and piping systems that utilize or produce energy.

2.3 **Approach Boundaries** - are the distances to an exposed, energized electrical part or circuit.

2.4 **Bolted Fault Current** – is the calculated highest fault current as a result of a direct short circuit.

2.5 **Electrical Hazard** – is a recognizably dangerous condition such as exposed energized parts or unguarded electrical equipment that is energized or may unexpectedly become energized.

2.6 **Exposed** - Terminals, conductors or equipment, not shielded or guarded from contact.

2.7 **Exposed (As applied to live parts) -** Capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to parts not suitably guarded, isolated, or insulated**.**

2.8 **Employee(s) –** CNSE employees, tenant employees, vendors, contractors, subcontractors, field service engineers/technicians, students, professors and visitors.

2.9 **General Contractor -** an outside firm (Construction Manager, Primary Contractor, etc.) performing work under contract to CNSE or CNSE tenants who has sole responsibility for the completion of the contracted work.

2.10 **Guarding or Shielding** - Nonconductive shields installed in electrical cabinets/boxes over hazardous voltage components that could be inadvertently contacted during electrical work.

2.11 **Hazardous Voltage** - Voltages in excess of 50 volts or capable of releasing high energies causing arcs and or arc blasts.

2.12 **High-Voltage** - Voltages including and above 600 volts.

2.13 **Inadvertent Contact** - Any unintentional contact with hazardous voltage because of work in close proximity to energized components.

2.14 **Qualified Person** - Qualified persons must be certified by their managers or supervisors, complete the proper training requirements, be capable of working safely on energized circuits and familiar with proper use of special precautionary techniques, personal protective equipment, insulating/shielding material, and insulated tools. Certification shall be based on training, experience and knowledge of the electrical hazards involved with the work being performed.

2.15 **Non-qualified Person** - The same as unqualified. This is a non-OSHA term sometimes used in place of unqualified.

2.16 **Standby Personnel** - Designated employee meeting the following qualifications, and within sight or calling distance of "qualified" employee working on exposed high voltages:

- Familiarity with the means of removing power from the equipment or circuit ;
- Familiarity with the notification procedures to summons emergency personnel.

2.17 **Unqualified Person** – Person not familiar with the construction and operation of the equipment and the hazards involved.

3. RESPONSIBILITIES

3.1 **Management** (i.e., supervisors, professors) is responsible for ensuring work areas are free from electrical hazards, individuals working on electrical equipment and systems are authorized for such work and an electrical safety program is implemented which includes management

authorization, training, safe work practices, personal protective equipment and hazard recognition.

3.2 **Employees** are responsible for completing necessary training and authorization and utilizing safe work practices such as Lockout/Tagout, use of adequate PPE and industry accepted techniques.

3.3 **Site Facilities and Other Organizations Installing Electrical Equipment or Coordinating Contractor Activity** is responsible for ensuring systems and equipment are installed in a safe and reliable manner, meeting local codes and regulations. Ensuring contractors working on electrical systems and equipment are qualified and utilize safe work practices that ensure the safety of their workers, CNSE, and tenant employees affected by their work.

3.4 **Environmental Health and Safety** is responsible for program development and advice and counsel to management and employees, professors, students, tenant, contractor, and vendor employees and administration of permit programs.

4. ASSOCIATED DOCUMENTS

4.1 **EHS-00054-F1** Energized Electrical Work Permit

4.2 OSHA 29 CFR 1910.303(b)(1)(i); 1910.303(b)(2)

4.3 OSHA 29 CFR 1926.404(b) (1)(ii). To view OSHA regulations go to the web site: OSHA Home

4.4 NFPA 70E Electrical Safety in the Workplace

4.5 NFPA 70 (NEC) National Electric Code. To acquire a copy of any NFPA document, go to the National Fire Protection Association

5. PROGRAM REQUIREMENTS

5.1 Safe Work Practices

5.1.1 All activities must be conducted in accordance with the applicable parts of the Occupational safety and Health Administration (OSHA) 1910 Subpart S - Electrical for General Industry and 1926 Subpart K - Electrical for Construction.

5.1.2 Individuals performing electrical servicing, individuals affected by electrical servicing, and individuals that operate electrical apparatus must be qualified and approved by management and EHS.

5.1.3 Risks must be eliminated and or reduced in accordance with the hierarchy of control principles:

5.1.3.1 Elimination (No working energized);

5.1.3.2 Engineering Controls (equipment design, enclosure/segregation, and or procedures);

5.1.3.3 Personal Protective Equipment (PPE);

5.1.3.4 Administrative Controls (posting signs and tags, procedures).

6. GENERAL ELECTRICAL SAFETY REQUIREMENTS

6.1 Extension Cords

6.1.1 Extension cords are for temporary use only, to supply electrical power to portable equipment such as audio video, hand drills and drop lights, not as a substitute for fixed wiring. These cords must be properly rated and listed for the intended use. Extension cords are not to be used inside equipment for providing electrical power to components.

