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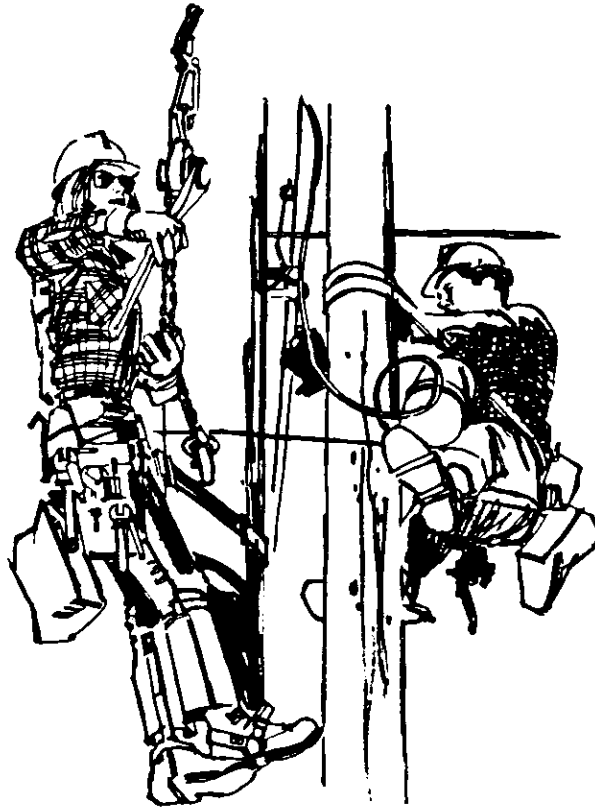
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Electrical Transmission and Distribution Safety Manual

**NAVFAC P-1060
July 1990**



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ABSTRACT

This Safety Manual P-1 060 is directed to operators, electricians and supervisors who perform and supervise operations and maintenance work.

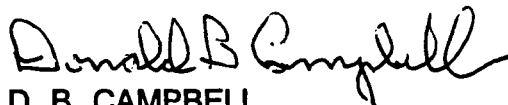
The manual is divided into four chapters. Chapter one covers definitions and general safety practices. Chapter two deals with switching, tagging, testing of circuits and equipment, while chapter three covers overhead lines, switchyards and substations. Chapter four addresses underground line maintenance.

FOREWORD

This publication provides guidelines on the safe operation and maintenance of electrical equipment and installations used for transmission and distribution of electrical power.

For maximum benefit, this manual should be used in conjunction with equipment manufacturers' manuals, parts lists and drawings. In case of conflict, manufacturers' recommendations on use, care, operations adjustment and repair of specific equipment should be followed. The manual is a general guide which establishes standards for the operators, electricians and supervisors who are responsible for carrying out operations and maintenance functions.

Additional information concerning procedures, suggestions, recommendations or modifications that will improve this manual are continually invited and should be submitted through appropriate channels to the Commander, Naval Facilities Engineering Command, (Attention: Code 165) 200 Stovall Street, Alexandria, VA 22332-2300.



D. B. CAMPBELL
Captain, CEC, U. S. Navy
Deputy Commander for
Public Works

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CHAPTER 1. GENERAL SAFETY PRACTICES

1. PURPOSE

The purpose of this manual is to provide facilities engineers with a general understanding of electrical safety and an awareness of electrical hazards in Transmission and Distribution Maintenance work.

2. JOB HAZARDS

Awareness of hazards is the key to accident prevention. Examples of job hazards are:

Electrical shock

Electrical burn - eyes/skin

Chemical, Polychlorinated biphenyl (PCB)

Confined space (oxygen deficiency)

Explosive vapor (battery charging)

Traffic

Heights

Obstacles (tripping)

3. POTENTIAL HAZARDS

Electrical shock is caused by current flow from a live conductor through the body to ground. The degree of shock and heart damage vary with the amount of current. Less than 50 milliamps can stun a person and reduce muscle functions. More than 50 milliamps can cause burns, chest pains and involuntary contractions with heart stoppage. Heavy current arcs can result in flash burns and ultra violet light. The latter can cause temporary blindness.

Chemicals such as polychlorinated biphenyl (PCB) are used in transformers and capacitors. PCB fluid is toxic and hazardous to health. It should be handled with care and any leaks should be monitored and stopped.

Battery rooms should be located in a ventilated corner of the control room because of potentially explosive hydrogen gas released from the battery acid. Combustible gases can accumulate in transformer vaults and manholes. A spark or a flame, e.g., smoking in the vicinity, can ignite these gases.

Improper work area set up, i.e., poor signs, traffic control or security could result in an accident. Vehicle operators should watch out for obstacles such as a high voltage pole and also for pedestrians. Activity regulations, federal regulations and safe working procedures should be followed. Planning should be tailored to the work site.

Personal judgement and individual alertness are essential elements in carrying out the job. Tripping over a wire or walking under a ladder are examples of personal hazards. Personal safety equipment prescribed by the activity Safety Office should be used. It generally includes:

Safety glasses and goggles

Safety boots

Non-conductive hard hats which serve as both protection and insulation

Work gloves

Long sleeved cotton work shirts secured at the cuffs. Do not wear loose clothing and jewelry. Avoid synthetic fabrics which can propagate fire. In warm climates, long sleeved shirts may be waived at the discretion of the supervisor.

4. ELECTRIC SERVICE HAZARDS

a. When installing or reconnecting circuits, an approved voltage check shall be made to verify voltages and phase connections.

b. Before starting work where the source of supply to polyphase motors is to be interrupted for transformer, line or service change, a phase rotation and voltage check shall be made before interruption, and compared to another phase rotation and voltage check before energizing to assure correct rotation of motors.

c. Service wires to any equipment shall be identified and labeled or marked when disconnecting service wires. Feed-backs may be caused by capacitors, battery charging apparatus, motors, emergency generators, and similar equipment served. Service wires, when disconnected only at the source, shall be considered energized unless they are short-circuited and grounded.

5. GENERAL SAFETY PRACTICES

Safe practices will prevent personal injury and equipment damage. Examples of safe practices are:

Planning the job and inspecting the site.

Use of proper protective equipment to prevent shock and accidents.

Checking and maintaining tools and working equipment.

Following proper procedures.

De-energizing a line, tagging it, testing the circuit for dead and grounding it before working on it.

Locking out equipment while servicing it.

Frequent safety training.

6. PROTECTIVE DEVICES

a. Function:

Protective devices help to reduce dangers associated with electrical work by detecting or preventing electrical hazards. For safe operation, these devices must be properly installed, set, tested and maintained.

b. Detection:

Visual detection of live circuits using a glow stick or meters.

Alarm or Sound detection, e.g., a ground fault sensor with an alarm relay.

c. Prevention:

In case of a fault, i.e., ground fault or short circuit, fuses, circuit breakers, reclosers and protective relays are used. In case of an overcurrent, a fuse will automatically melt or a breaker will trip. A recloser is a breaker that automatically recloses its contacts after a preset time interval if they have opened due to a transient fault, i.e., a bird short circuiting two phases of an overhead line. Reclosers are generally single shot or three shot reclosers. Once a protective device has opened to clear a fault, the problem must be corrected before re-energizing the circuit. Protective relays act on the trip coil of a

breaker through an auxiliary relay when they sense a fault that should be cleared. Examples of protective relays are overcurrent relays and differential relays.

