

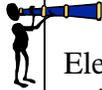
## Chapter 11

### Electrical



#### **Purpose:**

This chapter addresses the policies and procedures to be followed at Hanford to insure the safety of employees working on electrical systems.



#### **Scope:**

Electrical safety is dependent on good design and construction, and on trained and qualified personnel. Towards this end, the following topics are covered in this chapter. Other details of electrical safety appear here and many more are in referenced codes.

- ❖ Responsibilities
- ❖ Training and Qualification
- ❖ Design, Construction, Installation
- ❖ Procedures
- ❖ Protective Equipment
- ❖ Work Practices
- ❖ Maintenance and Testing
- ❖ Electrical Clearances and Work Permits
- ❖ Definitions
- ❖ References
- ❖ Attachments



#### **Responsibilities:**

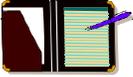
Line management shall be responsible for formal training and qualification of all electricians and line workers before they are permitted to perform electrical work.



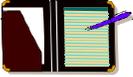
#### **Training and Qualification:**

Training and qualifications for all electrical workers shall be recorded. See Attachment 1.

1. Electrical work is defined as:
  - a) Work within the clearance distance from energized conductors. Potential mishaps shall be considered. (Clearance distance is defined by Articles 110-16 and 110-34, National Electrical Code), or
  - b) Work involving facility wiring or electrical components of a building, structure or line, or
  - c) Work involving electrical conductors or components which normally operate at voltages of 150 volts to ground or greater, grounded or ungrounded, (or 250 volts line to line or greater) and have input power capability of 1.5 kilowatts or more, except as specifically assigned in writing to experimental functions.



2. Line work is defined as work on electrical poles, on aerial lines, from aerial work platforms, etc.
3. A formal program of training and qualification for all electricians shall be required. It shall include both classroom and practical aspects, and applied demonstrations and tests. Qualification shall be recorded.
4. Re-qualification shall be required at periods not to exceed three years.
5. Line worker training and qualification shall include the same requirements as for electricians, and, in addition, shall include the safety procedures required for aerial work (see 2 above).
6. Both electricians and line workers shall be trained in first aid and cardiopulmonary resuscitation. This training shall be as prescribed by recognized agencies and renewed as required for current certification.
7. Persons qualified by training and experience as electricians and/or line workers before their arrival on the Hanford Site may be accepted as qualified until they have had a reasonable time to qualify on the Hanford Site. Supervisors shall record such temporary qualifications.
8. Lockout/Tagout Qualifications for Federal Employees  
Responsibilities and authorities necessary to allow RL employees to apply lockout/tagout in the role of authorized workers, and maintain a safe working environment, as required by 29 CFR 1960, Subparts A and C shall be assigned in accordance with this section.
  - a. RL Lock and Tag Program Manager shall provide technical guidance and assistance to RL management and employees for the purpose of Lockout qualifications.
  - b. RL management shall ensure that employees whose duties include the need to apply Lockout are qualified to do so in accordance with the following procedure:  
  
Procedures
    - a. To be qualified to apply Lockout and perform as the authorized worker, the employee shall be trained in the Hanford Site Lockout/Tagout Program (DOE-RL-SOD-INST-L&T.001) by either passing the Authorized Worker Lock and Tag Training (#003034 or equivalent) given by the contractor or via an indepth verbal examination of knowledge of the subject by the RL Lock and Tag Program Manager with a qualification certificate given in Attachment 2.



- b. When applying a lockout, the employee shall contact the controlling organization of that lockout for the purpose of facility orientation and interface with the controlling organization's hazardous energy control program.
- c. If the employee is not qualified to apply lockout the provision for outside personnel in the Hanford Site Lockout/Tagout Program, and the controlling organization's hazardous energy control program may be used if all individuals involved agree to invoke those provisions.



### **Design, Construction, Installation:**

1. The design, construction, and installation of permanent electrical systems and equipment shall be as required.
2. Whenever possible, electrical equipment shall be UL listed.

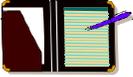


### **Procedures:**

Only qualified electricians and/or line workers may work on electrical systems, which normally operate at greater than 150V line to ground or 240V line to line. Except in emergencies, electrical work shall be performed according to written procedures or approved electrical safety rules or manuals. A supervisor qualified by training and experience in electrical work shall direct emergency electrical work, and who is in the direct line of supervisory responsibility.

