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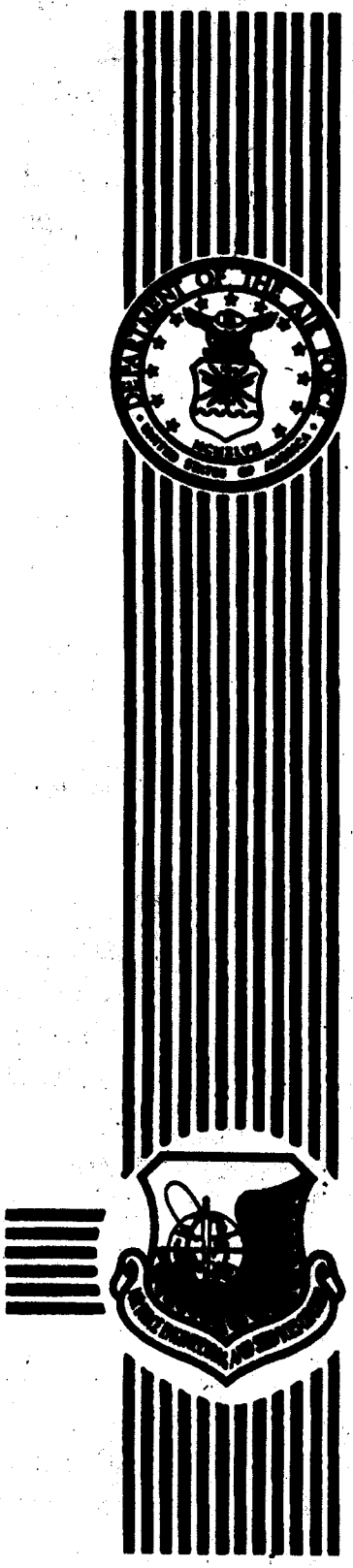
31 January 1990

Real Property Operations And Maintenance ELECTRICAL SAFE PRACTICES



AFESC

DEPARTMENT OF THE AIR FORCE
Headquarters US Air Force
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AF REGULATION 91–12

31 January 1990

Real Property Operation and Maintenance

ELECTRICAL SAFE PRACTICES

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Attachment(s)

Chapter 1
GENERAL INFORMATION

1-1. Application and Scope. This regulation gives Air Force personnel guidance on safety, fire prevention, and health precautions required to perform electrical distribution construction and maintenance. Each person involved in the construction, operation, or maintenance of electrical facilities should have a copy of this regulation. Also, each person must carefully study and comply with these rules. Supervisors should not allow a worker to perform any task until satisfactory knowledge of the applicable rules has been demonstrated. This regulation complies with AFR 127-12 and incorporates National Consensus Standards.

1-2. Fundamentals of Safety:

a. Common Mishap Causes. There is a perception that to be a mishap there had to be actual injury or damage. However, mishaps also include unplanned or unsought events which have the potential for causing injury or property damage. MISHAPS DO NOT "JUST HAPPEN;" they are caused. The identification, isolation, and control of these causes requires the cooperation of all personnel at all times. Mishaps which result in worker injury are usually caused by unsafe acts or conditions. Some examples of unsafe acts are:

(1) OPERATING WITHOUT AUTHORITY OR WARNING. For example, opening or closing switches without authority (violation of blocking or tagging rules), and failing to place signs or tags where they are needed.

(2) MAKING SAFETY DEVICES INOPERATIVE. For example, removing protective guards and blocking or by-passing protective devices.

(3) USING UNSAFE EQUIPMENT OR USING EQUIPMENT IMPROPERLY. For example, using damaged tools or using a hammer in place of a wrench.

(4) WORKING NEAR LIVE EQUIPMENT, MOVING MACHINERY. For example, not using insulating equipment when needed, or not using personal protective equipment such as rubber

gloves, sleeves, hard hats and face shields, and placing line trucks too close to energized systems.

(5) IMPROPER USE OF SHIELDS AND GUARDS. Lack of barricades around floor openings or excavations.

(6) USING DEFECTIVE MATERIAL OR EQUIPMENT. Using broken tools or equipment with design flaws or outdated testing such as come-alongs, pole top gins, or hot sticks.

(7) IMPROPER OR INADEQUATE VENTILATION. For example, vaults and manholes not ventilated, or inadequate ventilation when working with toxic materials.

(8) UNSAFE LOADING OR PLACEMENT. To carry or lift a load too heavy for equipment. To place objects where they are unstable and likely to fall. The failure to block such objects or equipment against unexpected movements.

(9) TAKING UNSAFE POSITION OR POSTURE. The use of improper work position such as off balance, positioned to the side of or too high on a ladder, walking under suspended loads, through hazardous work areas, or too close to openings or entrances to areas contaminated by gas or fumes without proper precautions, riding in unsafe locations in or on motor vehicles.

(10) DISTRACTING OR STARTLING. To play practical jokes, tease, quarrel, or annoy another person. Horseplay accounts for a large portion of the mishaps on and off the job.

b. Mishap Prevention. The mishaps that occur to electricians involve anything from falls to electrocution. The causes are many but in all cases, there is personnel error or a flaw in material design. To initiate and maintain a safe operation electrical supervisors and workers must understand the reason why accidents occur. See attachment 3 for more mishap discussions. Use this material in shop safety meetings.

1-3. Responsibilities of a Supervisor:

a. Personal Safety. The most important part of a supervisor's job is to get the job done SAFELY. To be a good safety-minded supervisor requires an understanding of good supervisory techniques and the ability to recognize those factors in the workplace that have mishap potential. US Air Force policy requires supervisors to provide a safe and healthful work environment where hazards are eliminated or

controlled. Air Force facilities, work areas, equipment, and work procedures must comply with safety fire and health guidance. The supervisor must provide for frequent and regular inspection of the job sites, materials, and equipment used. Tag any machine, tool, material, or equipment found unsafe, render it inoperative or physically removed it from its place of operation. The supervisor permits only those qualified by training or experience to operate equipment and machinery. A good supervisor knows the mishap problems and where, how, and why mishaps occur. The following are some of the supervisor's responsibilities:

(1) Ensuring Safe working conditions.

(2) Ensuring two qualified employees are working together when high voltage circuits or energized circuits are involved. (See 1-7b.)

(3) Ensuring that all employees understand and can administer cardio pulmonary resuscitation (CPR).

(4) Ensuring necessary guards and protective equipment are properly used.

(5) Ensuring that tools and equipment are properly maintained and used.

(6) Planning the work properly and ensuring that it is performed in a safe manner.

(7) Providing general and special safety instructions to their employees.

(8) Assigning employees to jobs which they can do safely.

(9) Correcting any observed or reported violations of safety rules.

(10) Helping with accident investigations.

(11) Reporting mishaps to base safety.

b. Worker Awareness. Each supervisor must make sure that workers understand why and how the work must be done, the hazards they may encounter, and the proper procedures for doing work safely. The supervisor should check job print or sketch with employees, point out existing and potential hazards, and the plan to control them.

NOTE: If the job involves special hazards or if there is any question as to complete understanding ask the employees to repeat their work assignments and the work methods.

c. Training Assistance. Ensure personnel have the opportunity to attend formal technical school training. Supervisors must make sure

that the employees are trained through an established shop safety education program conducted weekly.

d. Typical Topics of Safety Meetings:

(1) Safety rules.
(2) Methods and hazards applying to various jobs in progress.
(3) Unsafe practices.
(4) Accidents that may have occurred recently.
(5) Potential personal injuries.
(6) Personal protective equipment.
(7) Electrical tools.
(8) Handling materials.
(9) Good housekeeping.
(10) Adequate illumination.
(11) Working on or near machinery.
(12) Ladders.
(13) Work in elevated positions.
(14) Lifting and hoisting equipment including cherry pickers.
(15) Grounding systems.
(16) Work in underground facilities.
(17) Overhead lines.
(18) First aid.
(19) Rescue and resuscitation.

NOTE: The supervisor should both show and tell how the job is done. Make safety briefings interesting and successful using a variety of aids such as safety posters, mock-ups (using the actual equipment where appropriate), pictures and films. A certain amount of enthusiasm is also an important ingredient.

e. Specific Job Related Safety Training. Besides the general topics listed above, the supervisor must give special attention to hazardous conditions the worker may encounter on any new task to be performed:

(1) Instruct employees how to handle or use poisons, caustics, and other harmful substances safely and make them aware of the potential hazards, personal hygiene and personal protective measures.

