



SANFORD UNDERGROUND RESEARCH FACILITY

SOUTH DAKOTA SCIENCE AND TECHNOLOGY AUTHORITY

Electrical Safety Standard

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Revision History

Rev	Date	Section	Paragraph	Summary of Change	Authorized by
02	5/29/2024	5	5.2	Changed Hoist Operator to Duty Officer for emergency contact	CCR 948
03	2/24/2026	1, 3, 4, 5 & 6	4.2, 4.3.1, 5.2 & 6.1-6.5	Updated document due to change to the document numbering of controlled documents due to the change from DocuShare system to SharePoint system	CCR 1225

1.0 Purpose

The South Dakota Science and Technology Authority (SDSTA) is committed to providing a safe work environment by managing the risks associated with working on or near sources of electrical energy. This standard will guide the safety of all users and workers at the Sanford Underground Research Facility (SURF).

The codes and standards referenced and adopted by SDSTA include:

- NFPA 70, National Electric Code (NEC)
- NFPA 70B, Recommended Practice for Electrical Equipment Maintenance
- NFPA 70E, Handbook for Electrical Safety in the Workplace
- OSHA 29 CFR 1910.7, Definitions and requirements for a nationally recognized testing laboratory (NRTL)
- OSHA 29 CFR 1910.132, Personal Protective Equipment
- OSHA 29 CFR 1910.137, Electrical protective devices
- OSHA 29 CFR 1910 Subpart S (.301-.399), *Electrical (General Industry)*
- OSHA 29 CFR 1926 Subpart K (.400-.449), *Electrical (Construction)*
- OSHA 29 CFR 1910.269, Electric Power Generation, Transmission, and Distribution
- American National Standards Institute (ANSI) C2
- South Dakota (SD) Electrical Commission, SD Codified Law Chapter 36-16 and Article 20:44
- SOU-3000-A-015 SURF Electrical Safety Manual

2.0 Scope

This standard applies to all SDSTA personnel, users, contractors, and sub-contractors.

3.0 Definitions

Arc Flash Boundary (AFB) – When an arc flash hazard exists, an approach limit distance from an arc source at which incident energy equals 1.2 calories/square centimeter (5 Joules/square centimeter). (*NFPA 70E*)

(Informational Note: According to the Stoll skin burn injury model, the onset of a second-degree burn on unprotected skin is likely to occur at an exposure of 1.2 cal./cm² (5 J/cm²) for one second.) (*NFPA 70E*)

Arc Flash Hazard – A dangerous condition associated with the release of energy caused by an electric arc.

Arc Flash Hazard Analysis – A study investigating a worker's potential exposure to arc-flash energy, conducted for the purpose of injury prevention and the determination of safe work practices, arc flash protection boundary, and the appropriate levels of personal protective equipment (PPE).

Arc Rating – The value attributed to materials that describes their performance to exposure to an electrical arc discharge. (*NFPA 70E*)

Electrical Equipment – A general term, including fittings, devices, appliances, luminaires, apparatus, machinery, and the like used as a part of, or in connection with, an electrical installation. Electrical equipment can be classified as premises wiring or utilization equipment. (*ESM*)

Electrical Safety Authority Having Jurisdiction (AHJ) – An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure. (*NFPA 70E*) SDSTA AHJ's are defined in EL-4000-A-001 SDSTA Guideline for Authority Having Jurisdiction.

Electrically Hazardous – A condition within the limited approach boundary (LAB) or arc flash protection boundary (AFB) where exposed energized electrical conductors or circuit parts are operating at 50 volts or more or can store 10 Joules or greater of energy. A dangerous condition such that contact, or equipment failure, can result in electric shock, arc flash burn, thermal burn, or arc blast injury. (*NFPA 70E*)

Electrical Safety Committee (ESC) – Is a committee of subject matter experts in electrical construction, engineering, maintenance, and experts on SDSTA Safety Standards.

Electrical Work – Any job or task requiring a Qualified Electrical Worker (QEW). It includes any work that involves a shock or arc flash hazard or creates potential shock or arc flash hazards, energized or de-energized. (*ESM*)

Energized Electrical Work – Is any activity or interaction inside the AFB or LAB of electrically hazardous circuit parts.

