

Section 12

Electrical Safety Requirements

12.1 Scope

This section sets general electrical safety requirements for Reclamation facilities and operations to protect employees from electrical hazards. For tasks and activities that involve an exposure to hazardous electrical energy such as working on electrical equipment or interacting with energized electrical equipment, refer to FIST 5-14, *Electrical Safety Program*. For work on or near any equipment or system that produces, uses, or stores hazardous electrical energy refer to FIST 1-1, *Hazardous Energy Control Program*.

12.2 General Requirements

Reclamation’s goal is to control electrical safety hazards by de-energizing and locking out electrical equipment utilizing approved hazardous energy control procedures.

A qualified electrician or qualified employee must perform any electrical work, repair, or maintenance. This includes any work that involves removing electrical cover plates (faceplates) or control panel covers or otherwise exposing bare conductors, connectors, controls, or terminals. Qualified employees must follow the requirements identified in Table 12-1, Applicable Standards and Codes.

TABLE 12-1. Applicable Standards and Codes

Standard or Code	Title
Facilities Instructions, Standards, and Techniques (FIST) 1-1	<i>Hazardous Energy Control Program</i>
FIST 3-6	<i>Storage Batteries Maintenance and Principles</i>
FIST 5-1	<i>Personal Protective Grounding for Electric Power Facilities and Power Lines</i>
FIST 5-14	<i>Electrical Safety Program</i>
Facility-Specific Standards	<i>Facility Electrical Safety Program, Standing Operating Procedures, Written Grounding Procedures</i>
Occupational Safety and Health Administration (OSHA)	29 CFR 1926 Subpart K

Standard or Code	Title
OSHA	29 CFR 1910.269 Electrical Power Generation, Transmission, and Distribution
National Fire Protection Association (NFPA)	NFPA 70E
NFPA	NFPA 70, National Electrical Code (NEC)

12.3 Responsibilities

12.3.1 First-Line Supervisors

- 12.3.1.1 Shall ensure employees have the training and resources to perform assigned electrical work safely.
- 12.3.1.2 Shall review, update, and sign Job Hazard Analyses (JHA) prior to any electrical work performed by their employees.
- 12.3.1.3 Shall provide the necessary personal protective equipment (PPE) identified in the JHA and replace it if the condition of the PPE makes it no longer effective.
- 12.3.1.4 Shall complete Electrical Safety Training per FIST 5-14, *Electrical Safety Program*.

12.3.2 Onsite Job Leads

- 12.3.2.1 Shall review, update, and sign JHAs for electrical work they oversee.
- 12.3.2.2 Shall ensure required PPE is available and on hand at the job site prior to starting work.

12.3.3 Employees Performing the Work

- 12.3.3.1 Shall review, update, sign and follow the JHA for electrical work, including wearing PPE identified in the JHA.
- 12.3.3.2 Shall maintain electrical tools and maintenance equipment in good working condition (i.e., clean and dry state with no broken parts), and report necessary repairs to facility managers.

12.3.4 Regional Safety Manager

- 12.3.4.1 Shall provide support and guidance related to their regional facility electrical safety programs.

12.4 Training Requirements

12.4.1 Requirements

First-line supervisors must provide training to personnel to the level of work they will perform. Initial training for any employees with potential exposure to an electrical hazard while working on or around the sources of electrical energy shall include basic electrical safety training, the safe use of tools, an overview of lockout/tagout, and the proper use of PPE. All supervisors and qualified employees responsible for performing energized electrical work or risk assessment and mitigation must have Qualified Electrical Worker Safety Training and Risk Assessment and Mitigation Training as specified in OSHA 29 CFR 1910.269 and NFPA 70E. Refer to FIST 5-14 for additional detail on the training requirements for qualified electrical workers.

12.4.2 Recordkeeping

Supervisors must enter the required electrical safety training in the Department of the Interior's approved repository, managed in accordance with the Information Management Handbook as referenced in Reclamation Manual Directive and Standard, Information Management (RCD 05-01).