1. An electrical procedure shall be based on a thorough analysis of the job and its hazards. Simpler tasks of a repetitive nature may be performed under specific work rules, which are based on such analyses.
2. If no specific procedure is available, and the job is beyond the scope of written work rules, some kind of work permit may be used. The permit shall contain essential safety rules for the job and shall be signed by line supervision and a safety representative.
3. Instrumental or experimental electrical equipment with 300 volts or more, and with an energy equivalent of 0.25 joules or more, shall require safeguards equal to electrical work. If the energy equivalent is 15 joules or more, a lethal hazard exists and such work shall be done according to special procedures approved by the local safety authority.

Safe work procedures shall consider, and provide, as necessary:

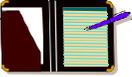


1. De-energized circuits, if possible, and means to prevent re-energizing. A lock and tag is the preferred way to assure an open switch.
2. Decay or drain of capacitance charges.
3. Grounding conductors and all possible conducting parts.
4. Control of associated generating equipment.
5. Testing of equipment to assure safe conditions.
6. Proper insulated tools.
7. Insulating protective equipment.
8. Qualified and equipped stand-by personnel.
  - a) Workers shall correct and/or report to their immediate supervision all electrical hazards that come to their attention.
  - b) Electrical workers shall use insofar as practicable, insulated tools.
  - c) Electrical workers shall not use metal ladders, or flashlights with conductive cases.
  - d) Care must be taken in operating load switches and transformers to assure a proper sequence to protect both the worker and the equipment.
  - e) Special provisions shall be made for handling and/or disposing of polychlorinated biphenyls (PCB's) and PCB contaminated equipment. Electrical equipment containing PCB's shall not be procured. Transfers and reinstallations of electrical equipment containing PCB's shall require the approval of the responsible safety authority.



#### **Protective Equipment:**

1. Insulating equipment, gloves, sleeves, hose, hoods, blankets, and mats shall be manufactured, tested, controlled, and used according to the provisions in the ANSI Codes. Note that the insulating values of classes of these items vary. The ANSI codes shall be consulted as to the maximum voltage on which each class may be used.
2. Where head contact with energized equipment is possible, nonconductive hard hats shall be worn. Their care and use shall be according to the ANSI Z89 Series.
3. Where the work threatens the integrity of required insulating rubber gloves, clean, dry, leather gloves shall be used to protect the rubber.
4. When contact work is to be done on energized conductors at 400 volts or more, eye and face protection shall be provided and used. Specific rules shall be devised and followed.
5. Insulated high voltage tools such as "Hot Sticks," fuse pullers, etc., shall be inspected before each use, and shall be tested on a regular



schedule. Tools shall be tagged with the date of last test. New tools shall require a manufacturer's certificate of testing.

6. Tools shall be kept clean and free of surface contamination.



#### **Work Practices:**

This section lists some, not all, of the safety aspects that must be considered.

#### De-energized Circuits

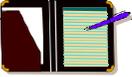
Whenever practicable, electrical work shall be done on de-energized equipment. These following precautions are required:

1. Open all sources of power, switches, fuses, circuit breakers, etc. If possible, jack open breakers. Disconnect leads.
2. Lock out and Tag switches and breakers.
3. Allow plenty of time for stored charges (capacitance) to drain or decay. Bleed off charges by safe procedures, which should be prepared in advance.
4. Grounding procedure shall be established to assure that residual charges cannot accumulate.
5. Assure that generators cannot re-energize the circuitry.
6. Use a safe test procedure to assure the circuitry and components are de-energized.
7. Aerial work on de-energized circuits shall require the same precautions as other electrical work. In addition, two assured circuit openings must exist and assured grounds shall be established on both sides of the work section.

#### Energized Circuits

Work on high voltage energized circuits shall only be performed by qualified electricians. For this purpose, high voltage is defined as 1.5 kW capacity or greater and /or more than 150 V to ground (grounded or ungrounded), or 240 V line to line. Exceptions may be made for experimental functions where they are approved in writing by the local safety authority.

When an electrical box or panel, normally provided with a cover or door, contains energized components and is without a cover or door, a protective



cover of non-conductive material shall be placed over the open face of the box or panel.