Energized Electrical Work Permit (EEWP) – A work planning document that details the safe work practices to be employed, justifies why the work must be performed in an energized condition, and is approved by at least two Electrical Safety Committee members before energized work begins. ESH-9000-P-001 Energized Electrical Work Permit (EEWP).

Ground-Fault Circuit Interrupter (GFCI) – A device intended for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a current to ground exceeds the values established for a Class A device.

(Informational Note: Class A ground-fault circuit-interrupters trip when the current to ground is 6 mA or higher and do not trip when the current to ground is less than 4 mA. For further information, see ANSI/UL 943, Standard for Ground-Fault Circuit Interrupters.) (*NFPA 70*)

Labeled – Equipment or materials to which has been attached a label, symbol, or other identifying mark of a Nationally Recognized Testing Laboratory (NRTL)... and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner. (*NFPA 70E*)

Learning Management System (LMS) – a software application or web-based technology used to plan, implement and assess a specific learning process.

Listed – Equipment, materials, or services included in a list published by a Nationally Recognized Testing Laboratory (NRTL) and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose. (*NFPA 70E*)

Limited Approach Boundary (LAB) – An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists. (*NFPA 70E*)

The LAB is a shock protection boundary determined through risk assessment. This boundary is the closest distance that unqualified personnel can come to exposed energized conductors or circuit parts without a QEW escort.

Nationally Recognized Testing Laboratory (NRTL) – A private organization, which is recognized by OSHA and which tests for safety, and lists or labels or accepts, equipment or materials. (*OSHA 1910*) Common NRTL's include CSA, FM, ETL, TÜV, and UL. A complete list of NRTL's can be found at: <https://www.osha.gov/nationally-recognized-testing-laboratory-program/current-list-of-nrtls>

Non-Qualified Electrical Worker (Non-QEW) – Personnel that lack experience and training in identifying and reducing the hazards associated with working on or near electrical equipment and systems.

Qualified Electrical Person (QEP) – One who has skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to recognize and avoid the hazards involved. (*NFPA 70*)

SDSTA recognizes QEP as those that:

- Have completed the required site, area, facility, equipment, and apparatus-specific training.
- Possess the work experience and formal training necessary to execute the work according to recognized and accepted technical standards.
- Have sufficient understanding of a device, system, piece of equipment, or facility to be competent in recognizing and controlling hazards present.
- Qualifications are documented by Environment, Safety and Health (ESH) in SDSTA's Learning Management System.
- A person may be considered qualified with respect to certain equipment and methods but not qualified for others.

Qualified Electrical Worker (QEW) – A qualified person who has demonstrated skills and knowledge related to the construction, installation, maintenance, and operation of electrical equipment and installations, and has received advanced safety training to identify the hazards and reduce the associated risks. Such a person is familiar with the proper use of precautionary techniques, personal protective equipment, insulating and shielding materials, insulated tools, and test equipment in addition

to SDSTA's specific procedural requirements. QEW's must possess a combination of education and supervised work experience and be approved by the ESC to perform electrical work at SURF.

- QEW 1 – An electrical worker who is qualified and approved to work on energized electrical equipment and systems 50 – 300 VAC, 50-60 Hz power, provided there is no arc flash hazard.
- QEW 2 – An electrical worker who is qualified and approved to work on energized electrical equipment and systems 50 – 750 VAC, 50-60 Hz power, with or without arc flash hazard.
- QEW 3 – An electrical worker who is qualified and approved to work on energized electrical equipment and systems of any voltage for which they are specifically trained and familiar.

Restricted Approach Boundary (RAB) – An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased likelihood of electric shock, due to electrical arc-over combined with inadvertent movement. (*NFPA 70E*)

The RAB is a shock protection boundary determined through risk assessment. This boundary is the approach limit for qualified personnel. Only QEWs who are properly insulated or guarded from the energized electrical conductors or circuit parts may cross the RAB.

Safe Work – A condition or state in which a circuit part to be worked on or near has been disconnected from energized parts, locked/tagged in accordance with established standards, tested to ensure the absence of voltage, and grounded if determined necessary.

Shock - The flow of electrical current through any portion of a worker's body.

Subject Matter Expert – Someone who, by their experience level, education, training, or background, are uniquely qualified to assess specific hazards and controls.