(2) On job sites where harmful plants or animals are present, instruct employees exposed to them, in the potential hazards, how to avoid injury, and how to use the first aid procedures in case of injury.

(3) Instruct all employees required to enter into confined or enclosed spaces in the hazards involved and the necessary precautions. Ensure they comply with specific regulations that apply to work in dangerous or potentially dangerous areas.

1-4. Work Injuries. As stated in AFR 127-12, report injuries, even minor ones, to the employee's immediate supervisor. Obtain prompt medical attention. In case of electrical shock, apply CPR immediately and continue until the patient is breathing normally or until a competent medical authority tells you to stop (see chapter 7).

1-5. Mishap Reports. Every mishap involving personnel injury, property damage, or near misses must be investigated to determine the cause and the corrective action needed to prevent recurrence. The supervisor or base safety personnel conduct the investigation. The wing or installation safety staff must be notified of all mishaps that involve personnel injuries or property damage. Certain mishaps must be investigated and reported through safety channels according to AFR 127-4.

1-6. Applicable Codes. Knowledge and compliance with the following codes is essential: National Electrical Code (NEC), National Electrical Safety Code (NESC), ANSI and host nation codes.
NOTE: The NESC is published as ANSI Std C2.

1-7. Energized Circuits:

a. General Rules. When possible, deenergize electrical circuits and equipment before working on them. However, work may be performed on energized circuits and equipment when certified by the electrical superintendent as necessary to support a critical mission, prevent injury to persons or protect property. In such instances, ensure there are at least two workers, fully qualified for hotline work, and all necessary protective equipment and special tools (see paragraph 6-16a(14) for bucket trucks).

b. Exempted Circumstances. Low voltage control, power, and lighting circuits may be worked on while energized for the purpose of testing, calibrating, trouble shooting, minor repairs and replacement of

fuses and circuit breakers. When working on circuits over 300 volts, ensure a safety observer is present.

CAUTION: Connections or contact between energized conductor and ground, or between two energized conductors, are equally hazardous. A grounded apparatus frame, equipment cover, or floor is a potential second point in completing a circuit through your body.

c. Protective Equipment. When it becomes necessary to work adjacent to energized circuits, use rubber blankets or other suitable guards.

d. Scheduling Routine Maintenance. Schedule routine maintenance when the disruption of power causes least inconvenience to all power users. Arrange electrical circuits and equipment so that routine maintenance tasks can be accomplished efficiently and with a minimum number of outages of the prime source of power to important facilities. (See AFM 88-15, chapter 7.)

Chapter 2
SAFE WORKING PRACTICES

2-1. Good Housekeeping:

a. Standards and References. Good housekeeping is essential to safe and efficient operations and must be practiced in all shops, yards, buildings, and mobile equipment. Supervisors are responsible for good housekeeping in or around the work they are supervising. A complete and current listing of AFOSH Standards can be found in AFR 0-17. The following AFOSH Standards provide information relevant to this chapter:

(1) AFOSH Standard 127-2, Walking and Working Surfaces.

(2) AFOSH Standard 127-9, Scaffolds and Working Platforms.

(3) AFOSH Standard 127-11, Electrical Installations and Equipment.

(4) AFOSH Standard 127-31, Personal Protective Clothing and Equipment.

(5) AFOSH Standard 127-50, Ground Communication Electronics Systems.

(6) AFOSH Standard 127-51, Communications Cable and Antenna Systems.

(7) AFOSH Standard 127-66, General Industrial Operations.

(8) AFOSH Standard 161-8, Permissible Exposure Limits for Chemical Substances.

b. Typical Housekeeping Tasks:

(1) Do not place material where one might stumble over it, where it might fall on someone, or on or against any support unless you are certain the support can withstand the additional weight.

(2) Keep aisles and passageways clear of tripping hazards.

(3) Remove nails from loose lumber or turn the points down.

(4) Remove snow and ice from all walkways and work areas where it may create a hazard or interfere with work. If ice cannot be readily removed, spread sand on walkways and work areas.

(5) Keep trash and other waste materials in approved receptacles only, must do not allowed it to accumulate, and remove and dispose of as soon as practicable.

(6) Do not let surplus or waste materials accumulate in any mobile equipment. Storte tools and supplies stored.

(7) Do not lock doors to main disconnect switches, distribution panels or fire alarm boxes, do not store or place materials or tools to prevent access.

(8) Stack wire reels with strips of wood between reels.

(9) Do not use electrical or mechanical vaults and equipment rooms for storage they must be secured to all but authorized maintenance personnel.

2-2. General Safety Precautions. There are a number of safety precautions which can be taken to minimize the degree of exposure to electrical shock.

a. Don't work on energized circuits if it can be avoided.

b. Avoid working alone. Work with or around someone who knows how to turn off the power, how to get help in an emergency, and how to apply CPR.

c. Follow the procedures in approved technical and safety manuals.

d. Rig power cables properly. Never use power cords or other equipment in such a way that a male plug can be energized when it is in a receptacle. When connecting a motor or other equipment to a power source, first make sure that the switch on circuit breaker is open at the source. Then connect the cord on cable to the equipment you plan to use, and work backward to the source with a dead cable in your hand. Never connect to a power source first. Never make intermediate connecting unless the power is off.

e. Keep yourself and your equipment dry.

f. Make sure that grounding is proper and complete.

g. Be familiar with first aid procedures.

h. Use the right tool for the job.

i. Use safety lights in closed or fume laden areas. Use only approved sealed safety lights and explosion proof equipment in places where volatile fumes could collect.

j. When helping a shock victim, don't become a victim. Turn off the power or manipulate the wires with something nonconductive.

2-3. Handling Materials. Manual handling of material accounts for about 15 percent of all US Air Force occupational injuries. Strains, sprains, fractures, and bruises are the common injuries caused by materials handling. They are caused, primarily, by unsafe work practices--improper lifting, carrying too heavy a load, incorrect gripping, failing to observe proper foot or hand clearances, and failing to use or wear protective equipment.

a. Hand Injuries. A large number of injuries occur to fingers and hands. Supervisors should caution employees on the following as necessary:

(1) Inspect for slivers, jagged edges, burrs, rough, or slippery surfaces.

(2) Grip objects firmly.

(3) Watch points where fingers can be pinched.

(4) Avoid ends of long objects such as pipe and lumber.

(5) Wipe off grease and dirt to reduce slipping while handling.

(6) Keep hands and gloves free of oil and grease.

b. Back Injuries. Since the largest number of injuries occur to the back, use caution when lifting, hauling, or pushing to avoid strains and sprains, which are often due directly to incorrect posture or failure to secure help. There are five steps to safe lifting (see figure 2-1). If there is any doubt as to your ability to lift or lower the load without strain, confer with the supervisor directing the work.

2-4. Work in Elevated Positions. When working in an elevated position, employees must take all possible precautions against dropping tools or material which might endanger others in the work area. Every reasonable effort must be made to prevent others from passing underneath. Approved signs or guards must be suitably placed as required for this purpose. Life line with approved harness or body belts, and safety straps must be used for support where a falling hazard exists (see paragraph 5-4b).

LIFT THIS WAY

1. Check weight and size. A bulky, awkward load can cause more strain than a compact heavier one.
2. Plant your feet firmly, well apart, and squat down.
3. Watch out for sharp edges. Get a good grip.
4. Keep your back as straight as you can. Lift slowly (don't jerk) by pushing up with your legs.
5. Don't twist your body with the load. Shift your feet.

Figure 2-1. Correct Lifting Instructions.

2-5. Ladders and Scaffolds:

a. Use Approved Ladders. AFOSH STD 127-6 must be followed concerning fixed ladders and those of AFOSH STD 127-4 for portable ladders. Portable metal ladders and wooden ladders with metal siderails reinforcement or metal rungs must not be used by electrical maintenance personnel. However, fiberglass ladders with metal rungs are acceptable. Do not use the top two rungs of a stepladder when performing work. Ladders must be of sufficient length to permit workers to reach their work when standing on the third or fourth rung from the top of a straight ladder, or the second or third step from the top of a stepladder which is over 5 feet in length.

b. Use Approved Scaffolds. Scaffolds must comply with the provisions of AFOSH STD 127-9. They must be well braced and fully capable of

supporting the total load to be imposed on them. All decking must be securely fastened. Do not remove any part of the scaffold while the decking is in place.