6.1.2 Extension cords shall not be fabricated using electrical boxes or duplex receptacles. Job-made extension cords are not allowed.

6.1.3 Extension cords used in the workplace must be used in conjunction with Ground Fault Circuit Interrupter (GFCI) protection.

NOTE: Portable GFCI's are not required where the power source is already protected by a GFCI device.

6.1.4 Extension cords must not be extended across aisles or doorways, or draped over equipment, facilities, etc.

6.1.5 Extension cords are to be inspected routinely for external defects (e.g., damage to the insulation, loose parts, deformed or missing pins, etc.). Any found to be damaged must be discarded (altering or repairing a listed device voids the listing of the device).

6.2 Multi-Outlet Strips/Temporary and Relocatable Power Taps

6.2.1 Extension cords or devices identified as Multi-Outlet Strips or Temporary Power Taps may not be used as a substitute for fixed wiring.

6.2.2 Relocatable Power Taps may be used in offices, labs and cleanroom areas to provide electrical power to equipment such as personal computers provided the combined load does not exceed the rating of the

circuit and the taps are listed and equipped with circuit protection that does not exceed the rating of the power source or outlet nor be modified or used in combination; that is to plug one into another ("daisy-chained"). When used, these devices must be located so that they are not susceptible to damage and are easily accessible. Power taps are not to be used inside of equipment unless they are specifically listed, approved, and designed by the manufacturer for that use.

6.2.3 Devices with multiple outlets identified as power taps with line conditioners/stabilizers or spike/surge suppressers may also be used in offices, labs and cleanroom areas. These devices, must have a UL, CSA, ETL, or equivalent listing/approval and be used as intended by the manufacturer of the device; have a combine load not exceeding the rating of the wall outlet; be equipped with an over current device (circuit protection) and not be used in combination, that is, not "daisy chained" or plug one into another.

6.3 Office Appliances, Commercial Equipment and Components

6.3.1 These units must be maintained in safe working condition and should be listed, labeled, identified, or approved for their intended use by a recognized testing laboratory (or equivalent).

6.3.2 Equipment Covers and Guards must be in place during normal operation to ensure employees are not exposed to energized circuits, components, or connections. Damaged or unsafe apparatus shall be removed from service.

6.3.3 Employees must maintain a safe distance from electrical servicing activities and never attempt to remove another service person's lock and / or tag from the equipment or system being serviced.

6.3.4 Circuit Breakers in Panel Boards must be labeled with what they control.

6.3.4.1 Ground Fault Circuit Interrupters (GFCI's) are required on circuits serving outlets in damp, wet, outdoor locations, and in any other location where individuals using electrical apparatus could become well grounded, i.e., unfinished or concrete, brick, tile or metal walls, floors or ceilings.

NOTE: GFCIs must be tested in accordance with the manufacturer's recommended test frequency.

6.3.5 **Permanently Installed Safety Devices** must be tested in accordance with the manufacturer's recommended frequency.

6.3.5.1 Monthly Examples: GFCI outlets, and GFCI and AFCI circuit breakers.

6.3.5.2 Annual Examples: Ground Fault Monitors, Room Emergency Power Off (EPO) circuits.

6.3.6 **Portable Electric Equipment** (cord and plug connected) must be:

6.3.6.1 Only used by qualified persons.

6.3.6.2 Visually inspected before use for external defects and for evidence of possible internal damage (such as pinched, frayed, or crushed insulation; casing cracks, etc.); and any defective or damaged unit removed from service.

6.3.6.3 Listed or approved for specific uses, i.e. damp/wet location, nonconductive for flammable location, etc.

6.3.7 Electrical Test Instruments and Equipment must be:

6.3.7.1 Only be used by qualified persons.

6.3.7.2 Visually inspected, including all associated test leads, cables, power cords, probes, and connectors, before the equipment is used. If there is a defect or evidence of damage, they must be removed from service.

6.3.7.3 Listed or approved for specific uses, i.e. damp/wet location, nonconductive/intrinsically safe for flammable location, etc.

7. REQUIREMENTS FOR ELECTRICAL SERVICING ACTIVITIES UP TO 600V

7.1 Appropriate Electrical Safety processes, procedures or practices for Electrical Servicing Employees shall exist. Requirements shall address risks associated with electrical servicing activities such as shock, arc, blast and flash.