7. LOCKOUT/TAGOUT/TRYOUT OF HAZARDOUS ENERGY SOURCES

All Naval activities are required to comply with the latest Occupational Safety and Health Administration (OSHA) standards 29CFR1926 Subpart V. This standard covers safe work practices to be used in construction of electric transmission and distribution lines and equipment. Construction includes erection of new lines and equipment and alteration, conversion and improvement of existing equipment. Part of the standard requires that the following safety precautions be observed when working on lines and equipment rated over 600 volts. Sections of lines or equipment to be de-energized shall be clearly identified and isolated from all energy sources. The designated employee shall ensure that all switches and disconnecting devices have been de-energized, opened, tagged and locked out to indicate people are working on the circuit downstream. After all disconnecting devices have been opened, tagged and locked out, visual inspection or tests with a voltmeter or other instrument shall be conducted to insure that the equipment or lines are de-energized. Finally, protective grounds shall be placed on the disconnected lines or equipment to be worked on. In summary, all Naval activities are required to:

- a. Develop an equipment lockout control program.
- b. Ensure that new or overhauled equipment can be locked.
- c. Employ additional means to ensure safety when tags rather than locks are used by instituting an effective program.
- d. Identify and implement specific procedures (generally in writing) for the control of hazardous energy including preparations for shutdown, equipment isolation, lockout-tagout application, release of stored energy, and verification of isolation.
- e. Institute procedures for release of lockout-tagout including machine inspection, notification and safe positioning of employees, and removal of the lockout/tagout device.
- f. Obtain standardized locks and tags which indicate the identity of the employee using them, and which are of sufficient quality and durability to ensure their effectiveness.
- g. Conduct inspections of equipment lockout control procedures at least annually.
- h. Train employees in the specific equipment lockout control procedures with training reminders as part of the annual control inspections.

i. Adopt procedures to ensure safety when equipment must be tested during servicing, when outside contractors are working at the site, when a multiple lockout is needed for a crew servicing equipment, and when shifts or personnel change.

8. TRAINING.

Not enough emphasis can be placed on the need for well trained operators, both in day-to-day operations such as using a bucket truck and in rescue operations. Annual training in Cardiopulmonary Resuscitation (CPR) is required. Crews generally work in pairs or a team. Each crew member should be trained to go to a crewmate's rescue if the person appears to need help, providing the helper himself is not in any danger whatsoever. Crews should be trained to inspect bucket trucks before use on a job. Training in visual inspection for damage, hydraulic fluid leaks, abraded hoses, securely fastened components etc., should be given. Crews should also be trained to check control system functions and practice operating the boom from the main control system on the bucket, as well as from the back up system on the truck. Crews should verify that all vehicles including aerial lift trucks are chocked when parked at a work site.

The following topics should be included in an activity's training program:

Basic electrical theory and practice:

Training in general safety practices.

Awareness of potential hazards.

Attitude towards the job.

Proper attire.

Use of personal safety equipment, e.g., hard hat, safety glasses.

Inspection, maintenance and test of tools and equipment.

Regulations and proper procedures for operation of tools, equipment and protective devices.

Teamwork and communication. Supervisory interface with team.

Use of reference manuals, e.g., NAVFAC P-1060, PWC 5100.xx et al.

Specific job training:

On the job training (OJT) in high voltage work.

Job hazard planning and analysis. Job site briefing before work begins.

Lock out/tag out procedures.

Confined space training.

Rescue operations, including CPR.

Training Seminars:

Should be held in-house at the PWC, EFD or activity.

Supplementary training from commercial sources, i.e., General Electric, Multi-Amp, should be scheduled as required.

9. RESCUE OPERATIONS

Rescue operations will vary with the individual situation. A good rule of thumb is never to touch any live parts or any person in contact with live parts without using an insulating medium. Always wear personal protective equipment. Before rendering any assistance, the rescuer should make an emergency call to the dispatcher on the two-way radio or the nearest telephone. He/she should quickly pinpoint the location of the mishap, describe the problem and the assistance required.

10. POLYCHLORINATED BIPHENYL (PCBs) - INSULATING FLUIDS

The term Polychlorinated Biphenyl (PCBs), also known under the general trade name of “askarel” generally describes a broad class of non-flammable synthetic chlorinated hydrocarbon insulating liquids used in capacitors, street light ballasts, transformers, and accessory equipment operated at power frequencies.

If the liquid from any of these types of equipment contacts exposed parts of the body, or is ingested, check the tag on the equipment to determine if the liquid is oil or an askarel. Askarel may be designated by a trade name such as Aroclor, Diaclor, Pyranol, Inerteen, etc.

It is beyond the scope of this manual to prescribe procedures to follow in the event of a release of PCBs due to leakage, fire or explosion. The installation safety office and/or environmental division should be consulted to establish contingency plans to be followed in the event of an emergency involving the release of PCBs. In the event a worker discovers a release of PCBs, take whatever measures can be SAFELY taken

to stop or contain the release **WITHOUT COMING INTO CONTACT** with the PCBs, e.g., close valves, erect temporary dikes, etc. and immediately notify the installation safety office, environmental division or other appropriate authority as established by local policies.

a. Objectives

(1) To provide for the protection of personnel from adverse health effects which may result from exposure to Askarel.

(2) To prevent contamination of the environment when handling damaged equipment from which askarel is leaking and to safely dispose of capacitors, street light ballasts and transformers that are no longer useful.

b. General safety precautions

Under normal circumstances capacitor grade askarel does not create a hazard provided precautions are taken to avoid direct skin contact, ingestion, or inhalation.

(1) Avoid breathing vapor from askarel. This is normally not a hazard but can be under some circumstances such as warm, confined spaces with open askarel containers. Consult with the installation safety office for recommendations concerning respiratory protection requirements.

(2) Allow overheated transformers to cool before performing work on them.

(3) Avoid skin contact with liquid askarel.

(4) Ingestion of askarel is rare. Should ingestion occur, do not induce vomiting. Inform your supervisor and seek medical assistance. Report to the base dispensary/clinic.

(5) Wash with warm water and soap before eating, drinking, smoking or using toilet facilities following possible exposure to askarels.

(6) Should you develop skin rashes or respiratory tract irritation while working with askarels, inform your supervisor and seek medical assistance from the base dispensary/clinic.

(7) In case of slight spillage on your personal clothing, remove it as soon as practical, wash your skin and launder clothing. If clothing is saturated, remove it as soon as possible, wash skin thoroughly with water, place clothing in a plastic bag, dispose of it in accordance with local policies for handling hazardous waste.

(8) If liquid askarel contacts your eyes, irrigate your eyes immediately with large quantities of water for 15 minutes and then have them examined at the base dispensary/clinic.

c. Protective clothing

(1) Nitrite and neoprene are suitable materials for gloves, boots and aprons used during routine handling of PCB containing equipment. Where significant exposure to PCBs is expected such as during cleanup of spills, more extensive protection using other materials may be needed. Consult with the activity safety office for requirements under unusual circumstances.

(2) Eye protection must be worn where there is a risk that askarel might be splashed in the eyes. Chemical splash goggles or a face shield are acceptable eye protection.

d. Handling damaged capacitors or transformers from which askarel is leaking.

Regulations and procedures for handling and disposal of leaking PCB containing equipment are sometimes quite complex and beyond the scope of this manual. Contact the activity safety office and/or environmental division concerning appropriate protective clothing, handling and disposal procedures.

CHAPTER 2. SWITCHING, TAGGING, TESTING OF CIRCUITS AND EQUIPMENT

1. SWITCHING, TAGGING, TESTING FOR DEAD AND PROTECTIVE GROUNDING

a. General

(1) Applicability

These switching and tagging procedures are applicable to circuits and equipment at all Naval activities.

(2) Circuit/Equipment Access

No person shall access any electric system circuit or equipment requiring switching, tagging and supervisor's permission until:

(a) It has been de-energized, tested dead

(b) It has been isolated, tested dead

(c) It has been locked out and tagged out

(d) It has been grounded, if required, and

(e) Permission has been granted by the supervisor and the person has reported "On" to perform work.

b. Authority

Power dispatching supervisors have the authority to:

(1) Order switching on circuits and equipment.

(2) Order the placement and removal of "Danger-Hold" tags.

(3) Order the placement and removal of grounds.

(4) Report authorized persons "On" and "Off" circuits and equipment.

c . T a g s

(1) "Danger-Hold" Tag

A “Danger-Hold” tag, for use by substations or for field tagging by work crews shall be placed at each disconnection location isolating a de-energized circuit from all sources:

- (a) For protection of workers.
- (b) To prevent circuits which are unavailable for service from being energized.