2-6. Wearing Apparel and Accessories:

a. Protective Equipment. The supervisor must make sure that workers wear personal protective equipment. This problem can be minimal if the workers understand the necessity, the equipment fits well, is easy to use and the supervisor has instilled good safety discipline among the workers. (See AFOSH STD 127-31.)

b. Protective Apparel. Wear clothing suitable to weather conditions and to work being done. Loose clothing, dangling sleeves, or ties will not be worn around moving machinery. While working on or around live equipment and lines, or high-temperature equipment, keep sleeves rolled down; do not wear garments with exposed metallic fasteners or metal articles such as wrist watches, finger rings, watch or key chains, metal cap visors, loose or flapping clothing; or any flammable articles such as celluloid cap visors. Metal frame glasses are not a shock or electrocution hazard to personnel working on energized electrical equipment of any voltage. The hazard is to the equipment if the glasses slip off and fall into an energized circuit causing shorting. Even this can be avoided if metal frame glasses are fastened to a head or neck band to prevent falling into the energized circuit. Also, safety goggles could be worn over the metal rim glasses. This extra safety precaution applies when working on energized circuits.

c. Protective Footwear. Footwear is available which can provide protection against impact and protection against electrical shock. Worker's shoes must be the safety-toed type and nonconductive since workers are required to handle heavy loads such as poles, crossarms, apparatus, conduit, reels, and motors. Under no condition will persons exposed to electrical shock hazards wear conductive shoes which provide low resistance to the ground. Electrical hazard shoes (nonconductive) that provide high resistance to ground must be worn.

d. Head Protection. Helmets or "hardhats" must be worn by all overhead and underground power and communication linecrews. Hats have been designed and manufactured to provide workers protection from impact, heat, and electrical and fire hazards. Workers must wear

helmets when working in congested areas, below other workers or when working in close proximity to exposed energized lines. Helmets must be of the class B, high voltage resistance type rated to meet voltage test of 20,000 volts AC (rms), 60 Hz for 3 minutes with leakage currents not exceeding 9 milliamps.

e. Eyes and Face Protection. Goggles or "face protection equipment" must be provided when machines or operations present potential eye or face injury from physical, chemical, or radiation agents. Specifications for design and use are described in AFOSH Standard 127-31. Eye and or face protection must be worn when:

(1) Chipping, grinding, impact drilling, and breaking concrete, brick, and plaster.

(2) Welding or helping with welding of any type.

(3) Cleaning machines with compressed air.

(4) Tinning or soldering lugs or large joints, or pouring molten metals.

(5) Trimming trees.

f. Ear Protection. Hearing protection must be provided when working around high noise areas such as the flight line. Ear protectors fall into two categories--plug or insert type and the cup or muff type. Muff type is the preferred type. Ear protective devices inserted in the ear must be fitted or determined individually by competent persons. The comfort of the device is a very important factor in ensuring their use. Therefore, trained personnel must perform the fitting of employee hearing protective devices. It is also advisable for supervisors to have their people entered in a hearing conservation program. (See AFR 161-35 for detailed information.)

2–7. Electrical Tools. Electrical shock is a major hazard when using electric tools. This shock can cause burn, falls, even result in death. Since it is possible for a defective tool to continue operating, it is mandatory that the tool be grounded with a ground wire as part of a three-wire power cord or use a tool designated as "double insulated" types. The object of grounding is to ensure that there is a metallic connection of low resistance directly from all metal surfaces of electric tools to ground. In figure 2-2, it is obvious that if the grounding path is broken (or if a grounding cable is not used) THE CURRENT FROM A

DEFECTIVE TOOL WILL PASS DIRECTLY THROUGH THE PERSON TO GROUND. UNDER NO CONDITION WILL THE ELECTRIC TOOL POWER CORD BE "ALLIGATOR CLIPPED" TO THE SECONDARY OF AN OVERHEAD DISTRIBUTION SYSTEM. Suitable extension cords will be provided for connection to an available power source such as a nearby facility or portable generator. Remember, shortcuts kill.

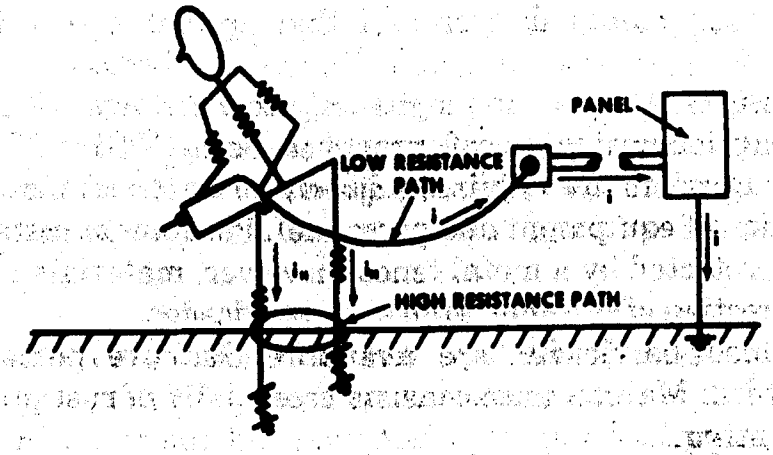

Figure 2-2. Current Paths for an Effectively Grounded Hand Tool.

2-8. Measuring Tapes and Rules. When dimensions must be measured near electrical equipment or conductors, USE ONLY WOODEN RULES OR NONMETALLIC TAPES.

2-9. Extension Cords. Handle cords to avoid damaging the insulation. Dragging them over sharp edges, or rolling heavy trucks or materials over extension cords damages the insulation causing an unsafe condition. Maintain plugs and cords in a serviceable condition. All extension cords serving portable equipment or tools must have a separate grounding conductor and grounding type plugs. Only UL listed 3-wire male to 2-wire female plug adaptors can be used, when necessary.

2-10. Warning Signs and Barriers. Hazards must be eliminated where possible, but if they can't be eliminated, the employees must be informed of the hazard by signs posted as reminders. Work must not be undertaken in areas which require guarding until the work area is defined or barricaded by signs or other devices appropriate to the time of day or night, either indoors or outdoors.

a. Danger Signs. Use danger signs only where an immediate hazard exists. There is to be no variation in the type of design of signs posted to warn of specific dangers. All personnel must be instructed that danger signs indicate immediate danger and that special precautions are necessary.

b. Caution Signs. Use caution signs only to warn against potential hazards or to caution against unsafe practices. See AFOSH STD 127-45.

c. Barriers. Barriers are required adjacent to electrical installations for the protection of equipment and personnel. Permanent installations are normally protected by a metal fence, however, materials should be available for erection of suitable temporary barricades.

(1) Preformed barricades are available that are portable and readily assembled. Maintenance consists essentially of rust prevention by periodic painting.

(2) Barriers may be constructed on a temporary basis, using rope or tape with stanchions. This type of barricade is effective only in marking a boundary and should be used only where the limitations imposed by such a barricade are within established safety practices. Stanchions should be periodically cleaned and painted as required.

(3) In addition to providing barriers, it is often necessary to install some type of visual warning. Generally these include warning signs, flags, flares, and flashing lights. Since these are often required on an emergency basis, they should be readily available to electrical maintenance personnel. Extra batteries and bulbs or complete lights should be carried on the truck.