Except in emergencies and for trouble-shooting (approved by supervision), the following rules apply to energized high voltage work:

1. Appropriate, approved and tested protective clothing and equipment shall be used.
2. A qualified, briefed, and equipped electrician or line worker, as appropriate, shall stand by with no other duties.
3. Work shall be done according to approved, detailed written procedures.

#### Switches and Fuses

Operation of load switches shall require the operator to first close the cover and stand as clear as possible. Insertion or removal of fuses in energized circuits requires the employee to use face and eye protection. Circuits should be de-energized if practicable. Fuse pullers of the proper insulation value shall be used for fuse insertion or removal in circuits of 400 V and higher.

#### Instruments for Electrical Measurements

Instruments for Electrical Measurements shall be used according to manufacturer's directions or specific written procedures. There are many risks associated with the use of such instruments and the procedures shall consider all the necessary precautions. Some of these risks are:

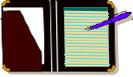
1. Deterioration or damage.
2. Inadequate insulation and/or fusing.
3. Inadequate or improper identification of instruments or leads.
4. Confusion of special leads, adapters, etc., with those regularly used.
5. Lack of use of a required ground.
6. Failure to use safest points of connection.
7. Failure to use protective equipment.

#### Portable Electric Equipment, Cords, GFCI's

All practical means shall be used to prevent low level electric shock. The requirements in the Subpart and in Subpart M of this manual are minimum requirements.

#### Tools and Lamps

1. Portable electric tools shall be inspected and tested semi-annually for all aspects of safety and shall be marked or labeled to determine compliance.
2. Portable electric tools shall be double insulated, case grounded, or low voltage. They shall be visually inspected before each use.

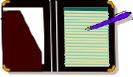


(Cordless battery-powered tools are exempt from this and from (1) above.)

3. In wet or extremely damp areas, or where workers are well grounded by pipes, tanks, etc., portable power tools must be cordless, GFCI protected, or connected to an assured grounding system (29 CFR 1910, Subpart S.)
4. Trouble lamps of the non-grounded, double insulated type, where not otherwise restricted, may be used if the lamp guards are on non-conducting material. Conducting lamp guards, even if coated with insulating material, shall be grounded.
5. Low voltage tools shall be powered from an isolating transformer supplying not more than 50 volts. Both transformers and tools shall be tested and marked as are other portable power tools. The maximum leakage rate, primary to secondary and secondary to ground, shall be 4 ma.
6. Underwater lights and similar devices shall have non-current carrying conductive parts grounded by a three (or more) wire grounding cord and plug with GFCI, or they shall be of the low voltage isolating referred to in (5) above.
7. Twelve volts (open circuit) shall not be exceeded for portable electric lighting used in hazardous locations such as drums, tanks, vessels, etc., (29 CFR 1926.401). NFPA 70, Chapter 5, shall be followed carefully with respect to electrical equipment near sources of flammable vapors.

#### Extension and Flexible Cords

1. Extension cords shall be visually inspected before each use. Flawed cords shall not be used.
2. Cords and connectors shall be protected from wet or damp conditions, from traffic of all kinds, from excessive heat, from chemicals, and from other agents which might cause failure.
3. Cords shall have conductors of a size appropriate to the required service and the length of the cord. (NEC Table 400-4)
4. Plugs and sockets shall be of the dead-front, molded, semi-rigid type.
5. Cords shall be of a service type appropriate to the usage.



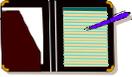
6. Examples are:
  - a) Hand held electrical devices shall be supplied by “Extra Hard Usage” cords.
  - b) Laboratory or bench type electrical equipment shall use “Extra Hard Usage” or “Hard Usage” cords.
  - c) Office type electrical equipment shall use any appropriate three-wire cord.
7. Extension cords smaller than #8 AWG shall not be spliced. Splices, where used, shall comply with NEC 400-9.
8. The following types of cords connected devices shall be grounded by three (or more) wire cords and plugs.
  - a) Equipment described in Section 250.45 (c) and (d) NEC. (Refrigerators, washing machines, etc.)
  - b) Water coolers, portable fans and heaters.
  - c) Office equipment such as typewriters and cord connected calculators, reproduction machines, etc.
9. Annual ground adequacy and continuity tests, similar to those on portable tools, are required on the following types of cord connected equipment. Contractors shall develop implementing programs.
  - a) Water Coolers
  - b) Washing Machines, all types.
  - c) Laboratory or test equipment using conductive fluids or used in all wet areas.The equipment shall be marked or tagged to indicate the date of the last test.