(2) A “Danger-Hold” tag shall also be placed on a circuit energized from its normal or any other source in any of the following situations:

- (a) A circuit or equipment under test.
- (b) Work with live line tools.
- (c) Proximity work.
- (d) An abnormal operating condition.

Note: All tags shall include the employee’s name and the date so that circuit status can be verified.

d. Tag Placement

Preparing circuit for work

Before any employee or work crew shall work on an electric system power circuit, except for authorized live line work, the circuit shall be de-energized, isolated, tested dead, grounded (as required) and tags placed for the appropriate supervisor and/or crew leader as outlined below:

(1) Outage Request

A crew leader must submit a normal outage request through his/her office to the supervisor. In an emergency, an outage request may be made directly to the appropriate supervisor.

(2) Approval

The supervisor will consider the request, and upon approval, notify the affected office and switching groups.

(3) Switching

Switching personnel shall:

(a) Open lock, if possible, and place “Danger-Hold tags on all switches and switching devices necessary to isolate the circuit from all sources of electrical energy.

(b) Test to confirm the circuit is dead.

(c) Connect or supervise the connection of protective grounds when included in the outage request.

(d) Report the completed switching and “Keep Out” tags placed to the appropriate supervisor.

(4) Reporting “On”

The supervisor shall inform each tag holder directly or through an operator at generating stations that the tag has been placed on the circuit. Each tag holder shall report “On” the circuit to the supervisor directly or through an operator at generating stations.

(5) Testing/Grounding

Before proceeding with work, each tag holder shall test to his/her satisfaction that the circuit has been isolated, is dead, and protective grounds connected if indicated in the outage request. Guards or barricades shall be erected adjacent to energized circuits, if necessary.

(6) Starting Work

Crew members shall not work on the circuit until directed by the tag holder.

e. After completion of work tagholder shall:

(1) Determine that the circuit and equipment are ready to be energized.

(2) Ensure removal of all personal grounds that have been placed.

(3) Advise all crew members:

(a) That work is complete.

(b) To stay off the circuit and equipment.

(c) He/she is about to report “Off” the circuit.

(d) To consider the circuit to be energized.

(4) Report “Off” the circuit to the appropriate supervisor or operator at generating stations.

NOTE: When all tag holders have reported “Off” the supervisor shall direct that:

- o All “Danger-Hold” tags be removed.
- o All protective grounds be removed.
- o The circuit be phased if necessary and restored to service.

CAUTION: The circuit may be energized immediately or switching may be delayed up to several hours. Although still isolated, the circuit shall be considered as energized by all field personnel.

f. Reporting “On” and “Off” Circuit

(1) Circuit “Tagged Out”

A circuit is declared “Tagged Out” after it has been properly switched open, “Danger-Hold” tags placed for one or more tag holders, and reported to the appropriate supervisor or operator at generating stations.

(2) Reporting “On”

Before a crew may start work, the tag holder shall report “On” a circuit, which has been “Tagged Out” by the appropriate supervisor directly or through an operator. This is applicable to all persons designated in the outage request. A crew leader shall report promptly any deletions, additions or changes in personnel designated on the outage request to the supervisor.

(3) Reporting “Off”

When a crew has completed its work, the tag holder shall release his/her tag by reporting “Off” the circuit directly to the supervisor or through an operator.

(4) Restoring Circuit

The supervisor shall direct switching personnel in removing grounds and in the switching required to restore the circuit to service only after all persons for whom the circuit was tagged have reported “Off”.

g. Tag Placement - Removal

“Danger-Hold” tag shall be placed for the appropriate supervisor/crew leader at his/her request in the following situations:

(1) Voltage Tests

When high or low voltage tests are to be performed on a cable which has been previously de-energized, all tag holders shall report off and fresh “Danger-Hold” tags placed. After completion of tests, the tag used for testing shall be removed and previously removed tags shall be replaced to permit continuation of work.

(2) Work With “Live Line” Tools

On circuits where work is performed with live line tools, the work crew supervisor shall request “Danger-Hold” tags be placed for him/her at substation terminals and controls for automatic reclosing devices turned off. After completion of the live line work, the supervisor shall release the tag and the recloser controls may be restored to normal.

(3) Proximity Work

A supervisor/crew leader may request a “Danger-Hold” tag and reclosing control turned off on an energized circuit when the crew is working on an adjacent circuit, and release it when the work is complete. The person requesting the tag will maintain contact with the appropriate supervisor at all times under these conditions.

(4) Abnormal Condition

A circuit which is operating under an abnormal operating condition such as load or voltage restriction, temporary control selection or partial loss of an auxiliary or protective feature. The “Danger-Hold” tag shall be removed when the condition has been corrected.

h. Safety Precautions

The following measures shall be observed in connection with tagging procedures:

Security of “Tagged” Switches

(1) Tags

No person shall remove a tag from any switch or circuit control point, except by direction of the appropriate supervisor, after the tag holder has reported “Off”.

(2) Switches

No person shall close a switch or other disconnecting device which is open and "Tagged Out," except by direction of the appropriate supervisor after all tags have been removed from that particular location.

(3) Operating De-energized Switches

(a) In substations, during an outage, a construction and maintenance or test crew may operate a circuit breaker or other switching device without releasing a "Danger-Hold" tag under the following conditions:

There is a "Tagged Out" switch isolating each side of the switch to be operated.

Permission of the tag holders has been obtained and their tags removed and recorded in the station log. After completion of operation the tags shall be replaced and log entry recorded.

The operator or appropriate supervisor at the location where an alarm may be received has been notified.

(b) A construction and maintenance or test crew may operate a circuit breaker in the "test" position in metal clad switchgear under the following conditions:

Permission of other tag holders has been obtained.

Personnel at the remote alarm terminal have been notified.

(c) In the field, work crews may operate de-energized and isolated switches after observance of appropriate measures to insure the safety of all personnel.

Crew members working on a "Tagged" circuit

Tag Holders Direction:

Crew members shall work on a tagged circuit only under direction of the tag holder and with strict observance of applicable safety measures.

Leaving "Tagged" Circuit Area

The tag holder or any crew member who leaves the "Tagged circuit area shall observe applicable safety measures, and retest the circuit for being dead before resuming work.

Circuit Release:

When the tag holder advises crew members that work is complete and is about to report “Off” the circuit, crew members shall consider the circuit as energized and make no further access.

Non-crew members access to a “Tagged” circuit

Non-crew members, for example, engineers, exempt and technical personnel, manufacturers, contractors, craft personnel and members of crews (for a brief period) may require access to a “Tagged” circuit. Such persons shall report to the tag holder and request permission for access. The tag holder or assigned crew member shall direct the access of the non-crew member.

When the non-crew member has completed work or inspection, he/she shall advise the tag holder and the non-crew member shall make no further access.

Circuits Opened - Not Isolated

A tag shall not be placed on a circuit which has been de-energized but has not been isolated from all sources of electricity.

If a supervisor decides to open circuit breakers to de-energize a circuit but leave isolating switches closed, the circuit shall not be tagged.

The circuit shall not be re-energized until authorized by the supervisor.

Application of test voltage in substations

Test voltage may be applied to tagged cables or circuits only under the following conditions:

All crew personnel working on or in close proximity to circuits have been notified and are at a safe distance from the conductors under test.

The safety of all personnel has been assured.

Necessary precautions shall be taken to prevent the unintentional application of voltage by:

Induced high voltage from low voltage applied to secondary wiring or terminals of potential or station service transformers.

Underground conductors not fully discharged after removal of normal or test voltage.

Power capacitors not fully discharged after removal of normal or test voltage.

Accidental contact of a de-energized conductor with an adjacent energized conductor.

Induced voltage from an energized parallel line into a non-energized overhead line.