2-11. Portable Metering Equipment:

a. General Procedures. Voltage metering should be taken preferably on the low-voltage side of transformers or distribution systems and from ground to energized conductors. Use an insulated cable with universal clip on the ground connection and an insulated cable with a short

pointed probe to momentarily contact the energized conductor. When voltage between two energized conductors must be measured and the separation is such to cause a hazardous condition for one person to conduct the test, two persons, each using an insulated probe should do the metering.

b. Taking Ampere Reading. Ampere metering is normally done with a clamp-on type ammeter on the low-voltage side of transformers or distribution systems. When necessary to take ampere readings on the high-voltage (primary) side of a transformer, it is often the case that one side of the primary coil of the transformer is grounded. In such cases, the clamp-on ammeter should be placed on the grounded side of the primary coil. In this manner, full ampere load through the coil (or phase) is metered at zero volts. CAUTION: ALTHOUGH A CONDUCTOR OR TERMINAL MAY BE KNOWN TO BE SOLIDLY GROUNDED, IT SHOULD ALWAYS BE CONSIDERED AS BEING ENERGIZED AT AN UNSAFE VOLTAGE.

c. Personal Safety Precautions. Extra precautions should be taken when holding meters or insulated metering cables while also using appropriate rubber gloves, sleeves, mats, shoes, and other safety equipment. One of these precautions is to keep the left arm close to the side of the body while working right-handed. This procedure reduces the chance of electric current to flow through the heart in case of accidental shock. Secondly, if work is being done while standing or crouched, weight of the body should be evenly distributed on both feet. NEVER SHOULD THE BODY LEAN HEAVILY ON THE FOOT NEAREST THE ENERGIZED EQUIPMENT; if an energized part were to be accidentally touched, the shocked body would lose equilibrium and fall into the energized equipment.

2–12. Power Plants. For the operations and maintenance of US Air Force power plants, a minimum crew of two people is recommended when working around fumes, fuel chemicals, high voltage and battery banks.

2–13. Aircraft Arresting Systems. Barrier should not be entered alone after an engagement because of the possibility of carbon monoxide poisoning.

2-14. Cable Testing. When testing electrical cable by the high potential method, follow the safety practices recommended by the manufacturer of the high potential test set. In addition, a safety observer must be stationed at each isolated end of the cable. The purpose of this observer is to keep pedestrians away from the cable ends.

Chapter 3

ELECTRICAL APPARATUS AND SYSTEMS

3-1. Distribution System Engineering. Generally, Air Force electric power systems are well designed and safe to operate. To retain their original safe condition they must be maintained and supported by a vigorous maintenance program; the integrity of system protective and interlocking devices must be retained and must be supported by skillful, conscientious electricians.

a. Diagrams and Schematics. Base and weapon system electric power and control systems are shown by one-line and schematic diagrams. Operators and maintenance electricians refer to them to gain an understanding of the operation of the system, the location and application of protective devices, and the location and connections of all circuits. TO OPERATE AND MAINTAIN ELECTRIC SYSTEMS SAFELY, A THOROUGH KNOWLEDGE OF SCHEMATIC AND ONE-LINE DIAGRAMS IS ESSENTIAL. Up-to-date accurate system diagrams and schematics are necessary for all operations involving primary distribution systems and circuits. Standard symbols for electrical diagrams are established in MIL-STD-15-1A and MIL-STD-15-3.

b. Engineering Guidance. No additions or changes to electric power and control systems will be performed without adequate engineering guidance. Reliance upon accurate and complete diagrams is the only practical guidance for operating and maintaining electric systems. SYSTEM ONE-LINE DIAGRAMS MUST BE KEPT UP TO DATE. (See AFR 91-4.)

c. Use of "Mimic-Buses." A valuable tool in operating electric power systems is provided by "mimic-buses" on the front of switchboards. This visual indication of the load or apparatus served by each switch or circuit breaker results in a reduction in switching errors.

3-2. System Protective Devices:

a. Relays:

(1) A relay is a device installed on the system to detect changes in the system and to complete a circuit to operate the associated circuit

breakers, or contactors, when these changes conform to predetermined conditions. Relays may be simple overcurrent devices responsive to current magnitude only, a combination of current and voltage or current and current, current balance, direction of current flow or other conditions. Relays are classified according to their primary purpose or function. The four general classifications are protective, regulating, auxiliary, and verification (see attachment 2). Some relays may qualify for more than one classification depending on application. A particular class of relays of interest and importance are protective relays, which detect defective over-head lines, cables, apparatus, and other hazardous or undesired conditions and to initiate or permit suitable switching or to give adequate warning. A major function is to detect such abnormal system conditions and to initiate tripping of the associated circuit breaker to isolate the defective portion of the system.

(2) There are many types of protective relays designed for specific functions, such as:

(a) Instantaneous overcurrent relay.
(b) A-C time overcurrent relay.
(c) Overvoltage relay.
(d) A-C directional overcurrent relay.
(e) Power-factor relay.
(f) Differential current relay.
(g) Ground protective relay.
(h) Frequency relay.

NOTE: These devices are adjustable, but must be precisely calibrated by knowledgeable technicians. This calibration and maintenance should be performed by shop personnel to achieve needed familiarity with these important devices.

(3) To ensure satisfactory system protection, relays must be coordinated with each other and with fuses which are on the same feeder. The coordinated relay setting and proper fuse size and type must be recorded on a designated coordination single-line diagram and also at some point adjacent to the relay or fuse holder. This will ensure that changes in the system coordination are not made when performing routine operation or maintenance functions. If a feeder circuit breaker trips incorrectly it may result in losing a large portion of the system, or perhaps the entire system, and may be dangerous as well as

inconvenient. IF INSTANCES OF IMPROPER TRIPPING, OR FAILURE OF CIRCUIT BREAKERS TO TRIP ARE DISCOVERED, LOCK OUT OR BLOCK OPEN THE DEFECTIVE EQUIPMENT, TAG IT WITH AF FORM 980 (SEE PARAGRAPH 6-1.) AND IMMEDIATELY REPORT THE CIRCUMSTANCES TO THE BASE CIVIL ENGINEER. An engineering study is required to determine the proper corrective action.

b. Fuses:

(1) Fuses do not have the same flexibility as relays but a certain amount of coordination can be effected between fuses, and between fuses and protective relays. Fuses having standard voltage and current ratings with different time-current characteristics can be procured. Fuses are suitable for providing overcurrent protection or fault protection on many parts of the electrical system, provided there is a sufficient source of fault current, or if the fault current is not limited by impedance or resistance at the point of the fault (the usual reason overhead lines are frequently found still energized although broken and lying on the ground).

(2) Many burns, eye injuries, shocks and falls have occurred when workers were handling primary fuses of all types. The following rules must be observed when handling primary fuses:

(a) An approved "hot stick" must be used for this purpose. Fuse holders must not be removed or installed by hand.

(b) Employees must never attempt to pull a fuse located either on a pole or structure where a fall might result, without using a safety belt. Remember that the feet and body must be kept away from grounds and, to eliminate any danger of a fuse falling on a worker, the body must be kept to one side of the pole. The worker must "get set" on the pole or structure before beginning any fusing operation.

(c) When pulling a fuse under load, turn your head to one side to protect your face, then pull the fuse. Remember that there is still the possibility of tank rupture and fire when closing in on apparatus that have internal faults.

(d) Since the proper operation of an expulsion fuse depends on a high pressure interrupting and clearing the arc, do not stand in line with the barrel of the fuse when closing.

(e) Replace the blown fuse with the proper SIZE and TYPE link. The fuselink should be installed as prescribed by the cutout manufacturer.

(f) Approved eye protection should be worn when fusing distribution transformers and lines.

(3) Because of the multiplicity of types of fuses and functions, all with separate characteristics, fuse types and sizes are not to be changed without engineering guidance. This is especially true if a coordination study has been implemented.

(4) Use approved fuse pullers to remove low voltage fuses.

c. Potential and Current Transformers:

(1) Potential transformers are associated with relay and metering circuits. They provide a means of obtaining low voltage from high-voltage circuits. To serve their intended purposes they must be designed and selected within certain accuracy limits and burdens. Units procured as replacements must have characteristics identical with the original units. There are certain hazards inherent in the maintenance and removal of these units. A potential transformer has a constant voltage maintained on both the primary and secondary although there is a fixed difference between the two voltages. If the secondary is short circuited, a very high current will flow in both windings, causing them to overheat very quickly.