12.5 Pre-job Briefing and Planning Requirements

12.5.1 Job Briefing

Before starting each job that involves exposure to electrical hazards, the supervisor or designee must conduct a job briefing with all employees that use, install, or maintain electrical equipment under lockout/tagout, or that perform other jobs in an area where employees are performing such maintenance. The supervisor or designee must hold additional briefings if significant changes occur during the course of the work. The briefing must cover the following topics.

12.5.1.1 Job Hazard Analysis. The JHA must identify all electrical and nonelectrical hazards associated with the job and the supervisor or designee must discuss these hazards with the employees performing the work. Electrical hazards must include a shock risk assessment and an arc flash risk assessment.

12.5.1.2 Hierarchy of Controls. The JHA should consider and document these safety control strategies, listed below in order of decreasing effectiveness, prior to performing any electrical work.

12.5.1.2.1 Elimination. Qualified employees can achieve the elimination of risk from sources of electrical energy by de-energizing, verifying de-

energization, locking/ tagging, and applying personal protective grounds (as applicable). This is also referred to as establishing an electrically safe working condition.

- 12.5.1.2.2** **Substitution.** The substitution or replacing of high-voltage control circuitry with lower voltage control circuitry to reduce potential hazard and risk by reducing energy.
- 12.5.1.2.3** **Engineering Controls.** Protection of the worker by keeping the worker away from the source of an electrical hazard or at a reduced energy state, such as use of remote racking system, providing a faster protection system, and/or guarding energized electrical conductors and circuit parts to reduce the likelihood of electrical contact or arcing faults.
- 12.5.1.2.4** **Awareness.** Posting signs alerting to the potential presence of hazards.
- 12.5.1.2.5** **Administrative Controls.** Supervisors must consider administrative controls including training, procedures, policies, or shift scheduling that lessen the threat of an electrical hazard to an employee.
- 12.5.1.2.6** **Personal Protective Equipment.** In the case of an arc flash, PPE does not eliminate the risk of injury, rather it only reduces the severity of the injury. Employees must use PPE as the last line of defense after considering all other strategies. First line supervisors must provide, and employees must use, the appropriate PPE needed to accomplish the job safely. Employees working on energized conductors and circuit parts operating at 50 volts nominal or greater must use the appropriate level of PPE identified in NFPA 70E that meets ASTM standards.

12.6 Hazardous Environmental Conditions (Weather/Other)

Whenever possible, schedule outdoor electrical work for a time that minimizes exposure to inclement weather. When this is not possible, ensure the JHA includes controls to mitigate the effects of weather conditions, such as specialized switching gear (e.g., cold weather switching gear, wet weather switching gear) and other PPE. Refer to Reclamation Safety and Health Standard (RSHS) 4, paragraph 7.1, *Lightning Safety* for additional information.

12.7 Personal Protective Equipment

NFPA 70E 130.7 provides in-depth information on PPE selection, care, and restricted items.

12.7.1 Arc Rated PPE

All employees, when working within the arc flash protection boundary, must wear non-melting, treated or untreated, natural fiber, or arc rated (AR) clothing. This includes undergarments, as a base to the appropriate PPE to protect the body from severe injury

from an arc flash. AR clothing is a form of PPE. All AR PPE clothing worn within the arc flash boundary must meet the requirements of ASTM F1506. When the work requires AR PPE clothing, employees must follow the direction of NFPA 70E, and the PPE must allow for movement and visibility.

12.7.2 Shock Protective Equipment and Clothing

When working within shock protection boundaries, employees must wear shock protective PPE at the level identified in NFPA 70E. Reclamation does not permit conductive apparel including clothing, jewelry, or other personal items when working on or near exposed electrical conductors or circuit parts.

12.8 Safe Practices

12.8.1 Electrically Safe Working Conditions

Establishing an electrically safe work condition (ESWC) is the safest method for working on electrical equipment or circuit parts. For details on establishing an ESWC, see FIST 5-14.

12.8.1.1 Non-ESWC Work and Normal Operations. Not all electrical work can be performed under an ESWC. Supervisors must consider safety control strategies to bring the hazardous energy down to the lowest level possible before working on energized electrical equipment. For details on conditions that may justify working on energized equipment, see FIST 5-14 and OSHA 1910.269, *Electric power generation, transmission, and distribution*.