Static charges on circuit breakers and transformers while oil is being pumped or filtered.

i. Field Tagging

(1) General

(a) A special weather resistant “Danger-Hold” tag shall be used for field tagging. It should show the following pencil entries:

Name of tag holder

Date

Device (if necessary)

(b) A tag shall be placed on the equipment lock or means of disconnection after the equipment has been opened or disconnected at the supervisor’s direction. The placement of the tag shall be reported to the supervisor and acknowledged by him/her.

(c) All inquiries regarding the status of such “Danger-Hold” tags shall be made to the appropriate supervisor.

(d) A tag shall be removed only at the supervisor’s direction.

(e) Use each tag only once. After removal, save tags for record for a period of 1 year.

(2) Danger-Hold Tag Entries.

(a) Use a pencil to print firmly and legibly.

(b) Print in “Tag for” section the name of the person reporting “On” the circuit.

(c) Print in “Date” section the date the tag is applied.

(d) Print in “Device” section the device being tagged and the phases being tagged. For example, A B C O, Tie Switch 237-25830, etc.

(3) Tag Placement

(a) Overhead Lines

Gang Operated Switch: Place tag on switch lock shackle.

Blade pull switches and fuseholders: Place tag on a hot-line clamp tap bolt and attach the clamp to the wire or cable on the de-energized side of the device.

Isolated Sections of Feeders or Radial Taps: Place tag(s) on de-energized wire/cable at points where tap(s) on de-energized wire/cable has (have) been disconnected at feed end(s) of wire or cable.

(b) Underground Lines

Oil Switch: Place tag on the grounded yoke bolt of the oil fuse cut-out.

Underground Residential Distribution: For pad-mounted, sub-surface, subway equipment, place tag in pull ring of elbow terminator.

j. Testing circuits for voltage/testing for dead

(1) When electrical circuits or equipment are de-energized for working thereon, a test for voltage shall be made before protective grounds are attached.

(2) The test for voltage shall be made with an approved device such as a ringer, a glow stick or a voltmeter.

(3) All voltage detectors shall be proof checked on a known voltage before and after use.

(4) A glow type voltage indicator shall be checked before and after use either by applying it to an energized circuit, to the spark plug of a running engine, or by other approved methods.

k. Protective Grounding and Short Circuiting

(1) All circuits or equipment are to be considered energized at full voltage unless protective grounds preinstalled in accordance with the provisions of this subsection.

(2) The circuit or equipment must be de-energized, tagged and tested for voltage before protective grounds are attached.

(3) When attaching grounds, the ground end shall be attached first and the other end shall be attached and removed by means of insulated tools or by other approved methods.

(4) All conductors, including the noninsulated static wire and neutral of the circuit or equipment shall be effectively grounded in a manner so as to both ground and short circuit the conductors before the work is started.

Exception: On 3 phase single conductor wye underground circuits below 15,000 volts, one or more phases after being positively identified may be de-energized, tested for voltage, and protective grounds installed on those conductors where no voltage is indicated. It is not necessary to de-energize, ground, and short circuit all phases unless specific operating conditions require it. Rubber gloves and rubber sleeves shall be worn when performing this work.

(5) Only approved grounding devices capable of carrying the fault current shall be used, but in no case shall the grounding cable be smaller than No.2 AWG copper or equivalent per OSHA 1926.954 (j).

(6) Protective grounds shall be placed on all sides of the work where there is a possible source of power (including wire crossings and parallel lines) and as close to the point of work as possible. When this is not possible, supervisory approval shall be obtained.

(7) Additional grounds shall be placed to reduce static charges and induced voltages from adjacent lines, specifically in the following instances:

(a) When work is being performed under de-energized conditions at various locations on the circuit and the protective grounds are one mile or more apart.

(b) On conductor stringing blocks where conductors are being pulled across energized circuits unless the conductor being pulled is worked as energized.

(c) On poles, structures, or towers between protective grounds when handling conductors, if the common neutral or a noninsulated static conductor is not included in the grounding procedures, a personal ground shall be installed. A single lead from ground potential (common neutral, tower leg, noninsulated static wire, etc.) to the conductor being worked shall be considered adequate for this "personal ground".

(8) Protective grounds shall not be removed until all workers are clear of the circuit or equipment.

The best protection is afforded when the shortcircuiting and/or grounding is close to the work.

The procedure for attaching and detaching grounds is as follows:

(a) Grounded Metal Structures or Towers

All protective grounding cables shall first be attached to a common point on the metal structure or tower leg or connected together with a jumper not smaller than No.2 AWG copper or equivalent. After this is done, attach one of the grounded cables to each conductor of the circuit, keeping as far below the conductors as possible, and keeping clear of the grounded cables or clamps.

To remove protective grounds on metal structure or tower lines, first detach the grounded cables from the conductors, keeping as far below conductors as possible, and keeping clear of the grounded cables and clamps until all conductor clamps are removed; then remove clamp or clamps from metal structure or tower leg. Start at the top and work down.

(b) Pole lines

First, drive ground rod if there is no existing anchor rod in the immediate vicinity. Second, attach protective cable or cables securely to the ground rod or anchor rod. Guy wires shall not be used for this purpose. Third, attach a grounded cable to each conductor of the circuit, including the noninsulated static wire and neutral where they exist, starting with the lowest and/or nearest conductor and working upward and/or outward, keeping as far away from conductors as possible. All workers shall keep clear of the grounded cables and clamps until the grounding is complete.

For protective grounding of distribution lines, the common neutral conductor will be used.

The protective grounds shall be removed in the same order in general as specified for steel tower lines.

(c) Substations

In performing work on substation equipment, extreme caution should be exercised to eliminate the danger of feed-back from other sources by testing,

disconnecting, grounding or shortcircuiting transformers regardless of application, potential devices, coupling capacitors, etc.

First, attach protective grounding cable or cables, to the station grounding system. Then attach a grounded cable to each conductor of the circuit or bus, keeping as far away from conductors as possible and below if practicable, being sure that all workers keep clear of the grounded cables and clamps until the grounding is completed.

To remove protective grounds, detach the grounded cable from each conductor, keeping as far away as possible and being sure that all workers keep clear of the grounded cables and clamps until all conductor clamps have been removed. Then remove ground clamp or clamps from the station grounding system.

(d) General

Protective grounding of conductors making up underground cables cannot always be done at the point of work. In such cases, the grounds shall be attached at the nearest location where the conductors can be reached, in accordance with protective grounding instructions for stations or overhead lines.

Where connected transformers are in the protected zone, between protective grounds, the primary side of the transformer shall be disconnected by either removing the line taps or opening the fuse cutouts. Where primary line work is to be performed on the transformer pole, the secondary wires shall also be disconnected or tested for voltage, grounded and short circuited. The secondary neutral will be considered as an adequate ground.

When grounding truck chassis, pulling equipment or other related devices, first consideration should be made for attaching the grounding lead to the common neutral. If this is impractical, an existing anchor rod or screw ground rod fully inserted into earth shall be used.

All circuits, equipment, wire, tube or bar shall be considered energized unless disconnected from all sources of energy, tagged, tested for voltage and grounded. Substation gates and doors shall be kept closed and locked when work is not in progress. When open for work, provisions shall be made to prevent entry of unauthorized persons.

2. WORKING ON ENERGIZED LINES

If work must be done on a live line or energized equipment the following protective safety gear is generally used:

Rubber gloves and protective leather covers

Rubber sleeves

Rubber mats

Flexible rubber cover gear placed over live busses, terminals or insulators to avoid accidental contact

Hot line sticks, usually fiberglass poles (“pogo” sticks)

Fiberglass buckets/bucket truck

Checklist of required safety equipment is given in appendix A.

Note: Live-line bare-hand work is expressly prohibited per NAVFACINST 5100.17 (See sect. 15 of Chapter 3) except when a situation leaves no alternative. In such cases, the activity Commanding Officer must certify in writing for each specific instance that live-line bare-hand work is required and must follow all the requirements of NAVFACINST 5100.17.

All protective gear must be stored correctly, inspected periodically and tested before use. Test requirements and test intervals are given in tables 1-1 through 1-4.