(a) Replacing a blown primary transformer fuse is potentially dangerous when the circuit to the transformer is energized. The secondary fuses must be removed to prevent the possibility of energizing the potential transformer from the secondary side. A thorough investigation must be made in either case to determine the probable cause of the trouble before attempting to install a new primary fuse. Ordinarily, trouble in the transformer is apparent from visual evidence in the form of a smoked or burned case, damaged bushing, or the condition of the fuse. Also, before any inspection or replacement is done, be sure the service to the primary side of the potential transformer is disconnected. On modern switchgear a drawout arrangement usually automatically disconnects and grounds the transformers when access to the fuses is necessary.

(b) The supervisor must give instructions for replacing a blown primary fuse on a distribution voltage potential transformer located indoors, or where it is impossible to use a standard 6-foot puller.

(c) At some substations, disconnecting switches are installed between the bus and the transmission voltage potential transformers. In such a case, the disconnecting switches must be opened before attempting to replace primary transmission fuses. Where a transmission voltage potential transformer is connected to a circuit breaker lead, the breaker must be bypassed or opened and associated disconnects opened to clear the potential transformer before replacing the fuse. After replacing the fuse, the potential transformer is energized through the circuit breaker. The supervisor must give instructions for replacing a fuse when a circuit breaker or sectionalizing switch is not provided to isolate the potential transformer and associated blown fuse.

(2) Current transformers are also associated with relay and metering circuits. The main risk involved with the maintenance of current transformers occurs when the secondary side is unintentionally opened while the primary side is energized. Opening the secondary side causes a very high voltage to be set up in the secondary winding which stresses the insulation and presents a serious personnel hazard. THE SECONDARY CIRCUIT OF A CURRENT TRANSFORMER MUST NOT BE OPENED WHILE THE PRIMARY SIDE IS ENERGIZED. Before opening the secondary circuits of any current transformer, the secondary leads must be short-circuited and grounded at some point between the current transformer and the location at which the secondary circuit is to be opened.

(3) Voltage regulators are installed with bypass and disconnect switches. Before closing the bypass to disconnect this equipment, the regulator must be set on neutral and the automatic control inactivated according to the manufacturer's recommendations. When regulators are maintained as spares in substations, the bushings must be short-circuited and grounded.

d. Capacitors. Capacitors consist of electrical condensers housed in suitable containers. They are provided with discharge devices for draining the electrical charge to 50 volts or less within 5 minutes after they have been completely disconnected from the circuit. The operation of these discharge units, however, must not be depended on for safety.

When capacitors are being removed from service for any purpose, they will be considered at full voltage until the terminals have been short circuited and discharged to ground by the approved method. DO NOT SHORT CIRCUIT TERMINALS UNTIL CAPACITORS HAVE BEEN DEENERGIZED FOR AT LEAST FIVE MINUTES. USE ONLY EQUIPMENT APPROVED FOR THIS PURPOSE.

3-3. Types of Grounding. The three types of grounding systems are static, lightning and equipment grounding.

a. Static Grounds. Electrostatic charges can be an explosion hazard. Static grounds are used to prevent explosions in atmospheres containing hazardous gases, vapors, or dust. A spark in the presence of a mixture of air and one of these substances in the proper amounts may cause an explosion. There are two methods to prevent explosions; gaseous materials that are widely distributed and used are tightly sealed in containers and explosive dusts are solidified in open tanks. If during the manufacturing or use of these materials it is not possible to confine the explosive gases or dust, the second approach is to "prevent the spark."

(1) Sparks occur due to the accumulation of electrical charges until the voltage becomes high enough to break down the resistance or insulating value of the intervening air. The air becomes "ionized" and the electrical charges are conducted to ground with a spark or discharge of energy.

(2) A common solution is to ground all surfaces--a static grounding system. The resistance of the static grounding conductor or path can be relatively high and still be adequate as a static ground, but consideration of mechanical strength and reliability dictates the use of substantial grounding conductors and connections. As a result, there is no uniformity as to the acceptable maximum resistance of static grounds in the various technical orders and industrial standards, but the intent, in all cases, is to obtain secure, mechanically strong grounding systems. Tests for grounding resistance should be conducted as outlined in the various Air Force criteria. THE IMPORTANT POINT IS THAT THE GROUNDING PATHS MUST BE CONTINUOUS--there must be no breaks in the grounding paths. Well

designed grounding systems are constructed to prevent mechanical damage and corrosion of conductors at points of connections.

b. Lightning Grounds. Lightning grounds are designed to carry large currents for short time periods. As a result, lightning grounds are usually not damaged during the flow of induced current. However, if the system is poorly grounded (high impedance to ground), a high-voltage will be impressed between the down conductors and earth, resulting in possible damage to the system as well as presenting a hazard to personnel or equipment in the vicinity. The lightning conductors should be short and as straight to ground as feasible. It is important that all connections be tight and periodically inspected.

c. Equipment Grounds. The main purpose of grounding equipment is to protect all persons who may come into contact with electrical equipment enclosures, frames, and associated equipment supporting components. Therefore, all metal structure parts, motor and generator frames, control equipment enclosures, switchgear, cable armor, conduit, portable electric equipment and any metallic body enclosing an electrical circuit which is accessible to persons, must be grounded. The effective grounding of a metal surface ensures sufficient current flow in the event of an accident or deterioration of insulation to permit positive operation of ground detecting devices and the operation of the associated circuit breakers or fuses. It also tends to prevent the potential between a conducting surface and ground from rising to a dangerous value. Impedance of the return path for ground fault current should be as low as practical and the grounding conductors should be large enough to carry the maximum ground current for a reasonable time without burning off. Secondary voltage grounded neutrals must not be used as equipment grounding conductors. Specific rules for effectively grounding equipment and systems are outlined in Article 250 of the National Electric Code and part 2 of the National Electrical Safety Code.

3-4. Askarels and Polychlorinated Biphenyls (PCB):

a. Purpose and Limitations. Askarel is a class of nonflammable liquid insulation which was used in place of standard transformer oil. Since it contains PCB (which is a suspected carcinogen), it is no longer

manufactured. It was distributed by several manufacturers under various trade names such as Inerteen, Pyranol, Chlorextol, and others.

b. Personal Contact Precautions. Avoid contact with Askarels. If PCB skin contact does occur, remove with waterless hand cleaner, wipe with towels, and dispose of these towels with rags and other contaminated material. If eye contact occurs, flush eye thoroughly with water.

c. Cleaning Spills. Askarel spills must be cleaned up immediately. It is extremely important that the Askarel be prevented from reaching storm drains, sewers, drainage ditches, or any other place where water is flowing. The spill must be handled and reported according to base and Environmental Protection Agency (EPA) requirements. This is accomplished through the Base Environmental Coordinator.

d. Controlling Equipment Containing Askarel. Equipment containing Askarel must be marked, handled, stored, disposed of, and accounted for according to the latest EPA standards.

NOTE: Contact the Base Environmental Coordinator for additional information and the latest EPA rulings.

3-5. Storage Batteries:

a. General Precautions. Electric storage batteries emit hydrogen and oxygen, particularly while on charge. This forms a highly explosive mixture. Ensure that battery compartments are well ventilated. Smoking, welding, or the use of blowtorches must never be permitted around batteries.

b. Cleaning and Servicing Batteries. Do not clean batteries or terminals with brushes or other devices which may short circuit the cell. Battery jars have exploded from the ignition of hydrogen-oxygen mixture in cells by a spark from a short on the terminals.

(1) When work is being done on batteries where contact is made with the electrolyte, a container with baking soda and water must be provided to use on hands and tools to neutralize electrolyte.

(2) NEVER POUR WATER INTO THE ACID; the acid must always be poured slowly into the water, otherwise an explosion may occur.

(3) Guard the eyes and skin from splashing acid. To prevent acid burns when handling electrolyte, shop personnel must wear protective goggles, gloves, aprons, and nonslip shoes or boots.

(4) Do not store sulfuric acid in places where freezing temperatures are possible.

(5) Keep the electrolyte at a level above the tops of the separators.

(6) For further information on servicing and maintaining storage batteries, see the manufacturer's instructions.