Working On (energized electrical conductors or circuit parts) – Intentionally coming in contact with energized electrical conductors or circuit parts with the hands, feet, or other body parts, with tools, probes, or with test equipment, regardless of the personal protective equipment a person is wearing. (*NFPA 70E*)

Work Planning and Controls (WPC) – The use of a formal, documented process for identifying and mitigating risks when planning, authorizing, releasing, and performing work. Refer to ESH-2000-S-001 Work Planning and Control Standard.

4.0 Responsibilities

4.1. SDSTA Executive Director

- 4.1.1. Ensures accountability of the requirements of this document with direct reports.

4.2. ESH Department

- 4.2.1. Appoints an ESH Representative to serve as a member of the Electrical Safety Committee.

- 4.2.2.** Provides feedback, incident reports, and recommendations to the Electrical Safety Committee.
 - 4.2.3.** Develops and provides training with appropriate subject matter experts.
 - 4.2.4.** Maintains training documentation, including 3rd party provided training/certification as required per this standard.
 - 4.2.5.** Performs periodic assessments of electrical safety compliance at SURF.
- 4.3.** The Electrical Safety Committee (ESC)
- 4.3.1.** Provides oversight of the SURF Electrical Safety Program to promote workplace electrical safety for all users and employees at SURF.
 - Assists the ESH department in developing electrical safety policies and training.
 - Reviews and approves employee qualifications to perform electrical work.
 - Periodically reviews the Electrical Safety Program manual and standard to ensure concurrency with OSHA, NFPA, and State codes and standards.
 - Evaluates incident reports involving electrical procedures, equipment, and systems.
 - The committee shall be comprised of the Director of ESH (or delegate), the Director of Surface Operations and Utilities (or delegate), an Electrical Engineer, and a QEW 3 appointed by the Director of Surface Operations and Utilities.
 - Approves EEWPs.
 - 4.3.2.** Addresses issues and/or conflicts concerning SDSTA electrical documentation and provides recommendations on electrical safety matters.
 - 4.3.3.** Reviews and approves requests for electrical exclusions or waivers.
 - 4.3.4.** Reviews major facility and research project proposals and designs for electrical safety and electrical codes and standards compliance.
- 4.4.** SDSTA Department Directors
- 4.4.1.** Ensure accountability of the requirements of this standard with direct reports.
 - 4.4.2.** Ensure that direct reports are trained to perform the assigned work.
 - 4.4.3.** Ensure that only approved electrical equipment is procured and used on SDSTA property.
- 4.5.** Science Director
- 4.5.1.** Adheres to the responsibilities in 4.4.
 - 4.5.2.** Ensures that all research and scientific equipment used on SDSTA property is listed and labeled by an NRTL and is compliant with this and other SDSTA standards or is inspected and approved by an authorized QEW as appropriate to establish the safety for its users and SDSTA employees.
- 4.6.** Electrical Engineer
- 4.6.1.** Provides oversight of the construction, installation, and modification of electrical equipment and systems to assure that design criteria, codes, standards, and procedures are followed.
 - 4.6.2.** Serves as a member of the ESC.

- 4.6.3. Interprets the National Electrical Code (NEC, NFPA 70) and other codes and approves construction, installations, and installed electrical equipment for code compliance.
- 4.6.4. Reviews major facility and research project proposals and designs for electrical safety and electrical code compliance.
- 4.6.5. Ensure that only approved electrical equipment is procured and used on SDSTA property.

4.7. Project Managers

- 4.7.1. Ensure accountability of the requirements of this standard with contractors and subcontractors.
- 4.7.2. Ensure that contractors and subcontractors are competent in the use of WPC and are properly trained to perform their assigned work.
- 4.7.3. Assess the need for establishing, implementing, and maintaining procedures and/or work practices that will ensure the safe conduct of electrical work.
 - Pre-plan electrical work to ensure that hazards are recognized and mitigated.
 - Determine if a QEW is required for a particular task.
 - Ensure that only trained, qualified, and authorized employees are assigned to perform electrical work.
 - Take corrective action on any potentially hazardous operation or condition.
- 4.7.4. Ensure that approved, maintained, and tested PPE is provided and used properly.
- 4.7.5. Ensure that only approved electrical equipment is procured and used on SDSTA property.