7.2 De-energization is required where reduced clearances preclude the use of live diagnostics.

7.3 De-energization and Lockout/Tagout of the system or equipment or circuit prior to the start of work is the primary safety measure to prevent contact with hazardous energy levels. Reference: Lockout/Tagout

7.4 Provisions must be made for appropriate emergency response during potentially hazardous servicing activities.

7.5 Individuals performing work on electrical systems with exposed hazardous voltages shall be provided with and use protective equipment that is appropriate for the specific parts of the body to be protected and for the

work to be performed. Since the personal protective equipment required will vary depending upon the voltage levels present, fault current available, and the specific task to be performed, NFPA 70E should be used to select personal and other protective equipment.

7.6 Appropriate training is required for qualification to work on or near exposed hazardous electrical energy, when necessary to do so. Minimum training requirements should include:

- Skills and techniques required to distinguish exposed live electrical parts, and the nominal voltage of exposed live parts
- Electrical hazard recognition
- Effects of electricity on the body
- Any unique hazards of the electrical apparatus being serviced
- Minimum shock protection approach distances associated with 600 volts or less are provided in the tables in Section 9.3.

7.7 Proper use of precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools used for working near or on exposed energized electrical parts.

7.8 Use of safe electrical work practices such as:

- Restrictions for working alone in hazardous operations or locations
- Selection, safe use, and maintenance of tools and test equipment
- Lockout/Tagout procedures
- Testing of ground continuity
- Use and testing of GFCI's
- Use of appropriate PPE
- Testing of electrical PPE per OSHA requirements at OSHA 1910.137 Electrical Protective Devices

7.9 Management approval or authorization for servicing activities**:**

7.10 Documentation of the qualification and management approval of the employee performing electrical servicing activities is necessary. This documentation may be in the form of the qualified employees training

record, a listing of qualified employees, a qualification form or by other means. Training is required for "qualified" employees each time the job assignment or work scope changes or if management feels the employee would benefit from additional training.

7.11 Risk Assessment and approval for work on or near hazardous electrical energy, other than troubleshooting, diagnostics, and calibration:

7.12 Confirm that work with hazardous electrical energy is appropriate.

7.13 Document assessments of the rationale for performing this energized work

For Example:

Energized Electrical Work Permit: If live parts are not placed in an electrically safe work condition (i.e., for the reasons of increased or additional hazards or infeasibility, work to be performed shall be considered energized electrical work and shall be performed by written permit.

7.14 Notify management in the affected areas where the work will take place.

8. DE-ENERGIZED ELECTRICAL WORK

8.1 De-energizing to establish an Electrically Safe Working Condition is the preferred method of protecting employees from serious injury. Every possible action must be taken to service, inspect and/or calibrate electrical systems and equipment with the power locked and tagged out.

NOTE: A *qualified employee* (see the definition) cannot work on energized circuits as safely as on de-energized circuits. The decision whether or not to de-energize electrical circuits must not be made on a basis of convenience, custom, or expediency (see section 9).

NOTE: Live parts operating at less than 50 volts to ground need not be de-energized, provided there is no potential for exposure to electrical burns or to explosion due to arcs.

8.2 Systems, equipment and components that are de-energized but not locked and tagged out of service are considered energized and service activities are to be performed in accordance with all work practices beginning with Definitions of Employees, above, unless all the following criteria are met:

8.3 The qualified employee doing the work disconnects the means immediately adjacent to where the work is performed

8.4 The disconnected means are clearly visible and in control of that employee

NOTE: Control is the operative word here; example: if a cord and plug situation is such that the plug is behind equipment or out of sight of the service area, it may require a lock box to ensure that the cord is not inadvertently plugged back in by someone not realizing the equipment is being serviced.

- That employee never leaves the system unattended;
- The work does not extend beyond one shift.

9. ENERGIZED HAZARDOUS ELECTRICAL ENERGY WORK (ABOVE 50 VOLTS)

9.1 Live parts that operate at less than 50 volts to ground need not be de-energized if there will be no increased exposure to electrical burns or to explosion due to electric arcs.

9.2 Energized Hazardous Electrical Energy Work above 50 volts comprises work on or near exposed hazardous electrical energy and is permitted only when:

9.2.1 De-energizing the equipment will introduce additional or increased hazards such as:

9.2.1.1 Interruption of Life Support Systems

9.2.1.2 Shutdown of Hazardous Location Ventilation Equipment

9.2.1.3 Complete Removal of Lighting from an Area

9.2.1.4 Deactivation of Emergency Alarm Systems

9.2.1.5 It is not feasible due to equipment design or operational limitations to shut down a circuit that forms an integral part of a continuous industrial process that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment.

NOTE: The term “continuous industrial process” is used in the context of situations where the orderly shutdown of integrated processes and equipment would introduce additional or increased hazards.

9.2.1.6 A CNSE **Energized Electrical Work Permit** (EHS-00054-F1) is required any time live electrical work is done on systems 50 volts or greater where the justification meets the criteria of 9.2.1.1, 9.2.1.2, 9.2.1.3, 9.2.1.4, or 9.2.1.5.