Chapter 4
UNDERGROUND DISTRIBUTION SYSTEM

4-1. Distribution Manholes.

a. General Safety. Before entering a manhole, place warning signs as needed for protection of those working in and around the manhole, for the drivers of vehicles and for pedestrians. Test for oxygen deficiency and dangerous gases in the manhole before entering. If there is an oxygen deficiency or any gas is entering the manhole, provide adequate ventilation while working there. Smoking is not permitted in manholes. Fall protection equipment and emergency rescue harnesses may be required. Consult AFOSH STD 127-31 for fall protection guidance.

b. Preparing a Manhole Area. There are several devices used to protect personnel in and around manholes, however, these devices are of little value unless properly used.

(1) During the time that entrances at the sidewalk or street level in manholes or vaults are open, suitable barricades, traffic cones, warning signs, flags, and lights are placed and maintained.

(2) When working in underground manholes, traffic cones must be used to guide traffic around the danger area. Great care must be exercised not to obstruct traffic. In addition, a blinking light may be used on the traffic side of the hole, as well as sawhorse type barricades around the hole.

(3) For sidewalk manholes and vaults, the barricades must provide pedestrians and onlookers positive protection against falling over material or into the manhole. At night all open manholes must be outlined with either flashing lights or nonflashing lights.

c. Removing a Manhole Cover:

(1) A manhole cover may weigh from 200 to 350 pounds. Two persons, each with a manhole cover hook, are required to remove a cover. They are to lift with the leg and arm muscles, with the feet placed so that they will be clear if the cover should be accidentially dropped.

(2) If snow, ice, or other surface conditions cause insecure footing around the manhole cover, either clear the working area with a shovel or broom or spread sand, or other suitable material around the cover to ensure firm footing. Use a hardened bronze cold chisel to remove ice

from a cover. A bronze cold chisel will not produce sparks in striking the manhole cover.

WARNING: DO NOT STRIKE THE MANHOLE COVER WITH A STEEL OR IRON TOOL.

Do not use an open flame or salt to thaw ice around or over the cover. An open flame may cause an explosion if a combustible gas mixture is present in the manhole. A salt solution, seeping into the manhole may contribute to cable corrosion. Sink test holes into the ice to locate the edge of the manhole cover. A line or cable locator is useful in finding manhole cover locations when records are inadequate or when marking points are covered with ice and snow. If the exact location of the manhole is not known, a small channel may be cut from the outer edge of the general location to the center of the area where the cover should be. If the manhole cover is icebound, use enough hot water to melt the ice around the edge of the cover.

(3) If the manhole cover does not lift readily, first check to be sure the cover is not secured by a locking device. If a locking device is not holding the manhole cover, loosen the cover by placing a block of wood on the cover near the rim and striking the wood with a heavy hammer. Insert a manhole hook into one of the manhole cover holes. Pry the cover while the block of wood is being struck at several different points around the circumference of the cover.

(4) Do not leave a removed manhole cover in a location where it will present a hazard. If the cover cannot be left near the manhole opening, skid the cover to a safe location. If necessary, place a warning device near the removed cover.

(5) In a traffic area, the manhole cover is removed in a direction that will prevent personnel from falling into the path of traffic should the manhole cover hook slip during cover removal. The removal position must permit observation of oncoming traffic. When possible, insert manhole cover hooks in the hook holes on the side away from moving traffic. When this is not practical, insert the manhole cover hooks in the holes which permit the cover to be moved in the direction of traffic. Keep the oncoming traffic under careful observation.

(6) Before removing a manhole cover, mark the cover and the frame with a piece of chalk so the manhole cover may be replaced in its original position. Improper alignment of the cover within the frame may cause

considerable noise when vehicles cross over the covers. When the noise condition does exist, place a thin layer of oakum (or similar material) in the cover seat of the frame. Figure 4-1 shows the methods and steps for removing a circular manhole cover.

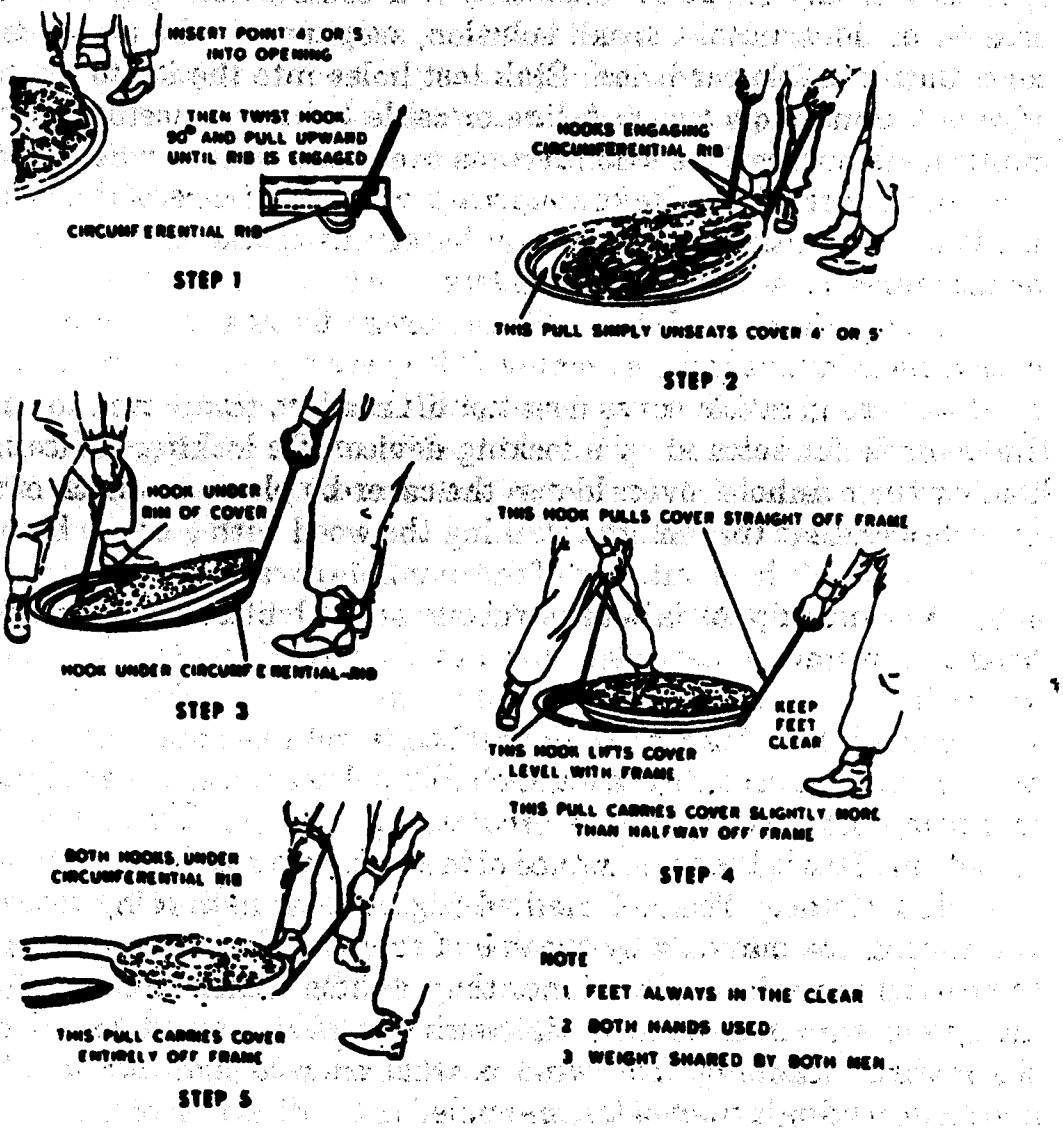

Figure 4-1. Removing a Manhole Cover.

d. Requirements for Two Workers. While work is being performed in manholes or vaults, a lineman must be available on the surface in the immediate vicinity to render emergency assistance if required.

4-2. Precautions Taken Before Entering Manholes or Vaults:

a. Determine Oxygen Availability. No one is permitted in unvented vaults or manholes unless forced ventilation is provided or the atmosphere is found to be safe by testing for both oxygen deficiency and the presence of explosive gases or fumes. Provisions must be made for a continuous supply of air when necessary.

b. Area Inspection. Before starting work, an inspection should be made to determine if there are any dangerous conditions such as burnt or cut cables, loose or defective ladders.

c. Open Flames. Before using open flames in manholes or excavations in areas where combustible gases or liquids may be present, such as near gasoline service stations, the atmosphere must be tested and found safe or cleared of the combustible gases or liquids. When open flames must be used in manholes, extra precautions must be taken to provide adequate ventilation.