4.8. Supervisors

- 4.8.1. Ensure accountability of the requirements of this standard with direct reports.
- 4.8.2. Ensure that direct reports are trained to perform the assigned work.
- 4.8.3. Assess the need for establishing, implementing, and maintaining procedures and/or work practices that will ensure the safe conduct of electrical work.
 - Pre-plan electrical work to ensure that hazards are recognized and mitigated.
 - Determine if a QEW is required for a particular job.
 - Assign only trained, qualified, and authorized employees to perform electrical work.
 - Take corrective action on any potentially hazardous operation or condition.
- 4.8.4. Ensure that approved, maintained, and tested PPE is provided and used properly.
- 4.8.5. Ensure that only approved electrical equipment is procured and used on SDSTA property.

4.9. Electrical Supervisor

- 4.9.1. Ensures that electrical work is conducted in a safe manner.
- 4.9.2. Provides input to the Electrical Safety Committee.
- 4.9.3. Ensures that employees doing electrical work are qualified QEWs, have received the necessary training, and are authorized to perform electrical work.
- 4.9.4. Submits QEW qualification documentation and third-party training records to the ESH Department.

- 4.9.5.** Ensures that WPC documents are developed before electrical work begins.
- 4.9.6.** Ensures that employees are equipped with and using the appropriate PPE and that the PPE is inspected and in good condition.
- 4.9.7.** Ensures that only approved electrical equipment is procured and used on SDSTA property.
- 4.9.8.** Evaluates the acceptability of electrical wiring, equipment, and apparatus provided by facility user organizations. In this capacity, the Electrical Supervisor will, as needed:
 - Review drawings, tests, and other documentation provided by the project engineers, principal investigators (PIs), or other responsible parties for compliance with accepted safety criteria and code intent.
 - Inspect power systems and incidental wiring related to the experiment.
 - Conduct other inspections and analyses as necessary to verify the acceptability of the apparatus involved.
 - Serve as the first contact within Sanford Laboratory, which will provide formal interpretations of OSHA electrical safety requirements and NFPA 70E.
 - Assist the Electrical Engineer with interpretations of NFPA 70.
- 4.9.9.** Evaluates existing workplace electrical safety by observing and assisting in the inspections of the workplace for OSHA, NFPA 70, and NFPA 70E code compliance.

4.10. Workers and Users

- 4.10.1.** Comply with WPC requirements.
- 4.10.2.** Perform work with or near electrical devices only when:
 - You are trained to recognize electrical hazards.
 - You are trained on the proper use of electric tools and equipment.
 - Potential hazards are adequately controlled.
 - You are trained to perform the task.
- 4.10.3.** Inspect equipment, tools, and power cords before each use to assure they are in good working order.
- 4.10.4.** Wear and use personal protective equipment (PPE) that is appropriate for the work being performed.
- 4.10.5.** Ensure that any electrical appliance, equipment, or tool brought onsite is listed by an NRTL and is in good working order or is inspected per work order instructions in the Computerized Maintenance Management System (CMMS) and approved by an authorized QEW.

4.11. Qualified Electrical Workers

- 4.11.1.** Adheres to the responsibilities in 4.10.
- 4.11.2.** Safely install, maintain, repair, and test electrical systems and equipment, control systems and instrumentation, and radio communications equipment.
- 4.11.3.** Be properly trained and qualified to work with electricity.

- Must possess significant knowledge and have verifiable experience in the electrical trades in accordance with SD Codified Law.
 - Receive advanced training in recognizing electrical hazards.
- 4.11.4.** Perform electrical work only when hazards are identified and adequately controlled.
- Pre-plan work by creating, reviewing, and following WPC for all work to be performed.
 - De-energize electrical systems and/or equipment before performing work.
 - Obtain an EEWP when de-energizing is not feasible.
- 4.11.5.** Know how to select, inspect, and use electrical PPE that is appropriate for the work being performed.
- 4.11.6.** Ensure that only approved electrical equipment is procured and used on SDSTA property.