12.8.2 Approach Boundaries

Prior to entering the arc flash boundary, shock protection boundary, limited approach boundary, or restricted approach boundary, qualified employees must meet the requirements of this RSHS section, FIST 1-1, and FIST 5-14. For approach boundary distances, see NFPA 70E table 2-1.3.4 and OSHA 29 CFR, 1910.269 table R6. Unqualified employees must not enter any of these boundaries.

12.8.3 Access Control

12.8.3.1 General. The facility must provide effective barriers or other means to ensure that people do not enter areas with exposed energized lines, electrical circuits, or equipment as passageways. The facility must also effectively guard live wiring or equipment to protect persons or objects from harmful contact.

12.8.3.2 Perimeter Markings. Onsite job leads should use approved perimeter markings to isolate restricted areas from designated work areas and entryways. The onsite job lead must erect approved perimeter markings (e.g., barricades and/or synthetic rope) before work begins and maintain them for the duration of work. The qualified employee must indicate on the barrier the name and contact information for the employee in charge. Approved perimeter marking must be:

- a. Barrier Tape. Install red barrier tape printed with the words “DANGER—HIGH VOLTAGE” around the perimeter of the work area and accessway approximately 42 inches above the floor or work surface.
- b. Synthetic Rope Barrier. Install a barrier of yellow or orange synthetic rope 36 to 45 inches from the floor with standard danger signs of non-conductive material attached at 10-foot intervals containing the words “DANGER—HIGH VOLTAGE.”

12.8.3.3 Barriers. Onsite job leads must construct and place fences, screens, partitions, or walls sufficient to prevent unqualified personnel or their equipment from entering the arc flash hazard or limited approach boundaries at the job site when live conductors are exposed or energized work is being performed. The onsite job lead must mark this barrier with tape or signage stating “DANGER—HIGH-VOLTAGE.” Only qualified employees authorized to perform the required work may cross this barrier.

12.8.3.4 Working Space. The onsite job lead must provide a working space of at least the width of the equipment or 30 inches (whichever is greater) horizontally where qualified employees will require front or rear access to work on energized parts of enclosed equipment. Doors and hinged panels must be able to open to at least 90 degrees. Employees must not store parts, tools, or equipment in the clear space.

12.8.3.5 Passage Barriers. The onsite job lead must use effective barriers or other means (barricades) to ensure employees do not use areas containing electrical circuits or equipment as passageways when energized lines or equipment are exposed for testing or maintenance. This includes open doors on motor control centers and switchgear.

12.8.4 Working Near Exposed Energized Conductors or Circuit Parts

12.8.4.1 General. To reduce the risk of electrical injury from exposure to an energized electrical conductor or circuit part, qualified employees must follow the approach boundaries specified in NFPA 70E subsection 12.8. This subsection discusses specific hazard identification and safety measures required of qualified and

unqualified employees while working on or near exposed energized electrical conductors or circuits.

12.8.5 Underground Lines

The facility must protect employees from all hazardous underground lines by installing surface signs and a longitudinal warning tape buried 12 to 18 inches above the lines. Qualified employees must not perform drilling, augering, or material excavating operations within 6 feet of underground lines unless the lines have been de-energized. Call 811 (the national call-before-you-dig number) to request marking of the approximate location of buried utilities with paint or flags prior to digging. Also contact any local utilities to ensure any other utilities/services that 811 may not cover or identify have been located.

12.8.6 Overhead Lines

The facility must protect employees from all hazardous overhead lines by implementing the following:

12.8.6.1 Equipment Transit Clearances. A signal or flag person must guide cranes, cherry pickers, high lifts, and other equipment in transit near exposed energized lines or parts at all times. Qualified employees or operators must not move any equipment or machinery under energized overhead high-voltage lines or near exposed energized parts unless employees confirm or maintain clearances listed in NFPA 70E. All employees are responsible for prohibiting equipment from coming any closer to overhead high-voltage lines or exposed energized parts than the distances required in NFPA 70E and OSHA 1926.1408, *Power line safety (up to 350 kV)--equipment operations*.