Exception: When Energized Electrical Work is required on a construction site turned over to and controlled by a General Contractor, the General Contractor is responsible for ensuring that the work can be accomplished safely in accordance with the OSHA Construction Rule 1926.416(a)(1).

NOTE: The term General Contractor would include: Construction Manager, or Primary Contractor (see definitions).

9.2.2 Live troubleshooting, diagnostics and calibration when done by a qualified employee must also include:

9.2.2.1 Not working alone.

9.2.2.2 Assure that test instruments and equipment are rated for the voltage and environment of use.

9.2.2.3 Inspect test equipment leads, cables, power cords, probes, and connections for defects and damage prior to use. Remove from service if defective.

9.2.2.4 Exercise a three-point voltmeter technique (test, take reading, test again).

9.2.2.5 Use protective barriers/shields to protect unqualified personnel from accidental contact.

9.3 Energized Electrical Work Practices

9.3.1 All work practices for energized electrical work must protect against electrical shock and Arc/Flash/Burn to the body based upon an evaluation of the specific work conditions, exposed voltage, and available fault current; then the selection and use of:

- Appropriate clothing
- Personal protective equipment (PPE)
- Insulated tools

Table of Work Practices

Criteria	Energized Work Requirements
Clothing Permitted	Untreated natural fiber clothing such as cotton or wool as base for daily work wear. Add Flame-resistant clothing for higher risk category tasks. **NOTE:** Cotton and polyester-cotton, silk, wool, and nylon fabrics are combustible. Flame-retardant clothing may ignite but will not continue to burn after the ignition source is removed. Natural fiber materials are acceptable provided that a flash hazard analysis determines that the fabric will not ignite and continue to burn under the arc conditions to which it will be exposed.
Clothing NOT Permitted	Synthetic clothing materials such as acetate, nylon, polyester, rayon, either alone or in blends with cotton Includes: Polyester Cleanroom Garments and Lab Coats These materials will: • Melt into the skin when exposed to high temperatures; • Aggravate a burn injury.
Conductive Objects	Jewelry, metal watch bands, bracelets, rings, key chains, necklaces, metalized aprons, clothing with conductive thread or metal headgear is not allowed
Work at 50V>	There must always be a standby employee who is: • Trained and currently certified in First Aid and CPR; • Able to safely remove power from the circuit or equipment; • Able to operate the equipment associated with the work, including instituting emergency measures
Guarding	Parts that are normally enclosed which are exposed for maintenance and repair must be guarded to protect unqualified employees from contact with live parts
Follow the “One Hand Rule”	Keep one hand in pants pocket to avoid putting the upper body between a potentially energized part and a grounded surface.

Criteria	Energized Work Requirements
Insulation	• Avoid having feet on a wet or conductive surface; • Use rubber soled shoes and/or insulating mats, if needed; • Avoid wearing jewelry, metal watch bands, bracelets, rings, key chains, necklaces, metalized aprons, metal headgear and clothing with conductive thread • Shirt pocket - Badges, pens, penlights, small screwdrivers should be worn elsewhere (pants pockets) to minimize chance of dropping into energized electrical circuits
Voltmeters/Test Equipment	Three point voltmeter technique: • Test, take reading, and test again. • Inspect test equipment leads, cables, power cords, probes, and connectors for defects and damage prior to use. • Remove from service if defective. Test Instruments & EQUIPMENT must be rated for the voltage and environment of use.
Confined Work Spaces	In addition to implementing the location's Confined Work Space procedure: • Use protective shields, barriers or insulating material • Secure all doors, hinged panels, etc.
Conductive Material and Equipment	• Anything conductive that is in contact with your body must never come in contact with energized parts • Safe work practices must be instituted to minimize hazards in areas where long dimensional objects, such as ducts and pipes, are being handled • Portable ladders must be nonconductive
ILLUMINATION	• Spaces with exposed energized parts require adequate lighting. • Do not reach blindly into areas containing energized parts which lack illumination or are obstructed.