Tables

TABLE 1-1 A-C PROOF-TEST REQUIREMENTS

class of Equip	Proof-Test Voltage rms V	<u>“Max Proof-Test Current mA (Gloves only)</u>			
		267-mm (1 0.5in) Glove	356-mm (14in) Glove	406-mm (16in) Glove	457-mm (18in) Glove
0.....	5,000	...8...	12	14	16
1.....	10,000	.....	14	16	18
2	20,000	.....	16	18	20
3.....	30,000	.....	18	20	22
4.....	40,000	.....		22	24

TABLE 1-2 D-C PROOF-TEST REQUIREMENTS

class of Equip	Proof-Test Voltage avg V
0.....	20,000
1.....	40,000
2.....	50,000
3.....	60,000
4.....	70,000

NOTE: The d-c voltages listed in this table are not appropriate for proof-testing rubber insulating line hose or covers. For this equipment, d-c proof-tests shall use a voltage high enough to indicate that the equipment can be safely used at the voltages listed in table 1-3. See ASTM D 1050-85 and ASTM D 1049-83 for further information on proof-tests for rubber insulating line hose and covers.

**TABLE 1-3 RUBBER INSULATING
EQUIPMENT, VOLTAGE REQUIREMENTS**

Class Design	Max use voltage a-c-rms	Retest voltage a-c-rms	Retest voltage d-c-avg
0....	1,000	5,000	20,000
1....	7,500	10,000	40,000
2....	17,000	20,000	50,000
3....	26,500	30,000	60,000
4....	36,000	40,000	70,000

The maximum use voltage is the a-c voltage (rms) classification of the protective equipment that designates the maximum nominal design voltage of the energized system that may be safely worked. The nominal design voltage is equal to the phase-to-phase voltage on multiphase circuits. If there is no multiphase exposure in a system area and if the voltage exposure is limited to the phase-to-phase ground potential, the phase-to-phase ground potential is considered to be the nominal design voltage.

If use is limited to nominal voltages less than the maximum use voltage, the voltage at which other than Class O equipment is tested may be reduced according to the following formula:

$$\text{Retest voltage (a-c, rms)} = \text{nominal use voltage} + 2000 + (0.05 \times \text{retest voltage given in Table 1-3}).$$

**TABLE 1-4 RUBBER INSULATING
EQUIPMENT TEST INTERVALS**

Type of equipment	When to test
Rubber insulating line hose	Every 12 months or upon indication that insulating value is suspect.
Rubber insulating covers.	Every 12 months or 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 it has been electrically tested within the previous 12 months.

Rubber gloves, rubber mats, blankets and cover gear, etc., can easily be cut or contaminated. They should be stored in special bags. On trucks, there are special compartments for gloves, sleeves and other equipment. Before use, all equipment should be visually inspected. Rubber gloves should be inflated with air to test for pinholes. Their insulation resistance should also be tested at regular intervals.

CHAPTER 3. OVERHEAD LINES, SWITCHYARDS AND SUBSTATIONS

1. JOB HAZARDS IN OVERHEAD WORK

- a. Rotted and cracked poles**
- b. Cracked crossarms**
- c. Frayed conductors and jumpers**
- d. Weak connectors**
- e. Broken insulators**
- f. Obstacles such as guy wires, CATV lines, etc.**
- g. Frayed ropes and hand lines**
- h. Poor personal protective equipment, i.e., rubber gloves with pinholes, damp and dirty hot sticks, aluminum hard hats instead of non-conductive ones**
- i. Cracks or tears in climbing gear, i.e., body belt, climber, safety strap (safety), dull gaffs or spikes**
- j. Wet weather**
- k. Failure to create a safe work area aloft by not using line hoses and guards, rubber covers and blankets**
 - 1. Failure to identify circuits and their configurations from the ground**
- m. Too much sag in the conductors can cause them to swing in the wind and cause line to line faults. The sag can be reduced by increasing the tension on the stringing reel.**

2. INSTALLING AND REMOVING CONDUCTORS ON POLES AND STRUCTURES

- a. When a conductor is being strung or removed and the possibility of accidental contact with an energized conductor above 600 volts exists or induced voltage could occur, the conductor, the pulling equipment, and tensioner shall be grounded.**

b. When crossing over energized conductors in excess of 600 volts, rope nets or guard structures shall be installed to prevent contact unless provisions are made to isolate or insulate the workers or the energized conductor.

c. The conductors being strung or removed shall be grounded between the tensioner and the first pole or structure, at the first pole or structure on either side of each energized crossover in excess of 600 volts, and at the last structure or pole. Grounds shall be placed no more than one mile apart.

d. Conductors being strung or removed shall be kept under positive control by use of adequate tension reels, guard structures, tag lines, protective equipment or other means to prevent accidental contact with energized conductors.

e. Conductor grips shall not be used on wire rope unless designed for that purpose.

f. While the conductor or line is in motion, the work crew shall not be permitted on supporting crossarms, nor directly under the line or conductor.

g. Reel handling equipment, including pulling and braking apparatus, shall have ample capacity, operate smoothly, and be aligned and grounded.

h. Reel tender shall have means of communication with the pulling operator during stringing and removal operation.

i. Reel attendants and others handling conductors or equipment shall wear rubber gloves and rubber sleeves.

3. ELECTRICAL TESTING

When performing electrical tests at any voltage, in addition to other instructions elsewhere in this manual, the following precautions shall be taken:

a. When performing tests, test personnel shall see that all nontesting personnel and the public are protected from the test voltages by the use of suitable barriers and danger signs.

b. Make certain that all temporary leads are securely supported.

c. When testing the resistance of a ground connected to energized equipment, approved rubber gloves shall be worn.

d. When electrical testing requires that circuits or equipment not be grounded, a ground shall first be applied and then temporarily removed during the test only.

e. Unauthorized personnel shall not enter a test area.

f. Only authorized employees shall operate and maintain test equipment.

g. De-energize conductors or equipment, verify tagout, ascertain that voltage test is made and protective ground applied.

h. Employees operating dielectric strength testing equipment having ungrounded metallic cases shall wear approved rubber gloves.

i. Employees handling electrodes of dielectric strength testing equipment, other types of voltage inducing equipment or earth probes to detect leakage voltage from faulty buried cables without insulated handles shall wear approved rubber gloves.

j. Employees handling current pick-up devices applied to cable sheaths for fault locating shall wear approved rubber gloves.

k. Upon completion of electrical testing, the test equipment and equipment tested shall be effectively grounded to remove charging current.

4. FUSING ENERGIZED CONDUCTORS OR EQUIPMENT

a. For voltages 0 to 600, either fuse pullers, rubber gloves, or other approved devices shall be used.

b. Fused cutouts shall not be bridged internally. When it is necessary to bridge fused cutouts, plainly visible external jumpers shall be used and the jumpers removed as soon as possible.

5. LIGHTNING ARRESTERS

a. Always check that the ground connection is intact before working on lightning arresters.

b. Lightning arresters rated above 15000 volts shall be disconnected from live circuits or equipment and discharged to ground before handling.

c. When lightning arresters are installed, ground connections shall be made before they are energized and arresters shall be de-energized before the ground connections are removed. Caution should be exercised to avoid repeated arcing when connecting

or disconnecting lightning arresters to or from energized conductors. If more than one unsuccessful attempt is made to connect or disconnect lightning arresters, wait two or three minutes before making further attempts. Failure to do this could cause an internal explosion.

d. Do not climb on or strap off to lightning arresters.

e. Wear eye protection when connecting or disconnecting lightning arresters to or from energized conductors.

6. TRANSFORMERS

a. When transformers are installed or replaced, the secondaries shall be checked for correct voltage and, where applicable, for phase rotation.

b. When transformers are installed and before they are energized, the ground connection shall first be made to the case, and to the neutral when applicable.

c. All transformers shall be considered energized at full voltage unless they are disconnected from the primary and secondary wires; or unless they are disconnected from the primary wires and the secondary wires are tested for voltage.