12.8.6.2 Sign Posting. It is the responsibility of the onsite job lead to post appropriate signs at all crossings where employees will move equipment under energized high-voltage lines. The onsite job lead must place the signs 50 feet from, and on both sides of, the lines. Signs must be large enough for employees to easily read them from moving equipment. The sign must include the following information:

- warning of the high-voltage line,
- line voltage, and
- maximum height of equipment that may pass under the line.

A qualified employee must determine the maximum allowable height of the equipment.

12.8.6.3 Placard Posting in Equipment Cabs. Onsite job leads must post a placard of minimum clearances in the cabs of all cranes, cherry pickers, shovels, backhoes, and any other equipment with booms or extensions that could possibly contact high-voltage lines. Clearances can be found in OSHA 1926.1408(d), *Operations below power lines*. Placards posted in machines must be made of a substantial material suitable for the environment. Devices originally designed by the manufacturer for use as a safety device (see § 1926.1415), operational aid, or a means to prevent power line contact or electrocution, when used to comply with this section, must meet the manufacturer's procedures for use and conditions of use.

12.8.7 Electrical Equipment and Systems

Electrical wire, conduit, apparatus, power tools, and equipment used must be approved or listed by Underwriters Laboratories Inc., FM Global, or another nationally recognized testing laboratory for specific applications. This approval or listing must appear on each piece of equipment or tool as part of the marking or labeling required below. A requirement for approval or listing of other types of electrical equipment is at the discretion of the electrical engineer of record for the project unless required by Federal codes and standards or by NFPA codes.

12.8.7.1 Marking or Labeling. Employees must not work on electrical equipment unless the manufacturer's name, trademark, and/or other descriptive markings by which the manufacturer is identified are located on the equipment. Markings must also provide voltage, current, wattage, approvals/listings, and ratings as required by the edition of the (NEC)in effect at the time of purchase. Markings must be sufficiently durable to withstand the environment.

12.8.8 Personal Protective Grounds

The application, removal, and use of personal protective grounds must comply with the applicable sections of FIST 1-1, FIST 5-1, and FIST 5-14.

12.8.8.1 General.

Qualified employees must comply with applicable provisions of FIST Volume 5-1 "Personal Protective Grounding." Qualified employees must also include written grounding procedures in all clearances, special work permits, etc. The JHA must include the procedures and employees must discuss them before beginning work.

12.8.8.2 Over 600 Volts.

Qualified employees must place grounds as close as possible to the work and within sight of the workers for all electrical circuits and equipment operated in excess of 600 volts. The clearance holder is personally responsible for proper placement and removal of protective grounds.

12.8.8.3 Personal Protective Ground Cables.

Personal protective grounds and clamps must be capable of conducting the calculated maximum fault current available for the time necessary to clear the fault. The personal protective grounds and clamps must be sized in accordance with FIST 5-1.

12.8.8.4 Prior to Applying Grounds.

After implementing hazardous energy control, qualified employees must use a hot stick “noise tester” or similar approved device of sufficient insulating capacity to verify that the circuit or equipment is de-energized before placing personal protective grounds. Qualified employees must test the voltage tester immediately before use on a known energized source of similar voltage before testing the equipment to be worked on. Employees must consider the circuit/equipment to be worked on energized while conducting the test.

12.8.8.5 Placement and Removal of Personal Protective Grounds.

After deenergization, the qualified employee must install personal protective grounds so that all phases of lines and equipment are visibly and effectively bonded together in a multi-phase short and connected to ground at one point. The qualified employee must not use single-phase personal protective grounds or grounding chains. The qualified employee must install personal protective grounds using a hot-stick or voltage-rated gloves on both sides of the work area, if possible. This precaution prevents a possible backfeed, especially when working on transformers and related equipment. When attaching grounds, the qualified employee must attach the ground end first, and then attach the other end to the de-energized circuit. When removing personal protective grounds, the qualified employee must first remove the grounding clamp from the de-energized circuit using a hot stick or voltage-rated gloves, and then remove the other end from the ground connection.

12.8.9 Temporary Wiring

12.8.9.1 Installation and removal. Temporary wiring must meet all the requirements of the NFPA 70E. Onsite job leads may only permit temporary service, feeder, and branch circuit wiring during the period of construction, remodeling, maintenance, repair, or demolition. The onsite job lead must ensure employees remove temporary wiring immediately upon completion of construction or purpose of installing the wiring.