4-3. Ventilating Manholes. There are three methods that can be used to ventilate a manhole. They are the forced air, sail, and natural methods:

a. Forced Air. The forced air method is nothing more than a power blower, blowing air into the manhole. The blower hose is placed into the manhole, forcing fresh air to circulate and oxygen deficient air to be forced out. This is the best method of ventilating a manhole.

b. Sail Method. The sail method (figure 4-2), is nothing more than ventilating the manhole by the use of the wind. A piece of plywood or some other material is placed over the manhole. The edge of the plywood facing the wind is lifted up until the plywood forms about 45 angle with the manhole opening. The wind is thus trapped and forced into the manhole, forcing air out of the manhole.

c. Natural Method. This method is simply taking the manhole cover off and letting the air circulate if it can. This method of venting a manhole is least effective. One reason it is so ineffective is that a gas heavier than air could lie in the bottom of the manhole and not rise out.

Use this way of venting a manhole only as a last resort.

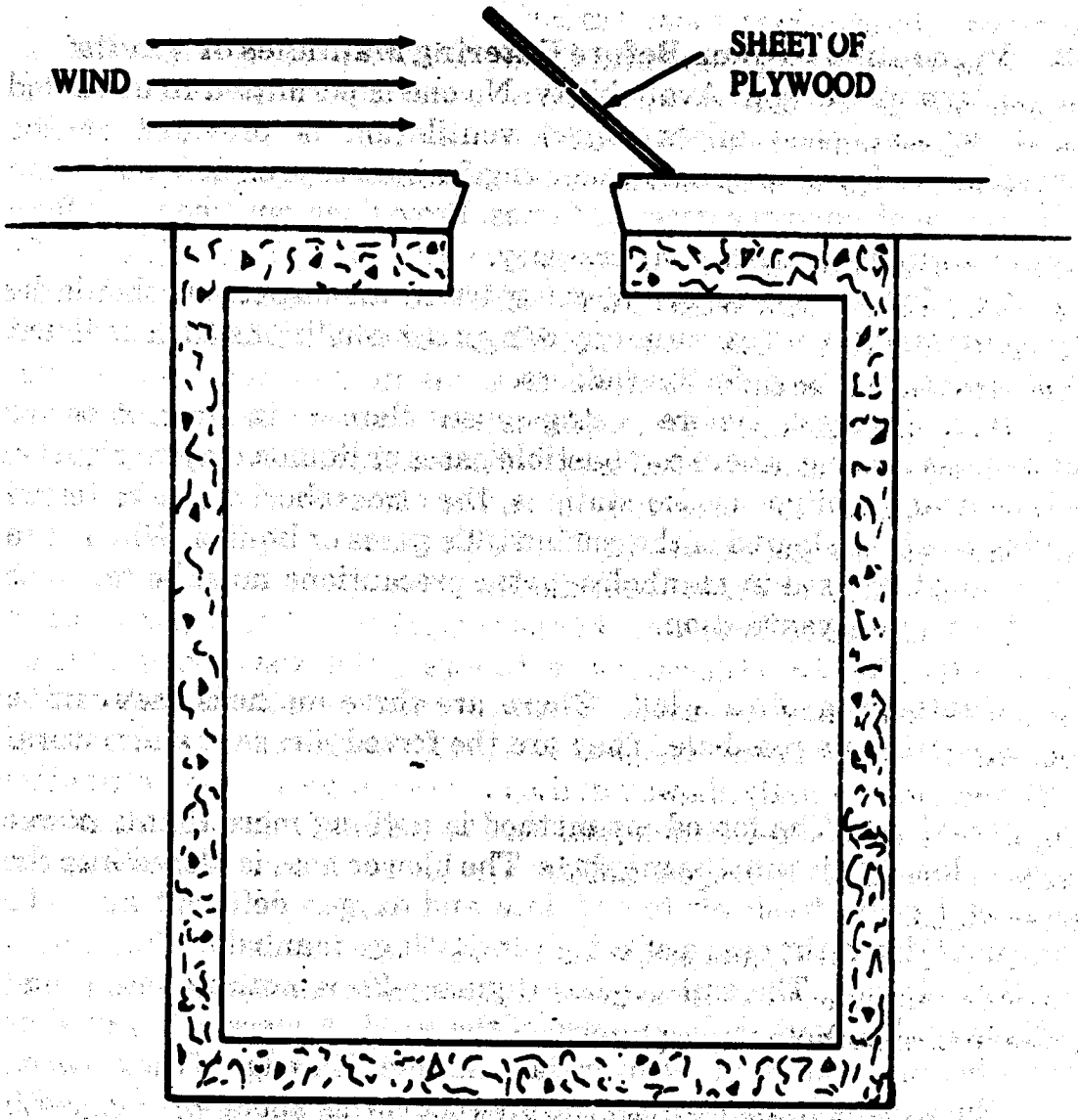

Figure 4-2. Sail Method of Manhole Ventilation.

4–4. Combustible or Toxic Gases:

a. Types. Since subsurface structures are subject to the accumulation of combustible or toxic gases, they must be considered hazardous until

proven clear by test or are ventilated. Combustible gases found in manholes or vaults are usually natural gas or hydrocarbon fuels. Toxic gases usually encountered are hydrogen sulfide, carbon dioxide, or mangrove gas (southern coastal areas).

b. When to Use Supplemental Oxygen. Entering a manhole with an oxygen deficiency can cause sudden unconsciousness and death by anoxia (blood starvation). Manholes containing less than 19.5 percent oxygen are not to be entered without a supplemental oxygen supply.

4–5. Testing Manholes for Dangerous Gases. TEST FOR LACK OF OXYGEN, COMBUSTIBLE AND TOXIC GASES BEFORE ENTERING ANY UNVENTILATED SUBSURFACE STRUCTURE. These tests are to be conducted as soon as the manhole cover is removed.

a. Oxygen Deficiency Tests. These tests can be performed with a safety lamp or an oxygen deficiency indicator. The safety lamp cannot be used to indicate the presence of carbon dioxide. Operation of the indicator instrument is found in TO 33C2-17-1.

b. Combustible or Toxic Gas Indicator:

(1) Colormetric Detectors. For the detection of "toxic gases," one of the simple effective colormetric detectors (color changes to indicate concentration) may be used. Hydrogen sulfide can be detected at concentrations as low as one part in 1,000,000. These detectors can be obtained commercially, however, the medical service bioenvironmental engineer is authorized a universal test kit with which concentration of carbon monoxide, hydrogen sulfide, and numerous other gases can be determined.

(2) TBA5100 Combustible and Toxic Gas Indicator. This unit is portable and is used to measure the amount of combustible and toxic gases in the manhole atmosphere.

4–6. Time Intervals for Test. WARNING: Do not enter a manhole until test results indicate that the manhole is free of poisonous or combustible gases.

a. Satisfactory Tests. If tests made upon removing the manhole cover indicate that the atmosphere is satisfactory, the manhole or vault may be entered and worked in. Additional tests must be made when each crew begins work; the time interval must not exceed 8 hours. When the

manhole is covered with a tent or tarpaulin, the test interval must not exceed 2 hours. Place the tent or tarpaulin so that an opening is left in the covering for ventilation.

b. Unsatisfactory Tests. If more than the allowable trace of gas is found on the initial test, ventilate the manhole or vault with a power blower for a minimum of 10 minutes, then make a second test with the blower running. If it tests satisfactorily, the manhole or vault may be entered. Make this test away from the direct blast of the blower. If gas is again found on the second test, continue to ventilate the manhole with a power blower until it tests satisfactorily. Work can then be started in the manhole, provided adequate power blower ventilation is continued. There must be enough ventilation to hold the quantity of gas in the manhole to an allowable value until the work has been completed and the cover is about to be replaced. While working in a manhole being ventilated with a power blower because of previous gas detection, test the atmosphere every hour. If the blower stops, leave the manhole at once and do not reenter until ventilation has been restored and the atmosphere tests satisfactorily. Operate the blower outside of the manhole tent or tarpaulin.