CAUTION: Induced voltage may be produced by test devices such as bell and battery sets, ohm meters, etc.

d. Internal work on transformers may be performed without wearing rubber gloves if the transformers have been de-energized and discharged to ground. On distribution transformers, the secondary neutral shall be considered a sufficient ground for this purpose, provided there is a grounding conductor which is interconnected with common neutral, the transformer case, and a ground electrode. Employees are cautioned to be alert for possible contacts with energized leads including lightning arrester leads, when performing internal work on transformers.

e. When removing transformers, the case and neutral grounds shall be disconnected last.

f. Transformer covers or handhole plates shall not be removed from energized transformers.

g. When working on or in the vicinity of any three phase WYE connected transformer bank, where the transformer neutral is not grounded, but is floated, the transformer neutral shall always be treated as a phase conductor because it is possible to have full phase to ground voltage on the neutral.

h. Unless transformers are rated "Tap Change Under Load" (TCUL), tap changer shall be operated only on a de-energized transformer. When re-energizing, maintain a safe distance, e.g., at least 20 feet to assure that internal switching was successful.

i. When relieving pressure on transformers, the pipe plug, pressure relief device or inspection cover plate shall be loosened slowly so the internal pressure will dissipate gradually.

j. Pressure relief valves shall not be opened during precipitation or high humidity except on failed transformers and when re-fusing.

k. Transformers or tanks shall not be entered unless forced ventilation or an air supply containing a minimum of 19.5 percent oxygen is present and maintained in the work area.

1. Energized padmounted transformers and equipment shall be locked or otherwise secured when unattended.

m. Transformers shall not be raised, lowered or repositioned with uncontrolled leads or jumpers.

7. METALCLAD SWITCHGEAR

a. Access to switchgear terminals through portholes in circuit breaker cells shall be limited to the following:

(1) When both sets of "Port" in a cell are dead, i.e., feeder and bus, transformers and bus, or bus and adjacent bus.

(2) Access to switchgear terminals through the ports then shall be permitted for cleaning, inspecting, and maintenance of terminals and bushings.

b. Access to bus, line or transformer circuit terminals shall be made using an approved ground and test device. Such access may be for application of protective grounds, phase identification on dead circuits and phasing tests on live circuits. The ground and test device positively and easily grounds the incoming cables and the switchgear bus. It also permits easy external connection points to bus or cable for testing.

8. CURRENT AND POTENTIAL TRANSFORMERS

a. Current transformer case and secondaries shall be grounded.

b. When more than one set of current transformer secondaries are connected electrically, a ground point shall be selected that provides grounding for the network.

c. Secondaries of current transformers shall never be opened while transformer is energized.

d. The case and one wire on the low voltage side of potential transformers shall always be grounded before energizing the transformer.

9. POWER CAPACITORS

a. All individual power capacitor tanks shall be grounded except the capacitors installed in banks on specially insulated mounting racks.

b. In order to work on any capacitor unit or bank, the capacitor or capacitors must be removed from service. A period of at least five minutes shall elapse after de-energizing the unit or bank and then protective grounds shall be installed to short-circuit and ground all capacitor units in the work area, and all other capacitor units adjacent to the work area that could be contacted.

c. In case of a capacitor bank mounted on insulated racks, the racks also shall be grounded before working on the bank.

d. Always perform tests in accordance with manufacturer's recommendations.

10. COUPLING CAPACITORS

a. The pedestal base of all coupling capacitors shall be permanently grounded.

b. Before any work is performed on the external part of a coupling capacitor, it shall be de-energized, each section discharged to ground and then grounded at the line side of the top section.

11. TREE TRIMMING AND CUTTING RIGHTS-OF-WAY

a. Ladders and/or aerial lifts shall be used for tree work. When this is impracticable, tree climbers may be used upon authorization of the Supervisor, but in no case shall tree climbers be used on shade or ornamental trees, unless the tree is to be entirely removed.

b. In trimming or cutting trees or limbs, they shall be lowered with rope when there is a danger that their free fall will cause property damage or personal injury.

c. Employees working in trees shall use belts and safety straps. When working near energized conductors, a life line shall be arranged so that a slip or fall will carry the employee away from energized lines.

d. All tools shall be raised or lowered with a hand line. Hatchets and axes shall not be used aloft in trees.

12. STREET LIGHTING

a. Street lighting circuits shall be considered energized at all times unless de-energized, locked out, properly tagged and tested for voltage.

b. Never open an energized series circuit while working on lamps or other series circuit devices. Always bridge the device with jumpers.

c. Exercise extreme care in moving and replacing globes to avoid possible injury to pedestrians and damage to property.

d. When installing or replacing globes, see that all fastening screws and latches are secure to prevent the globe falling or being blown off by a high wind.

e. Use extreme care in handling cracked or broken globes and/or refractors to avoid injury to yourself and to prevent fragments falling on pedestrians or parked cars. Use gloves to protect your hands. Remove all broken glass from the street.

f. Wear protective goggles and non-conductive hard hats when removing and replacing broken street light globes and lamps.

g. Aerial bucket or crane trucks shall not be moved in any manner while the booms are extended in the elevated position.

h. It is the responsibility of all employees to determine that the booms are properly and securely lowered to the traveling position before the truck is moved.

i. Bucket trucks and crane trucks shall be inspected for defects by the operator of the equipment before leaving the yard at the start of each shift.

j. Insulation integrity of ladders and buckets/booms shall be treated in accordance with manufacturer's recommendations including frequency of test.

k. All persons using ladders against metal street light poles, shall, by inspection and test, be sure that the pole is secure before ascending the ladder.

1. In all cases, follow the instructions included in this manual for the use of rubber protective equipment.

13. ENERGIZED CIRCUITS AND EQUIPMENT

a. All conductors and electrical equipment shall be treated as being energized at normal voltage unless de-energized, isolated, tested dead and grounded (as required).

b. Whenever possible, all work shall be performed from a position below the conductors. Insulating protective equipment shall be positioned so that loss of footing or slip will not result in contact with an energized conductor.

c. Chain hoists and other similar all-metal devices shall not be attached to energized conductors at a lower level, the hazard of the hoist chain or cable making accidental contact with energized conductors is serious. Under these conditions, when the use of rope blocks is not feasible, hoists may be used, but all possible sources of contact shall be securely covered with protective equipment, and in addition, the hoist chain or cable shall be secured or looped to further prevent accidental contact.

d. When the truck winch shaft is rigged with reel attachment for paying out or reeling wire, to or from poles or structures on which there are energized conductors or equipment, the truck chassis shall be grounded.

e. Electrical equipment and devices shall not be raised, lowered or repositioned with loose jumpers attached where accidental contact with energized equipment or conductors can be made.

14. LIVE LINE TOOL WORK

a. No job requiring the use of live line tools shall be started during precipitation. This rule will not apply to the utilization of switch sticks or other similar tools approved for all weather use, used routinely to restore service or clear trouble.

b. Employees using live line tools shall maintain a safe distance between all parts of their body and any energized parts of the tool or circuit. The following distances are minimum for handheld tools:

Phase to Phase Voltages from:	Distance in Feet:
2,000 volts to 15,000 volts	Two Feet
15,001 volts to 35,000 volts	Three Feet
35,001 volts to 120,000 volts	Four Feet

c. Examples of live line tools are hook sticks used for switching cut-outs and insulated poles used for protective grounding.

d. The length of insulation for conductor supporting tools (dead end strain poles, strain link sticks, etc.) may be reduced so long as the stick insulation is equal to or greater than the insulation.

15. LIVE LINE BARE HAND MAINTENANCE

a. Even though this technique has established uses for utility companies, it has very limited use at naval activities.

b. Stringent safety requirements are imposed on live line bare hand work by OSHA Part 1926.955(e). Special equipment and training are required.

c. NAVFACINST 5100.17 prohibits live line bare hand work except when a situation leaves no alternative. In such cases, the activity Commanding Officer must certify in writing for each specific instance that the live-line bare-hand work is required and must follow all the requirements of NAVFACINST 5100.17.