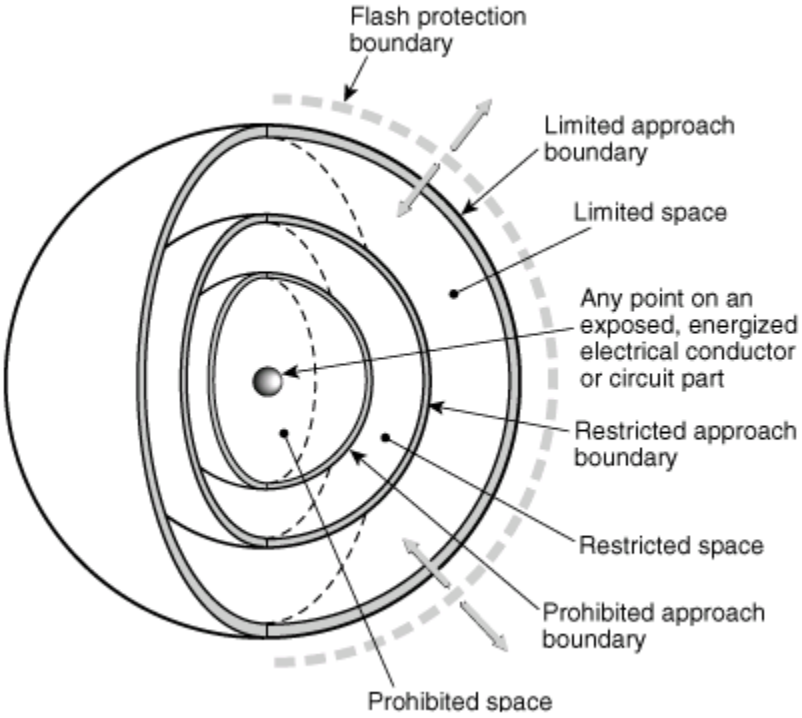
Criteria	Energized Work Requirements
Alerting Techniques	• Safety signs and tags • Barricades, in conjunction with signs and tags, positioned so that they do not pose an electrical contact hazard • An attendant, if signs and barricades are not sufficient
Flammable or Ignitable Materials	Never use electrical equipment in the vicinity of flammable gases, vapors or liquids; or ignitable fibers or filings
Interlocks	A qualified employee may temporarily defeat an electrical safety interlock, and must return the interlock to operation when the work requiring the defeat is completed or leaving the system unattended.
Activating a Power Circuit	• Wear proper clothing and PPE for the level of risk • Stand to the side of the enclosure, facing away from the door, when throwing a disconnect switch handle • Step away from the enclosure as you throw the handle to the energized position
Live or "Hot" WORK	All energized electrical work on replacing components or adding circuits must be done per Risk Assessment for Working with Live Electrical Circuits or Work Permit.

Approach Boundaries

SHOCK PROTECTION APPROACH BOUNDARY DISTANCES PER NFPA 70E-2004

Nominal System Voltage Range	Unqualified Persons-Limited Approach Boundary	Unqualified Persons-Limited Approach Boundary	Qualified Persons Conductive Tools	Qualified Persons With Approved Risk Assessment
Phase-Phase	Exposed Movable Conductor	Exposed Fixed Circuit Part	Restricted Approach Boundary	Prohibited Approach Boundary
0 to 50 volts	Not Specified	Not Specified	Not Specified	Not Specified
51 to 300 volts	10 ft 0 in.	3 ft 6 in.	Avoid Contact	Avoid Contact
301 to 600 volts	10 ft 0 in	3 ft 6 in.	1 ft 0 in.	0 ft 1 in.

9.4 Minimum Flash protection boundary approach distance shall be 4.0 ft for 600 volts or less based on a overcurrent protection clearing time of 6 cycles (.1 second) and an available fault current of less than 50 kA (or any combination not exceeding 300 kA cycles). Otherwise the approach distance must be calculated using an appropriate method from NFPA 70E.



Flash Protection Boundary

Arc Location Relative to Equipment	System Voltage	Flash Protection Boundary (feet)
Arc in air (not enclosed)	200 to 1000 volts	4 ft.
Arc in enclosure	200 to 1000 volts	10 ft. at Facilities Level 4 ft. at Process Tool Level

Arc/Calorie Rating of Clothing as Personal Protective Equipment

Table 130.7(C)(11) Protective Clothing Characteristics

Hazard/Risk Category	Typical Protective Clothing Systems Clothing Description (Typical number of clothing layers is given in parentheses)	Required Minimum Arc Rating of PPE [J/cm^2(cal/cm^2)]
0	Non-melting, flammable materials (i.e., untreated cotton, wool, rayon, or silk, or blends of these materials) with a fabric weight at least 4.5 oz/yd^2 (1)	N/A
1	FR shirt and FR pants or FR coverall (1)	16.74 (4)
2	Cotton underwear — conventional short sleeve and brief/shorts, plus FR shirt and FR pants (1 or 2)	33.47 (8)
3	Cotton underwear plus FR shirt and FR pants plus FR coverall, or cotton underwear plus two FR coveralls (2 or 3)	104.6 (25)
4	Cotton underwear plus FR shirt and FR pants plus multilayer flash suit (3 or more)	167.36 (40)

Note: Arc rating is defined in Article 100 and can be either ATPV or E_{BT}. ATPV is defined in ASTM F 1959-99 as the incident energy on a fabric or material that results in sufficient heat transfer through the fabric or material to cause the onset of a second-degree burn based on the Stoll curve. E_{BT} is defined in ASTM F 1959-99 as the average of the five highest incident energy exposure values below the Stoll curve where the specimens do not exhibit breakopen. E_{BT} is reported when ATPV cannot be measured due to FR fabric breakopen.