Temporary wiring shall be multi-conductor cord or cable of a type permitted by Article 590 of the NEC. Temporary wiring shall have a means of disconnecting such as a switch or plug connector and equipped with overcurrent protection in accordance with the NEC. Qualified employees must remove all temporary wiring from the site as soon as the work is complete.

12.8.9.2 Wet and Damp Locations. Article 310 of the NEC must list or approve any conductors used in tunnels, shafts, trenches, and wet or damp locations.

12.8.9.3 Bushings. Wiring installed in conduit must be equipped with bushings at the ends of the conduit.

12.8.9.4 Receptacles. Receptacle circuits must include ground fault protection for personnel (i.e., Ground-Fault Circuit Interrupter (GFCI)). Employees must not install receptacles at construction sites on branch circuits that supply temporary lighting. Receptacles installed in wet or damp locations shall have a weatherproof enclosure for the receptacle whether the attachment plug is inserted or not.

12.8.9.5 Lighting Strings. Temporary lighting strings must consist of nonconductive lamp sockets and connections permanently molded to the conductor insulation. All temporary lighting must use lamp guards to protect bulbs attached to festoon lighting strings and extension cords. Employees must promptly replace broken or defective bulbs and protect all lights from accidental contact or breakage.

12.8.10 Extension Cords

Extension cords must be three-wire grounded type, designated as hard service electrical cord or extra hard service electrical cord, and listed by a nationally recognized testing laboratory such as Underwriters Laboratories Inc. or FM Global. Employees must fully unwind cords prior to use. Employees must not exceed the rated load of the extension cord. Employees must only use cords in continuous lengths without splicing and must not use worn or frayed extension cords. To protect cable assemblies, flexible cords, and cables from damage, employees should provide support with approved staples, cable ties, straps, or similar fittings.

12.8.11 Prohibition of Daisy Chains

Reclamation prohibits daisy chaining, (i.e., connecting power strips or extension cords in series), as well as connecting power strips and extension cords together in any form.

12.8.12 Disconnect and Overcurrent Protection

- 12.8.12.1 Marking.** Reclamation facilities and operations must plainly mark, label, or arrange switches, fuses, and automatic circuit breakers to identify the circuits or equipment they control.
- 12.8.12.2 Switches.** Switches must have grounded enclosures and the installation must minimize the possibility of accidental operation.
- 12.8.12.3 Lockout Provision.** Reclamation facilities and operations must provide disconnects and breakers with a means of locking in the off position. Fuse cabinets and circuit breaker cabinets must have lockable doors.
- 12.8.12.4 Wet and Outside Locations.** Reclamation facilities and operations must encase switches, circuit breakers, fuse panels, and motor controllers in wet or outside locations in approved weatherproof cabinets or enclosures to prevent moisture or water from entering or accumulating within the cabinet or enclosure.
- 12.8.12.5 Service Entrance Disconnect.** Reclamation facilities and operations must install a means to disconnect the service entrance in a readily accessible location and as close as possible to the point where the service entrance conductors enter the premises. This device must disconnect all the ungrounded service entrance conductors supplying power to the service equipment. This device must also plainly indicate whether it is in the connected or disconnected position.
- 12.8.12.6 Overcurrent Protection.** Reclamation facilities and operations shall only install and use fuses or circuit breakers that provide adequate overcurrent protection at the level required for all ungrounded conductors. All overcurrent protection devices and conductors must be designed and installed according to the NEC Article 240, *Overcurrent Protection*, to ensure protection and proper installation.
- 12.8.13 Ground-Fault Protection**
- 12.8.13.1 Protection Requirement.** Per NFPA 70, *National Electrical Code*, all single-phase receptacles rated ≤ 150 volts, ≤ 50 amps, and all three-phase receptacles rated ≤ 150 volts, ≤ 100 amps must be equipped with GFCI for personnel protection when the receptacles are used for construction operations or placed outdoors or in potentially wet locations (e.g., laboratories, shops, garages, bathrooms, kitchens, rooftops, locker rooms, and crawl spaces). The GFCI must open the circuit on a ground current of 5 milliamperes and must have an integral push-button test circuit. Qualified

employees must install the GFCI in accordance with the manufacturer's instructions and test it before initial use and periodically thereafter.