16. WORKING ALOFT

a. Before climbing a pole, inspect it visually to determine if it is safe and set to the proper depth. If the condition of the pole is questionable, probe for decay at the ground line with a metallic tool. If found to be improperly set or to be decayed, it should be either guyed, reset, or replaced before climbing.

b. Make visual inspection and sound with hammer above the ground line.

c. To test a pole at the ground line, remove soil depth of 12 inches, and make visual inspection, and sound with hammer.

d. If the pole is safe for climbing, look it over for knots, cracks, decayed spots, nails, tacks or signs which would cause spurs to "cut out".

e. Be careful not to spike wires or cables attached to the pole.

f. When climbing poles, choose the most desirable side for ascent and descent, test steps for looseness, and look out for steps at right angles to those you are using.

g. When climbing poles, do not sway the pole any more than necessary as this may cause live wires to swing, come together, and burn down.

h. Never climb a pole or tower when another worker is climbing above you. Wait until individual is settled in position before starting.

i. Descending, wait until the person below you has reached the ground and is clear of the pole or tower before starting down.

j. When climbing or descending poles covered with ice or sleet, employees shall use their safety straps.

k. Where there is possibility of body contact with energized wires and/or equipment on a pole, such wires and/or equipment must be covered with suitable protective devices.

1. Employees shall not climb over, under or through energized wires, ground wires and/or grounded guy wires until such wires are covered with proper protective equipment.

m. When working distribution poles, the safety strap shall not be attached above the crossarm in the top gain of a pole or around insulator pins, crossarm braces, guy wires, or other insecure attachments. When there is no crossarm in the top gain, the safety strap shall not be placed higher than 18 inches below the top of the pole.

n. Employees shall not stand beneath poles or structures on which employees are aloft, except to perform the necessary duties of assisting the employees working aloft. When in this position, they shall be alert for falling objects.

o. When portable electric powered devices are used on poles and structures or in areas where there are energized conductors or equipment, the electric supply cord shall be secured in such a manner so as to prevent it from contacting energized conductors or equipment. The cord shall also be strung to prevent being stepped upon or causing a tripping hazard.

p. Hand line pulleys shall not be attached to the pole or crossarm by driving the pulley hook or any implement into the pole to hold it.

q. Conductors, service wires, guy wires, etc., shall be raised or lowered with a rope.

r. Employees shall not throw tools, equipment, or material from the ground up or from aloft to the ground.

s. Climbers

- (1) Maintain climbers in good condition and inspect them frequently.**
- (2) Sharpen gaffs in accordance with instructions.**
- (3) Gaffs shall not be less than 1 1/8 inches long measured on the under side.**
- (4) Climbers, pads, and straps shall be maintained in good condition.**
- (5) Do not wear climbers when working on the ground, on the roofs of buildings, erecting or removing poles, or when traveling to or from the job. Climbers shall not be used for tree work except as specified in section 11a.**
- (6) Climbers shall be stored in the tool box provided for them. Climbers shall not be hung up inside of truck bodies or laid on the floor of trucks.**

17. REPAIRING BREAKS OR OPENING COMMON NEUTRAL

When breaks occur or splices are to be made in common neutral conductors, faults may exist or occur during progress of the work. For these reasons, the following procedure shall be adhered to:

a. Using a conductor at least equal in current carrying capacity to the neutral, a shunt shall be placed around the break or splice. On voltages 600 volts and below, a shunt may be installed with a load pick-up jumper or other mechanical means. After the shunt is installed, all repair work on the neutral shall be performed with rubber protective equipment including rubber gloves and sleeves. Care shall be taken to see that all grounded equipment is completely interconnected where the neutral is being repaired or spliced.

b. On higher voltages, the circuit including the neutral conductor or equipment should be de-energized, tagged, tested for voltage, grounded and short-circuited where service conditions permit. When the circuit or equipment cannot be de-energized for the duration of repairs, protective grounds shall be installed on the neutral conductor on all sides of the break, if permanent grounds are not already connected. Then, using a conductor at least equal in current carrying capacity to the neutral, a shunt shall be placed around the break, preferably including the poles on either side of the break. After the grounds and shunt are installed, all repair work on the neutral shall be performed with rubber protective equipment, including rubber gloves and sleeves. Care shall be taken to see that all grounded equipment is completely interconnected where the neutral is being repaired.

18. POLES AND ANCHORS, HANDLING, SETTING, AND REMOVING

a. Poles shall not be stored with crossarms, braces, steps, or other hardware attached.

b. Poles temporarily spotted along highways or streets shall be placed as far away from the traveled portion as practicable, and chocked to prevent rolling.

c. All open pole and anchor holes shall be effectively covered when left unattended, to prevent injury to persons or animals.

d. When poles or anchors are removed, the hole shall be thoroughly filled and tamped. When poles of any type are being erected into or removed from energized lines, the following precautions shall be observed:

(1) Employees handling the butts of poles shall wear rubber gloves and rubber sleeves and not place shoulders, feet, or other portions of body against the pole.

(2) Whenever the derrick is less than ten feet from energized conductors, the conductors shall be effectively covered with protective equipment to prevent accidental contact.

(3) When poles or other such items are being installed or removed in energized circuits with a conductive winch line, pole-handling derrick or other such lifting equipment, the truck chassis shall be grounded.

(4) When unloading poles from railway cars, the cars shall be properly placed and securely chocked to prevent movement and the following procedure shall be used:

(a) When unloading flat cars, bind the load of poles by passing a winch line around the car and load at the middle. Skids for lowering the poles to a rack, or the ground, shall be firmly secured to the car. The standard on each end of the unloading side shall be snubbed by a rope from the top of the standard, over the poles, to the other side of the car. Next, cut the brands, or tie wires, working from the middle of the car to each end, leaving the end standards previously snubbed. Next, cut the last two bands. Then, working as far as practicable in the clear, partially cut the two snubbed standards.

(b) Reverse the snubbing ropes and break the standards. Finally, release tension on the load with the winch line, lowering the poles onto the skids. Only one worker shall be permitted on top of a loaded car at any time, and no one shall be allowed on top after the bands and standards have been cut or removed.

CHAPTER 4. UNDERGROUND LINE MAINTENANCE.

Use the same general safety precautions for all underground systems work. Treat all circuits as energized until tested for dead and grounded.

1. MAIN COMPONENTS OF UNDERGROUND SYSTEMS

Manholes

Vaults

Trenches

Cables

Pad mounted transformers, network protectors and protective devices.

2. MANHOLES AND VAULTS

Manholes, vaults, and other enclosed poorly ventilated spaces can accumulate toxic or flammable gases and vapors. Under certain conditions, such spaces might also contain insufficient oxygen to support life. Prior to entering such spaces, it is essential to test the air to ensure there are no conditions which could pose a threat to the health or safety of personnel. Employees under the cognizance of the Naval Facilities Engineering Command are required to follow the guidance contained in NAVFACINST 5100.11, Command Safety and Health Program, as well as any local installation directives that implement the Gas Free Engineering Program. Employees under the cognizance of other major claimants must follow the guidance of their claimants.

General

Each crew member will make sure that:

(a) Manhole rescue equipment is on the truck and in proper working order before leaving for the job site; and,

(b) Manhole rescue equipment is in proper position before entering or starting work in the manhole.

NOTE: This rule applies to every manhole or vault that requires vertical entry and that is deeper than 4 feet. This includes all full-depth manholes or vaults but does not apply to cases when a lone person enters a manhole or vault for a short duration as provided in (I) below.

(c) Manhole cover hooks, cover lifters, or recessed handles shall be used when removing or replacing manhole covers.

(d) When manholes, handholes, or vault gratings are open, they shall be protected with suitable barricades and with lights during the hours of darkness. In addition, signs, safety cones and warning flags shall be used to direct vehicular and pedestrian traffic around such openings in accordance with local, State and Federal regulations.