Table 130.7(C)(9)(a) Hazard/Risk Category Classifications

Task (Assumes Equipment Is Energized, and Work Is Done Within the Flash Protection Boundary)	Hazard/ Risk Category	V-rated Gloves	V-rated Tools
Panelboards Rated 240 V and Below — Notes 1 and 3			
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 parts, including voltage testing	1	Y	Y
Remove/install CBs or fused switches	1	Y	Y
Removal of bolted covers (to expose bare, energized parts)	1	N	N
Opening hinged covers (to expose bare, energized parts)	0	N	N
Panelboards or Switchboards Rated >240 V and up to 600 V (with molded case or insulated case circuit breakers) — Notes 1 and 3			
CB or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	1	N	N
Work on energized parts, including voltage testing	2*	Y	Y
600 V Class Motor Control Centers (MCCs) — Notes 2 (except as indicated) and 3			
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
CB or fused switch or starter operation with enclosure doors open	1	N	N
Work on energized parts, including voltage testing	2*	Y	Y
Work on control circuits with energized parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized parts >120 V, exposed	2*	Y	Y
Insertion or removal of individual starter "buckets" from MCC — Note 4	3	Y	N
Application of safety grounds, after voltage test	2*	Y	N
Removal of bolted covers (to expose bare, energized parts)	2*	N	N
Opening hinged covers (to expose bare, energized parts)	1	N	N

600 V Class Switchgear (with power circuit breakers or fused switches) — Notes 5 and 6			
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 parts, including voltage testing	2*	Y	Y
Work on control circuits with energized parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized parts >120 V, exposed	2*	Y	Y
Insertion or removal (racking) of CBs from cubicles, doors open	3	N	N
Insertion or removal (racking) of CBs from cubicles, doors closed	2	N	N
Application of safety grounds, after voltage test	2*	Y	N
Removal of bolted covers (to expose bare, energized parts)	3	N	N
Opening hinged covers (to expose bare, energized parts)	2	N	N
Other 600 V Class (277 V through 600 V, nominal) Equipment — Note 3			
Lighting or small power transformers (600 V, maximum)	—	—	—
Removal of bolted covers (to expose bare, energized parts)	2*	N	N
Opening hinged covers (to expose bare, energized parts)	1	N	N
Work on energized 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 parts, including voltage testing	2*	Y	Y
Application of safety grounds, after voltage test	2*	Y	N

NEMA E2 (fused contactor) Motor Starters, 2.3 kV Through 7.2 kV			
Contactor operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
Contactor operation with enclosure doors open	2*	N	N
Work on energized parts, including voltage testing	3	Y	Y
Work on control circuits with energized parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized parts >120 V, exposed	3	Y	Y
Insertion or removal (racking) of starters from cubicles, doors open	3	N	N
Insertion or removal (racking) of starters from cubicles, doors closed	2	N	N
Application of safety grounds, after voltage test	3	Y	N
Removal of bolted covers (to expose bare, energized parts)	4	N	N
Opening hinged covers (to expose bare, energized parts)	3	N	N
Metal Clad Switchgear, 1 kV and Above			
CB or fused switch operation with enclosure doors closed	2	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch operation with enclosure doors open	4	N	N
Work on energized parts, including voltage testing	4	Y	Y
Work on control circuits with energized parts 120 V or below, exposed	2	Y	Y
Work on control circuits with energized parts >120 V, exposed	4	Y	Y
Insertion or removal (racking) of CBs from cubicles, doors open	4	N	N
Insertion or removal (racking) of CBs from cubicles, doors closed	2	N	N
Application of safety grounds, after voltage test	4	Y	N
Removal of bolted covers (to expose bare, energized parts)	4	N	N
Opening hinged covers (to expose bare, energized parts)	3	N	N
Opening voltage transformer or control power transformer compartments	4	N	N

Other Equipment 1 kV and Above			
Metal clad load interrupter switches, fused or unfused	—	—	—
Switch operation, doors closed	2	N	N
Work on energized parts, including voltage testing	4	Y	Y
Removal of bolted covers (to expose bare, energized parts)	4	N	N
Opening hinged covers (to expose bare, energized parts)	3	N	N
Outdoor disconnect switch operation (hookstick operated)	3	Y	Y
Outdoor disconnect switch operation (gang-operated, from grade)	2	N	N
Insulated cable examination, in manhole or other confined space	4	Y	N
Insulated cable examination, in open area	2	Y	N

Note:

V-rated Gloves are gloves rated and tested for the maximum line-to-line voltage upon which work will be done.