5.0 Instructions

- 5.1.** The SDSTA will fulfill its responsibility to operate an electrically safe facility using these practices:
- Complying with Federal, State, and local requirements for workplace safety.
 - Following established codes and standards for developing, upgrading, expanding and operating the facility.
 - Eliminating hazardous electrical conditions, equipment, and work practices where practical and feasible.
 - Inspecting all research and scientific equipment to ensure it is compliant with this standard.
 - Replacing or retiring electrical devices that are unsafe, do not meet Nationally Recognized Testing Laboratory (NRTL) standards, or have exceeded their useful life.
 - Maintaining electrical one-line and wiring diagrams to document the existing conditions of the facility.
 - Providing resources and training to recognize electrical hazards and facilitate reporting, work planning, job hazard assessments (JHA), and the development of standard operating processes (SOP).
 - Providing appropriate personal protective equipment (PPE) required for performing electrical work, and training on the proper inspection, care, and use of the equipment.
 - Training on arc flash protection and how to determine the required level of PPE.
 - Continuously evaluating and improving established policies, procedures, standards, forms, work instructions, and training to adapt to changing workplace conditions.
 - Maintenance on electrical equipment will be performed in accordance with NFPA 70B.
- 5.2.** Electric Shock
- Receiving an electric shock or feeling the sensation of an electric shock is an incident that must be reported using incident reporting procedures.

- It is important to be examined by a healthcare provider after receiving an electric shock as the damage depends on various factors such as the voltage level, source, how it traveled through the body, the person's age, and overall health.
- The healthcare provider may order various tests depending on the person's history and physical examination. Tests may include an ECG to check the heart, a complete blood count, and blood or urine tests for muscle enzymes to indicate significant muscle injury.
- Exception: normal static electricity shocks from carpets and similar sources need not be reported.
- Electrical Injury Emergency Response Steps:
 - 1) STOP!! Do not touch the person. Look for the hazard.
 - 2) Shut off power and/or rescue the person with non-conductive objects if safe to approach.
 - 3) Check victim's responsiveness, airway, breathing, and circulation.
 - 4) If underground, immediately instruct any nearby personnel to notify the Duty Officer or if no one is nearby, call the Duty Officer yourself. State clearly to the Duty Officer who you are, where you are, what your situation is, what you need for help, and what actions have been taken thus far.
 - 5) If on the surface, immediately call 911 yourself or have another person call 911 and the Duty Officer.
 - 6) Get an Automated External Defibrillator (AED). If necessary, start CPR and apply AED as soon as possible.
 - 7) Barricade and control access to the scene.
- General Practices
 - WPC requirements shall be adhered to while conducting electrical work.
 - All electrical equipment having electrical hazards shall be enclosed with secured or interlocked covers or shall be isolated in a manner that will prevent inadvertent contact with potentially exposed energized parts.
 - Non-QEWs are not permitted to replace blown fuses or reset tripped circuit breakers rated more than 20 Amps at 120 Volts. Non-QEWs shall be permitted to reset single pole 120 Volt circuit breakers rated 20 Amps or less provided:
 - 1) It is verified that the affected circuit breaker is a 120 Volt single pole breaker marked as 20 Amp (or less) and is not otherwise tagged out. GFCI circuit breakers shall be treated as normal circuit breakers.
 - 2) The circuit has been examined, and a readily apparent cause for the over-current condition has been identified. If there is no apparent cause of overload, the breaker cannot be reset.
 - 3) Any readily apparent cause of the overcurrent condition has been corrected (disconnected from the circuit, repaired, or replaced.)
 - 4) The circuit breaker has not been previously reset for this occurrence.

If all conditions 1 - 4 cannot be satisfied, the circuit breaker is to be tagged out and a QEW must be contacted to assist in evaluating the situation. The QEW will determine what is required to troubleshoot and resolve the problem.