12.8.14 Hazardous (Classified) Locations

A hazardous (classified) location is any location where either a fire or an explosion can occur because of the presence of flammable, combustible, or ignitable materials (e.g., gases, vapors, liquids, dust, and/or fibers). Wiring methods used in hazardous locations must comply with more stringent requirements than wiring methods used in other locations.

- 12.8.14.1 Requirements for Wiring and Equipment.** Electrical wiring and equipment installed in hazardous locations as defined in the NEC must conform to the NEC Article 500. All components and equipment used in hazardous locations must be listed suitable for such locations by a nationally recognized testing laboratory, such as Underwriters Laboratories Inc. or FM Global.
- 12.8.14.2 Marking.** Approved equipment must be marked to show the class, group, and operating temperature or temperature range referenced to a 40-degree Celsius ambient temperature. Facilities must install approved equipment in accordance with NEC requirements.
- 12.8.14.3 Intrinsically Safe Systems.** Facilities must use an intrinsically safe apparatus and wiring in any hazardous (classified) location for which Reclamation has approved the apparatus.
- 12.8.14.4 Maintenance.** Qualified employees and facilities must maintain wiring components and equipment as explosion-proof. There must be no loose or missing screws, gaskets, threaded connections, seals, or other impairments to tight conditions.

12.8.15 Wet Locations

Only the following types of electrical systems are permissible for use in wet areas where there is danger of electrical shock.

- 12.8.15.1 Ground-Fault Circuit Interrupter.** Electrical circuits for lighting, hand tools, and other portable equipment must not exceed 120 volts and must be protected by UL-listed ground-fault circuit interrupters installed by qualified employees in conformance with the manufacturer's specifications and tested before beginning work.
- 12.8.15.2 Stationary Portable Equipment.**

Qualified employees must connect stationary portable electrically-powered equipment, such as pumps, heaters, blowers, welders, transformers, etc., to a circuit protected by a ground-fault circuit interrupter or effectively ground the equipment with both an internal grounding system and a visible flexible copper ground wire.

12.8.15.3 Substitute Equipment. Whenever practical, employees must use air, battery, or hydraulically powered tools instead of electrically powered tools (i.e., tools plugged into an electrical outlet).

12.8.15.4 Receptacles. Receptacles and cord connectors used in damp or wet locations must be designed for use in damp or wet locations and, unless approved for submersion, must not be allowed to lie in water.

12.8.16 Battery Systems

Employees shall maintain battery systems in accordance with FIST 3-6.

12.9 Definitions

Qualified employee An employee performing electrical work who is trained and knowledgeable in the construction and operation of electrical equipment or a specific work method and is trained per FIST 5-14 to identify and avoid the electrical hazards that might occur in connection with that equipment or work method. A qualified employee must also be trained in the use of appropriate tools and PPE.

Ground-fault circuit interrupter (GFCI) A type of circuit breaker that shuts off electrical power when it senses an imbalance between the outgoing and incoming current.

Arc-rated (AR) clothing A form of PPE designed to protect against arc flashes. AR clothing must meet the requirements of ASTM F1506 and have the appropriate ATPV or EBT rating (in cal/cm²) listed on the label.

Approach boundaries A distance from an exposed live part within which there is an increased risk of shock due to electrical arc over combined with inadvertent movement for personnel working near the live part. For more detail, refer to FIST 5-14.

12.10 References

ASTM International. ASTM F1506 REV A - *Standard Performance Specification for Flame Resistant and Electric Arc Rated Protective Clothing Worn by Workers Exposed to Flames and Electric Arcs.*

- Bureau of Reclamation. Facilities Instructions, Standards, and Techniques, Volume 1-1, Hazardous Energy Control Program. www.usbr.gov/power/data/fist/fist1_1/FIST1-1.pdf.
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- Occupational Safety and Health Administration. 29 C.F.R. 1926 Subpart CC. 1926.1411, Power line safety-while traveling under or near power lines with no load. <https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.1411>