Ground Fault Circuit Interrupter (GFCI's)

GFCI protection shall be provided for single-phase circuits that supply grounded electrical tools under any of the following circumstances.

1. Outdoors
2. Indoors in a wet or damp area
3. Where the worker is likely to be well grounded (in or on tank, pipes, metal, damp concrete, etc.)
4. Within three feet of grounded metal (structural members, fixed ladders, etc.)

Under the circumstance listed immediately above, portable GFCI's shall not be used where permanent GFCI is not provided. Portable GFCI's shall be trip tested by the user each day before use to assure that the device is functional. Portable GFCI's shall be ground current trip tested at 5 ma ( $\pm 1$  ma) upon receipt and at six month intervals thereafter. Each device shall be marked or tagged to indicate the date of last test. GFCI's shall not



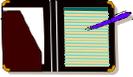
be relied upon for complete protection from electrical shock, since there is still a remote chance of injury within the trip time of a GFCI. All other protective measures are still required.



### **Maintenance and Testing:**

Adequate maintenance of electrical systems is inseparable from an adequate testing program. Therefore, this section is based on test being performed at specified intervals and corrective action where those tests indicate deficiencies. Obvious defects, such as corroded or discolored fixtures, charred insulation, etc., should be noted and corrected during the regular testing and maintenance program.

1. Electrical equipment shall be maintained at design and installation standards.
2. Qualified personnel shall perform inspections and tests.
3. All grounding systems shall be inspected and/or tested at specified intervals. Standard inspection and test forms for the various types of equipment shall be developed and used.
4. All grounding systems shall be tested and inspected at installation and at specified periods thereafter. A reliable test method shall be used and results must meet design standards.
5. Circuit breakers should be exercised upon installation and annually thereafter. A complete testing program should be based on NEMA AB-1, "Field Tests."
6. GFCI's should be trip tested at installation and at:
  - a) Three year intervals if panel board or permanent receptacle mounted.
  - b) Annually, if used on panels for outdoor receptacles, or on construction or experimental circuits.
  - c) Semi-annually, for portable use.
7. Aluminum conductor terminals used indoors shall be inspected and tested for tightness at least annually.
8. Un-grounded systems of 480 volts and higher should receive charging current tests at specified intervals.
9. Liquid cooled transformers shall be inspected at specified intervals. Special care must be exercised in handling PCB's and equipment using PCB's.



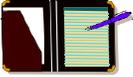
10. Switchgear protective relays should be inspected and tested at intervals not to exceed two years.
11. All other electrical equipment should be inspected, and tested if indicated, at specified intervals.
12. Electrical drawings shall be kept current. A rigid system of recording changes in electrical systems, and then integrating those changes into the applicable drawings, shall be enforced.



#### **Electrical Clearances and Work Permits:**

A system of “Clearances” and “Work Permits” shall be used whenever work is to be done on, or in proximity to, electrical lines or equipment energized to 600 V or greater.

1. Clearances
  - a) A clearance shall be required when work is to be done on or within 10 feet of normally energized high voltage line or equipment. A clearance may be obtained for other justifiable reasons.
  - b) A clearance is assurance to the person to whom it is issued that the line or equipment covered by the clearance is de-energized and will not be energized by normal means until the clearance is released.
2. Work Permits
  - a) A work permit shall be required when mechanical equipment capable of contact must work within 10 feet to 50 feet of energized high voltage electrical lines or equipment.
  - b) A work permit shall be required when work is to be done on energized high voltage electrical equipment.
  - c) A work permit is assurance to the person to whom it is issued that if the line or equipment covered by the work permit is de-energized for whatever reason, it will not be re-energized until the person to whom the work permit is issued reports that his operation is in the clear.
3. System Controls
  - a) High voltage electrical lines and equipment down to the 13kV substations serving the operating areas are under the control of the Hanford service contractor power engineer. The 138 kV transformer secondary mains and tie breakers are similarly controlled.
  - b) The substations serving the operating areas, and high voltage equipment within those areas, are under the control of the respective operating contractors.