V-rated Tools are tools rated and tested for the maximum line-to-line voltage upon which work will be done.

2* means that a double-layer switching hood and hearing protection are required for this task in addition to the other Hazard/Risk Category 2 requirements of Table 130.7(C)(10).

Y = yes (required)

N = no (not required)

Notes:

1. 25 kA short circuit current available, 0.03 second (2 cycle) fault clearing time.
2. 65 kA short circuit current available, 0.03 second (2 cycle) fault clearing time.
3. For < 10 kA short circuit current available, the hazard/risk category required may be reduced by one number.
4. 65 kA short circuit current available, 0.33 second (20 cycle) fault clearing time.
5. 65 kA short circuit current available, up to 1.0 second (60 cycle) fault clearing time.
6. For < 25 kA short circuit current available, the hazard/risk category required may be reduced by one number.

Facilities Electrical Live or "Hot" Work Under a Risk Assessment or Work Permit

Managers must.....	Qualified employees must.....
Assure that the assignment meets the definition of work with hazardous electrical energy	Complete *Risk Assessment or Work Permit for work on Energized ("Live") Electrical Circuits*
Assure that the person assigned to work is a qualified employee	Notify the manager of the area where the hazardous work will take place, detailing the need to work on energized equipment
Complete and sign *Risk Assessment or Work Permit* to confirm the work cannot be accomplished de-energized, and that the requesting qualified employee understands and has selected appropriate clothing and PPE for the tasks.	Not work alone, and be able to: • safely remove power from the circuit or equipment • operate equipment associated with the task • Implement emergency measures
Forward to site electrical safety engineer for review. Retain a copy of the signed permit request for 18 months.	Select personal and other protective equipment based on an engineering analysis by the location's electrical engineering group
Assure that reliable communication means is readily available at the work location in the event that Emergency Control must be notified for first aid response.	Inspect all portable and measurement equipment and hand tools prior to use, including. Removing from service any device that has a defect or contamination that could affect insulating, mechanical or grounding integrity; Testing and inspecting removed devices before returning them to service
Assure that the qualified employee is provided with and uses protective equipment appropriate for the task	Inspect PPE before using; change into appropriate clothing for the potential hazards of the task.

10. GENERATION, TRANSMISSION AND DISTRIBUTION (HIGH VOLTAGE) ACTIVITIES GREATER THAN 600V

10.1 Reviewed and management approved written procedures for

- switching (including notification)
- testing
- grounding
- locking and tagging

10.2 Job briefings during high voltage activities to ensure the safety of personnel

10.3 Established protocol for emergency situations and follow-up

10.4 Availability of appropriate PPE, Tools and Equipment

10.5 Standby persons trained in first aid including cardiopulmonary resuscitation (CPR).

10.6 Systems and equipment designed, installed, and modified in compliance with regulations, standards and industry practices.

10.7 Appropriate controls and work practices for performing high voltage activities, include hazardous locations such as confined spaces, elevations, test areas, etc.

10.8 Requirements for Generation, Transmission and Distribution Systems (Facilities High Voltage trained personnel ONLY)

10.9 Additional Requirements for Generation, Transmission and Distribution Systems (Facilities HV personnel ONLY)

10.10 Legal Requirements: Design, installation, modification, or extension of power distribution systems must be in compliance with applicable regulatory standards or practices.

10.11 Managers must assure that the following tasks are completed before servicing is done, or according to a periodic schedule as noted in the following table:

Task	When?	Comments
Electrical testing of rubber gloves	Prior to initial use; thereafter by an approved testing laboratory	Refer to *Rubber Goods Testing Frequency* gloves are stamped with date of last electrical test
Visual inspection and air testing of rubber gloves	Prior to each use	
Electrical testing of rubber insulating blankets, matting and covers	Prior to initial use and annually thereafter by an approved testing laboratory	Refer to *Rubber Goods Testing Frequency* dates of tests are stamped on equipment
Wearing of proper clothing	Performing work on high voltage systems	Avoid clothing with acetate, nylon, polyester and rayon, alone or in blends, to decrease the extent of injury from arcs and flames
Use required Personal Protective Equipment	Performing work on high voltage systems	Refer to *PPE Matrix*
Select a minimum of one qualified worker and one non-working supervisor	Prior to start of work	
Conduct job briefings	Prior to start of high voltage operations each day or shift, and whenever changes occur that affect the safety of operations	Briefings include: Sequence of operations the project; Written operating procedures for each assignment; Test equipment and PPE to be used; Identification of potential hazards and their potential impact to personnel performing the work

10.12 Switching Orders (Written Procedures)

10.12.1 Switching orders are required for all work on all high voltage circuits. A qualified employee (the "originator") writes these orders to assure that all energized circuits entering equipment, or an area in which work is to be done, are opened at a location remote from the work area. Switching orders must contain, at a minimum:

- Employment of Lockout/Tagout for each disconnecting device
- Testing of all exposed terminals, buss ways, and connections with a "glowtector" or "tic-tracer" (or equivalent testing device) after the equipment has been de-energized, and before grounds are applied
- A list of all tools and PPE required for the job
- Grounding of all exposed circuits with an approved ground set after the testing device indicates there is no potential present
- Isolation from back feeds from alternate power sources, emergency power supplies, or electronically coupled signals
- Notification of personnel potentially affected by the work (but not involved) prior to power shutdown, and again prior to power restoration
- Compliance with the procedures for control of hazardous energy and electrical safe work practices by any personnel not involved in the initial performance of the switching orders

10.12.2 Switching orders list sequentially each step that is required to take high-voltage out of service.

10.12.3 The originator of a switching order must sign it and the individual supervising the work and the high-voltage technician doing the work must review it.

10.12.4 All non-emergency work on high-voltage equipment must be planned in advance.

10.13 Periodic Inspection of High-Voltage Work

Periodic inspection of high-voltage work must be conducted by someone other than those engaged in the work to ensure that safe work procedures, practices, and use of personal protective equipment are being implemented. Documentation of the inspection must be noted on the switching orders.

10.14 Restoration of Power

Restoration of power may be treated as a continuation of the original switching order, or as a separate order. The restoration order lists the step-by-step procedure to:

- Verify that all personnel involved have completed their work and have returned to a safe area
- Check for removal of all tools, tags, locks, grounds
- Perform "high-pot" or phasing tests, where applicable
- Secure panels and covers
- Implement switching operations

10.15 Emergencies

Formal switching orders may not be available in emergency situations. Switching and repairs must be limited to the minimum necessary to eliminate any exposure to personnel or property. The high-voltage technician and the supervising individual must agree on the appropriate actions before each step is taken. The manager has the authority to make necessary emergency decisions. Written procedures are required to complete work beyond the initial response to an emergency.

10.16 Grounding Procedures

The high-voltage technician must follow these steps during a grounding procedure:

- Determine that equipment is de-energized before grounds are applied
- Use test equipment, approved for high voltage use, only on an area that has been isolated by opening breakers or disconnects between the equipment and all sources of power
- Apply this test equipment to all exposed terminals and conductors in the equipment to verify de-energization (3 point test of meter required)
- Touch, using a "hot stick," the grounded end of the grounding set to all exposed terminals and conductors; after which, firmly attach the ground clamps to all phase terminals or conductors
- Use protective grounding equipment capable of conducting the maximum fault current available at the point of the system being grounded for the time necessary to clear the fault:

- Determination of the required ground conductor size must be made by the location's facilities engineering.
- In no case is the protective grounding equipment to have an amperage capacity less than that provided by a No.2 American Wire Gauge (AWG) copper conductor, or non-U.S. equivalent.

10.17 High-Voltage Testing

High-voltage testing includes, at a minimum, the following work practices:

- Guarding of permanent test areas with walls, fences, or barriers
- Control of access to field test areas through the use of signs, physical barriers or barricades, or by assigning an observer to monitor the area
- Routine safety checks of the test area by the test operator in charge
- Grounding practices in compliance with the National Electrical Safety Code.

10.18 Confined Spaces

Individuals entering confined electrical spaces such as high-voltage manholes and vaults must be in compliance with the requirements of the Entry Procedures for Confined Spaces, EHS–00007.

11. MAINTENANCE OF ELECTRICAL PPE AND PERIODIC INSPECTION

11.1 Managers must ensure that electrical protective equipment is used, stored, maintained, inspected, and tested periodically, including at a minimum:

11.1.1 Inspection of Rubber Gloves/Electrical PPE: Assure that they are free from holes, rips or tears, ozone cutting, UV checking, and signs of chemical damage.

11.2 **Use of Rubber Gloves/Electrical PPE:** Must be used within voltage rating and/or Arc/Flash calorie rating.

11.3 Testing of Voltage Rated Rubber Insulated Equipment

Type of Equipment	When to Test
Rubber insulating line hose	Upon indication that insulating value is suspect
Rubber insulating covers	Upon indication that insulating value is suspect
Rubber insulating blankets	Before first issue and every 12 months thereafter (*)
Rubber insulating gloves	Before first issue and every 6 months thereafter (*)
Rubber insulating sleeves	Before first issue and every 12 months thereafter (*)

(*) – If the insulating equipment has been electrically tested but not issued for service, it may not be placed into service unless is has been electrically tested within the previous 12 months.

12. RECORDS

Written training and program records must be maintained in accordance with Federal, State and Local governmental regulations.