- All personnel are encouraged to routinely test GFCI devices.
- All personnel bringing electrical appliances, equipment, or tools to SURF must ensure they are listed and labeled by an NRTL and is in good working order or have it inspected by an authorized QEW.
- Any potentially electrically hazardous work will be performed following Lockout/Tagout (LOTO) rules as described in the ESH-7000-S-003 Lockout/Tagout Standard.
- Extension Cords
 - Extension cords are to be used as temporary (90 days or less) power sources only. Do not use extension cords in place of permanent facility wiring.
 - All extension cords must have a grounding conductor and plug. The grounding conductor must be the same size as the phase conductor.
 - The extension cord conductors must be appropriately sized according to the cord length.
 - Extension cords must be labeled by a NRTL.
 - Daisy-chaining of extension cords is discouraged. If daisy-chaining extension cords is necessary, only two extension cord sets may be daisy-chained and the gauge of the cord conductors must be sized for the total length of the extension (refer to the SDSTA ESM or NFPA 70B.)
 - GFCI devices must be used with extension cords.
 - Electric extension cord quarterly checks are required.
- Re-locatable Power Taps (Power Strips)
 - In general, all rules pertaining to extension cords apply to power strips.
 - There are no time constraints on how long power strips may remain connected to a branch circuit receptacle outlet.
 - Daisy chaining of power strips is not permitted.
 - Power strips must be labeled by an NRTL.
 - Power strips associated with office equipment are exempt from the quarterly check.
 - Note that Power Distribution Units (PDU's) for Information Technology equipment is listed to different safety standards and should not be used in place of power strips.
- Portable Heating Units
 - Temporary use of portable heating units is allowed on SURF property. These units will need to be approved prior to use. They are to be listed by a NRTL and must have a “tip switch” which shuts down the unit in the event that the heater is knocked over. Additionally, the location of the heater needs to be reviewed by a qualified person to avoid overloading the circuit.

5.3. Energized Electrical Work Requirements

- Work will only be performed on energized electrical components when it can be demonstrated that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations.
 - When work on energized components or within the RAB is justified and approved through an EEWP, controls (guards, covers, shields, insulated tools & probes, PPE and remote methods) must be used to reduce the potential for contact with energized components.
 - All employees who work within the AFB or LAB of energized components must be qualified and authorized by the Electrical Supervisor prior to performing such work.
 - Work within the AFB or LAB of energized components will be done in accordance with the requirements of NFPA 70E.

5.4. Training

- Electrical Safety Training Courses
 - All personnel will receive electrical awareness training.
 - Only competent persons who are both qualified and authorized may install, fabricate, repair, test, calibrate, or modify electrical or electronic wiring, devices, systems, or equipment.
 - The SDSTA course Lockout/Tagout is required for anyone who needs to isolate electrical energy from equipment before performing work on the equipment.
 - CPR and First Aid training is required for all persons working in electrically hazardous areas and for persons serving as required safety watch.
 - Specialized electrical safety training shall be offered by SDSTA on an as-needed basis.
 - Tasks that are performed less often than once per year shall require annual retraining in accordance with NFPA70E.
 - Training Matrix by job task is maintained within LMS.

5.5. Electrical Safety Considerations

- GFCI: The NEC, OSHA, and NFPA 70E require installation or use of GFCI devices at all times. GFCI protection for personnel shall be used when temporary wiring (e.g., extension cord sets) are used for activities including construction, remodeling, maintenance, repair, and demolition.
- Electrical PPE: Proper PPE must be used for electrical work. Hard hats and safety glasses with side shields must be electrically insulated and conform to ANSI Z89.1. Dielectric tested and rated rubber work boots should be worn. Electrical Hazard (EH) rated work boots meeting ASTM F2413 offer the best electric shock protection under dry conditions.
- Shock protection PPE shall be based primarily on the voltage of the highest exposure. Primary shock protection PPE consists of rubber insulating gloves, sleeves, and blankets. SDSTA provides qualified personnel exposed to shock hazards with Class 0 (1,000 VAC/1,500 VDC) insulating gloves. Additionally, QEWS 3 are provided with Class 2 (17,000 VAC/25,500 VDC) insulating gloves. Key factors to maintaining effective shock protection PPE are:

- Keep it clean and oil-free.
- Perform an air leakage test of rated gloves before every use.
- Arc-Flash protection PPE consists of arc-rated clothing and equipment that has been tested for exposure to an electric arc. Flame-resistant clothing without an arc rating has not been tested for exposure to an electric arc. All arc-rated clothing is also flame-resistant. Although all AR clothing is also flame resistant (FR), the inverse is not always true. FR clothing might not provide adequate protection against an arc flash. For electrical hazards, AR PPE is necessary rather than FR apparel because it has been specifically tested for protection against the thermal effects of an arc flash event. SDSTA provides two levels of clothing: Level 2 (8 calories/square centimeter) and Level 4 (40 calories/square centimeter) clothing. SDSTA-qualified persons are required to wear one of the two levels of arc-rated protection, depending on the available incident energy, at all times while exposed to arc-flash hazards. Two requirements for arc-rated PPE are:
 - Arc-Rated (AR) clothing requires special laundering to maintain its protection.
 - Ensure WPC documents reflect required PPE.
- Documentation: An up-to-date set of documentation adequate for operation, maintenance, testing, and safety should be available, per WPC, to anyone working on potentially hazardous equipment. Whenever electrical equipment or systems are installed, modified, or replaced, product information, drawings and updated one-line diagrams must be submitted to engineering to ensure the most up-to-date documentation is available for subsequent troubleshooting, maintenance, and repair activities.
- Test Equipment: Test equipment is considered PPE. A category classification system (UL 61010-2) is used for rating the transient overvoltage capability of testing and measuring instruments according to the type of mains circuits to which they are intended to be connected. Measurement categories take into account overvoltage categories, short-circuit current levels, the location in the building installation at which the test or measurement is to be made, and some forms of energy limitation or transient protection included in the building installation.
 - All probes and test leads must have the same category rating as the test instrument.
 - Equipment used for testing of the absence or presence of voltage must be verified prior to use.
 - Test equipment must be calibrated per manufacturer recommendation.
 - Each test instrument will have the actual category and maximum working voltage marked near the input terminals. The categories and ratings for intended service are:
 - ◆ Category I (CAT I): Protected electronic equipment, 120 VAC maximum.
 - ◆ Category II (CAT II): Single-phase receptacle level, 300 VAC maximum (30 feet from a CAT III locations, 60 feet from a CAT IV locations.)
 - ◆ Category III (CAT III): Inside feeders and branch circuits, 277/480 VAC maximum.
 - ◆ Category IV (CAT IV): Utility connections and outside circuits, 600 VAC maximum.
 - ◆ Note there are CAT II, CAT III, and CAT IV instruments rated for 600 volts and 1000 volts. The appropriate instrument must be selected.

- Electrical Two-Person Rule
 - When work is considered electrically hazardous, the “two-person rule” is required. Two qualified workers must be present at the work site, and each worker must be aware of the other worker’s tasks. Under limited conditions, the electrical two-person rule may allow for a second person that is not a qualified person.
- Exemption to Two Qualified Persons
 - When normal alerting techniques such as safety signs and/or barricades are not sufficient to prevent or limit access to exposed energized conductors or circuit parts, an attendant may be used to warn unqualified personnel about electrical hazards, which may endanger them. An Attendant may be a QEW or a non-QEW. The attendant shall:
 - ◆ Remain in the area as long as there is a potential for employees to be exposed to the electrical hazards.
 - ◆ Be stationed outside the LAB.
 - ◆ Provide manual signaling and alerting to keep non-QEWs outside a work area where the non-QEW might be exposed to electrical hazards.
- Electrical Safety Watch
 - A safety watch is a more stringent hazard control measure than the two-person rule and must be implemented when there are grave consequences from a failure to follow safe-work procedures. This occurs when work is considered high-hazard electrical work, as established by the work supervisor. The safety watch must be a QEW who is responsible for monitoring the QEW doing the work.
- Detailed information on PPE, electrical equipment, policies, practices and procedures can be found in the ESM.

6.0 Documented Information/Related Document

- 6.1.** ESH-2000-S-001 Work Planning and Control Standard
- 6.2.** ESH-7000-S-003 Lockout/Tagout Standard
- 6.3.** ESH-9000-P-001 Energized Electrical Work Permit (EEWP).
- 6.4.** SOU-3000-A-015 SURF Electrical Safety Manual
- 6.5.** EL-1000-A-001 Guideline for Authority Having Jurisdiction
- 6.6.** 29 CFR Part 1910, Occupational Safety and Health Standards, Department of Labor
- 6.7.** 29 CFR Part 1926, Safety and Health Regulations for Construction, Department of Labor
- 6.8.** NFPA 70, National Electrical Code
- 6.9.** NFPA 70B, Recommended Practice for Electrical Equipment Maintenance
- 6.10.** NFPA 70E, Standard for Electrical Safety in the Workplace
- 6.11.** NFPA 101, Life Safety Code
- 6.12.** Occupational Safety and Health Administration (OSHA) 29 CFR 1910 Subpart S and 29 CFR 1926 Subpart K