(e) Manholes shall be entered or exited by means of a ladder when practicable.

(f) When employees are working in manholes or vaults, one employee shall be stationed on the surface except as provided in rules (k) and (1) in this section.

(g) Tools and materials shall be raised or lowered in manholes and vaults by means of a suitable bucket, tool box, or rope, unless the tools or materials can be safely handed to one another. The 'A' frame used as a lifting structure for heavy equipment shall be securely positioned.

(h) Manhole covers and gratings shall be properly seated.

(i) Power tools such as concrete breakers, drills, and chisels, used around energized cables shall be grounded when practicable.

(j) Provisions shall be made for a forced supply of air when working in manholes or non-ventilated vaults, unless air quality is monitored.

(k) An employee stationed on the surface shall promptly summon help when required for those working in manholes and vaults. Ways and means of rescue shall be established before work is started.

(1) Qualified employees working alone may enter manholes and vaults for brief periods of time for inspection, housekeeping, taking readings or similar work that can be performed safely. (Check with Gas Free Engineer or Confined Space Program Manager).

3. TRENCHES

a. General

Adequate protection in the form of shoring and bracing is required to prevent excavated walls from collapsing and causing serious accidents. The following factors dictate how extensive a support system should be:

Soil structure, i.e., compact, loose, wet, etc.

Depth of cut

Water content of soil

Changes due to weather or climate, i.e., rain, frost

Superimposed loads

Vibrations, i.e., railroad in the vicinity

Other operations in the area

b. Safety Precautions

Banks more than five feet deep shall be shored, laid back to a stable slope, and braced. Upright timbers are generally used to support the walls, with horizontal timbers or stringers attached lengthwise to the vertical supports. Cross braces or trench jacks are then placed at intervals across the width of trench. There could be two or more rows of cross braces along the length of the trench. They should be truly horizontal across the width of the trench. Trenches less than five feet in depth shall also be protected when examination of the ground indicates hazardous ground movement may be expected.

Dirt and other excavated material shall be stored and retained at least two feet away from the edges. A means of exit, e.g., a ladder shall be available every 25 feet in case of the dirt walls caving in or cracking. Normal settlement and subsidence as well as tension cracks should be regularly inspected. If it appears dangerous, work should be stopped and the problem corrected by additional support systems. Shoring should be started from the top downward. All materials used shall be in good condition and free of defects. Use timbers, braces or trench jacks of the correct size. Do not use timbers with large or loose knots (see OSHA 29CFR 1926.652 for additional design requirements and guidance).

c. Additional precautions

Shoring should be started as soon as possible after excavation to avoid bulging and eventual collapse of dirt walls. Shore from the top downward.

Backfilling and removal of trench supports should be started as soon as possible after completion of work, i.e., laying a duct bank or direct buried cable in the trench. In unstable soil, use ropes to pull out jacks or braces from above. Remove trench supports from the bottom upwards.

Protect and support foundation of other structures in the vicinity during excavation. Cover any open holes in the area.

Water in a trench should be excavated by pumping or drained by other means such as a diversion dike or ditch. Otherwise, the soil may erode.

4. CABLES

a. Cables shall not be spliced while energized.

b. When cables are to be de-energized for working thereon, in addition to instructions elsewhere in this manual covering clearing, tagging, testing, grounding, and short-circuiting, employees shall comply with the following procedures when cutting into cables:

(1) Identify cable by electrical means or by physically moving the cable from a point that is identifiable, or by tag, ducts and/or duct records unless its identity is obvious by distinctive appearance. Tags on cables and ducts occupied by the cables shall be checked against records and physically checked on either side of the location where the work is to be performed when practicable.

(2) Rubber gloves shall be worn when removing metallic sheathing, shielding tape, semi-conducting material, or concentric neutral, when testing for voltage, and when cutting or sawing into cables.

(3) Before removing a section of metallic sheathing or concentric neutral wires from cables, the cable conductor shall be grounded on both sides of the work area. If grounding disconnects have not been installed, the use of a grounding device or jumpers should be considered.

(4) If no voltage is detected, remove half of the insulation thickness and test again. If no voltage is detected, then the conductor may be cut.

c. When underground cables are exposed, they shall be protected from damage and employees shall not stand or walk on them.

d. Cables energized above 600 volts shall not be moved to the extent that such movement would cause mechanical stress or movement of the conductor within the insulation wall.

e. Cables and their associated equipment shall bear identification tags or markings before energizing.

f. Employees may perform such work as installing identification tags and fault indicators on energized cables provided they are wearing appropriate rubber gloves and all energized parts are covered with proper protective material, and they do not come in contact with any portion of the cables above the midpoint of stress cones.

g. Temporary cables energized above 600 volts phase to phase, exposed to the public, shall be patrolled for public protection.

h. Underground cables above 600 volts shall be energized or de-energized in accordance with existing operating procedures.

i. Confined areas shall be clear of personnel and shall be well ventilated before splicing, welding or soldering. Flames and sparks shall be contained by use of a fire retardant blanket draped around the mold or cable.

5. NETWORK PROTECTORS AND NETWORK TRANSFORMERS

a. Perform visual inspection. Check for any damage or tampering. Check that all line and ground connections are secure and that they are not discolored from overloading.

b. Network protectors shall not be closed manually unless it has been determined that the primary feeder is in service and the transformer is energized with proper phase relation.

c. On the first trial operation of a network protector after repairs have been made on the mechanism or breaker, the door of the compartment shall be closed. The door of the compartment shall be closed during manual operations where secondary load is involved.

d. Before installing or removing secondary fuses in 125/21 6 volt network protectors, the protector shall be made inoperative to prevent reclosing. Before installing or removing secondary fuses in 277/480 volt network protectors, the primary circuit shall be de-energized if permission can be obtained from the supervisor. The protector shall be made inoperative to prevent reclosing. If it is necessary to remove the network protector mechanism, the primary circuit shall be de-energized and the protector shall

be made inoperative to prevent automatic reclosing and secondary fuses removed before other work is performed.

APPENDIX A

CHECKLIST OF REQUIRED SAFETY EQUIPMENT

1. **Rubber insulating gloves:** Rated for voltages worked on; no holes, tears, cracks or deformation; inflate to test for holes; electrically tested within last 6 months.
2. **Rubber insulating blankets:** Look for same conditions as for gloves; electrically tested within last 12 months.
3. **Rubber insulating sleeves:** Look for same conditions as for gloves; electrically tested within last 12 months.
4. **Rubber insulating line hose and covers:** Look for same conditions as for gloves; electrically tested within the last 12 months.
5. **Bucket trucks:** Check visually for any damage; hydraulic fluid leaks; abraded, torn or disconnected hydraulic hoses; operability of all system components including bucket and boom controls, automatic bucket leveler, emergency ground controls, outriggers, emergency brakes. Check that electrical test record is in cab of truck. Electrically tested within last 12 months.
6. **Insulating device for de-energizing transformers from the ground.** Sometimes called an "Extendo Stick".
7. **Insulated cables for making temporary connections on high voltage systems.** Sometimes called "Macks" or "Jumpers".
8. **Grounding cables to connect systems to ground.** Diverts current to ground in case of unintended energization of system.
9. **Equipment for testing to see that conductors are de-energized.** Volt-ohm meters (suitable for voltages involved), glow sticks.
10. **Leather gloves.**
11. **Safety belts and lanyards to be worn while in bucket truck.**
12. **Hard hats approved for high voltage.**

- 13. Hot sticks to manipulate energized conductors.**
- 14. Non-conductive ladders.**
- 15. Climbing belts (where used): no cracks or tears, no broken stitching.**
- 16. Safety glasses and/or face shields (for handling transformer oils which might contain PCBs).**
- 17. Gloves (neoprene, polyethylene, or fluoroelastomer type) for handling PCB containing oils.**
- 18. Aprons (material as for gloves in item 17).**

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