4. Request Procedure
  - a) Requests from operating contractors for clearances or work permits from the primary Hanford system shall be made to the Hanford service contractor's "Power Engineer."
  - b) Requests from construction contractors for clearances or work permits from the primary Hanford system shall be made through the responsible resident, liaison, or construction engineer to the Hanford service contractor's, "Power Engineer."
  - c) Requests for clearances or work permits in the operating areas shall be made to the respective operating contractors.
  
5. Service Contractor Procedures
  - a) The Hanford service contractor shall supply appropriate forms for application for clearances and work permits. These forms shall require all the information needed by the power dispatcher or area supervisor to fulfill his responsibilities.
  - b) The Hanford service contractor shall develop procedures and check lists that assure that the requirements of clearances and checklists are met with the maximum degree of safety.
  
6. Proximity to All Overhead Lines  
See 29 CFR 1926.550 for rules applying to work in proximity to all overhead lines.



**Definitions:**

1. "Deadfront" – An assembly where no energized parts are accessible without removing covers (generally screwed or bolted). A recognized deadfront plug is incapable of operation with cover removed.
  
2. "GFI or GFCI" – A ground fault circuit interrupter used for personnel protection with a t milliamp ( $\pm 1$  ma) ground fault current trip setting.
  
3. "Ground Fault Protection (Equipment)" – A device for detecting and acting upon equipment ground faults – generally in the order of 100's of amperes.
  
4. "Hot Stick" R – This term is a registered brand name, in common usage to indicate a tool, insulated for the rated voltage, and use with or without special fittings for a variety of electrical jobs.
  
5. "N.E.C." – The National Electrical Code, also approved as ANSI Standard C-1, NFPA #70, and incorporated intact into 29 CFR 1910.309 (OSHA).



6. “NEMA” – The National Electrical Manufacturers Association which publishes numerous electrical manufacturing and acceptance testing standards.
7. “PCB” – Polychlorinated biphenyl – An organic chemical liquid used as a dielectric and/or coolant in transformers, capacitors, etc. Common trade names (all registered) are “Askarel,” “Chlorextol,” “Clorinol,” “Dykanol,” “Elemex,” “Inerteen,” “LMX,” “No-flamol,” “Pyranol,” “SAF-T-Kuhl,” “Therminol,” and “Aroclors.”
8. “UL” or “Underwriters Laboratory” – An independent testing laboratory. UL, with Factory Mutual and Electrical Testing Laboratory, are the only approved testing laboratories which can approve electrical components in accordance with OSHA. There are certain limited exceptions which may be approved elsewhere or in other manners.
9. “Work” – The accepted definition of work, expanded to include measuring, checking, trouble-shooting, etc., and where contact with energized components is possible by slipping, tripping, falling, actions of others, or other inadvertent action of reasonable probability.



#### References:

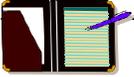
The National Electrical Code (ANSI C.1 or NFPA 70) is the primary reference for safe electrical installations.

- ❖ 29 CFR 1910, Subpart S, “Electrical”
- ❖ 29 CFR 1926, Subpart K, “Electrical”
- ❖ ANSI C.1, “National Electrical Code”
- ❖ ANSI C.2, “National Electrical Safety Code”
- ❖ ANSI D 120, D 178, D 1048 through D 1051, (Testing of Rubber Protective Gear)



#### Attachments:

- ❖ Attachment 1: *Electrical Worker Training and Qualification Records*
- ❖ Attachment 2: *Lockout Qualification Certificate for RL Employees*



**Attachment 1:**  
*Electrical Worker Training and Qualification Records*



Please insert a copy of applicable records following this page or indicate the location of these records on the form below.

Facility Name:		
Records Location:	Initial:	Date:

**Attachment 2:**  
*Lockout Qualification Certificate for RL Employees*

\_\_\_\_\_  
(name of RL employee)

The above mentioned RL employee has completed training in the Hanford Site Lockout/Tagout Program (DOE-RL-SOD-INST-L&T.001).

This qualification allows the RL employee to perform the duties of an authorized worker for RL and apply lockout by interfacing with the controlling organization in charge of the lockout.

This qualification is valid until the last day of the month of the one year anniversary of the below date.

\_\_\_\_\_  
RL Lock and Tag Program Manager

\_\_\_\_\_  
Date