4–7. Testing After Manhole Has Been Pumped. The removal of water may permit gas to flow into the manhole. Make the test just above the opened duct. If a test indicates that gas is entering, ventilate the manhole.

4–8. Testing After Removal of Duct Plugs. Immediately upon the removal of the duct plugs, make a test just above the opened duct. If gas is entering, ventilate the manhole.

4–9. Rescue From a Manhole:

a. Mishap Occurrence. There is always the possibility that even though normal precautions are observed, there may be an occasion when personnel are overcome by gas or injured so that rescue is necessary. Rescue without delay is important, however workers engaged in rescue attempts must protect themselves. In cases of asphyxiation or gas poisoning it is advisable to ventilate with a blower or wind curtain while preparing the rescue.

b. Safety Observance. All measures of safety should be observed. There should be, if at all possible, a helper present to help with the rescue before you go into the manhole, but if no helper is available, you should proceed with the rescue. There are many ways which a rescue can be done. Described here are two ways that are effective.

c. Three-Man Method:

(1) Before rescuing a victim, the rescuer must first know what to do. First and foremost is a rescurer's own personal safety.

(2) The rescuer must have two ropes. One must be tied around the rescuer and the other tied around the victim. The minimum size rescue rope is one-half inch in diameter and at least the depth of the manhole plus 15 feet.

(3) The rescue rope should be wrapped twice around the body under the arms of the victim. Tie the rope with a bowline at the back of the body. (See figure 4-3.) The knot may be tied in front of the victim and rotated to the back.

(4) Rescue steps are as follows:

(a) The rescurer's helper should assist with the rescue rope, keeping it from becoming tangled as the rescuer enters the manhole. The rescuer carries the free end of the rope into the manhole and ties it around the victim. The helper should be well-braced and ready, and at the call of the rescuer, pull the victim from the manhole.

(b) Once the victim is ready to be raised out of the manhole, the rescuer should call to the helper to pull on the rope. As the helper pulls the rope, the rescuer should assist by lifting the victim as much as possible.

(c) As soon as the victim is clear of the manhole, check for stoppage of breathing and give any first aid that is needed.

d. Two-Man Method. This is a far better method for both the victim and the rescuer. The smallest individual can rescue the largest victim.

(1) Use a manhole guard anytime manhole work is done.

(2) Install a windlass handcrank on the top of the guard. Use about 25 feet of 1/2-inch rescue rope or Polydak line. Keep system installed for material handling operations and it will be ready if a rescue is needed.

(3) Wrap the rope as shown in figure 4-3; however, PLACE THE BOWLINE KNOT IN FRONT OF THE VICTIM. This allows the head to lean back, keeping the air passage open.

(4) Use windlass to raise the victim until buttocks clear manhole rim.

(5) Position victim with back toward opening of manhole guard.

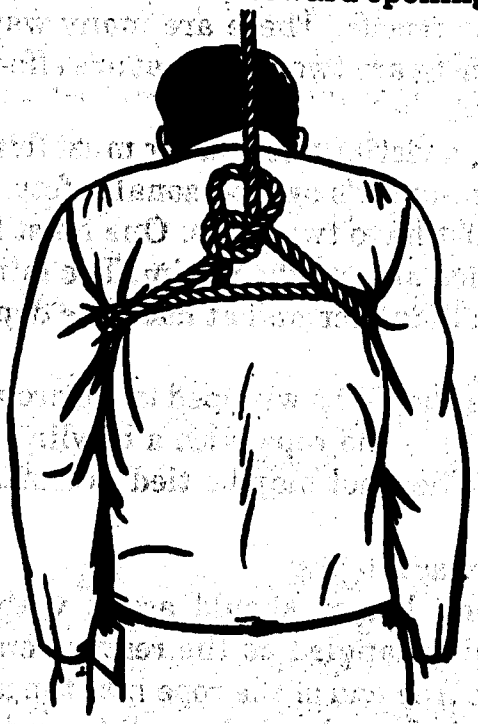

Figure 4-3. Rescue from a Manhole.

(6) Tip the manhole guard to allow the victim to lie on his or her back.

(7) CPR, if necessary, should begin immediately.

4–10. General Hazards. In addition to gas or oxygen deficiencies there are certain other hazards that also require precautions:

a. Entering or Leaving Manhole. Enter and leave manholes or vaults only by means of a ladder, do not step on cables or cable hangers.

b. Handling Tools and Material. Do not throw tools or materials into or out of manholes or vaults. Use canvas buckets or handlines for lowering and removing tools and equipment.

c. Low Voltage Energized Equipment. Low voltage (less than 600 volts) equipment is especially hazardous in or around subsurface structures. Motor frames and equipment cases may be energized by

electrical conductors with frayed or damaged insulation. The faults may occur only momentarily or may be prolonged through high resistance grounding paths. In either event, contact with these energized equipment surfaces and the damp and well grounded floors and walls often results in electrocution. Recommend that only pneumatic tools and low voltage (24 volt) lighting systems will be used in maintaining subsurface vaults and facilities. Flashlights are suitable sources of lighting.

d. Clear and Tag Equipment. All equipment such as transformers, network protectors, junction boxes and potheads must be considered energized until the procedure for the clearing and tagging has been followed.

e. Insulating Barriers. When working in any place that brings a worker in proximity to live parts, rubber blankets or other suitable insulating barriers must be placed in correct position to prevent accidental contact.

4-11. Work on Primary or Secondary Cables:

a. Determine Primary Cable. The external appearance of primary and secondary cables is often similar. For this reason, before starting work, a very careful check should be made of duct location and tag numbers. Any errors found in the tagging of cables or in the manhole records or maps should be immediately reported to the supervisor and work should not continue until authority is given by the supervisor. Under no circumstances should an identification tag be removed or placed on a circuit without direct permission from the supervisor.

b. Secondary Cable. After the cable has been deenergized and grounded at the source, the secondary voltage of any transformer fed from the same feeder cable should be checked when possible. The cable must be grounded on the other side of the work location.

c. Testing Cut Cables. If a cable is to be cut, it must be tested first to be sure it is dead. A good method is to use a wire tong or C-clamp device attached to a hot stick. The clamp, which has a sharp point on the screw end, can be tightened and be caused to penetrate to cable sheath and contact conductors. The use of a pike pole is also widespread for this operation but should be avoided as the pike does not have the rating of a hot stick. The pike pole would never be considered for overhead work so it shouldn't be used for underground work in this manner. A temporary ground should be placed on the cable before splicing takes place. This

allows the dissipation of any capacitance charge and helps to ensure the cable is deenergized. During the cutting operation primary rubber gloves, hard hat and safety glasses must be worn for protection in case of capacitance discharge flash.

Chapter 5
OVERHEAD DISTRIBUTION SYSTEMS

5-1. Distribution Poles:

a. Pole Handling. When poles are to be handled (setting, pulling, hauling, unloading), a minimum of two employees is required. If unloading occurs a night, adequate lighting must be provided.

b. Unloading Poles. Unloading of poles from trucks can be done safely if done properly. The principal objective is to unload poles so that none are broken and so that the poles do not roll onto any of the workers. There are several methods which can be used to unload poles but they all involve a few basic principles. The methods can be varied to suit the situation and are safe if these principles are followed. Refer to AFOSH STD 127-51 for safety guidance concerning outside cables and poles.

(1) Before starting any work, inspect the load for any dangerous situations such as weakness or breakage of binding wire, stakes, and other fastenings.

(2) Skids, manila or wire rope lines and slings (preferably 1/2-inch or 5/8-inch wire rope) must be thoroughly inspected to ensure they are strong enough for use in unloading poles.

(3) Place a skid on the side of the truck on which poles will unload.

(4) Bind the poles in some fashion to secure them while the stakes and binding wire on the unloading side are being removed or cut.

(a) One method involves the use of two trucks each equipped with a winch. Where such equipment is available, the winch lines can be drawn over the load of poles and anchored in vacant stake holes near each end and on the unloading site. By taking up on the winch lines, the poles will then be secured.

(b) If two trucks with winch lines are not available, then the poles may be bound with two or three guy wires. These guy wires should be anchored to vacant stake holes on the unloading truck with one near each end and perhaps one in the middle. The guy wires are then fastened to an anchor, winch line, or to the truck itself on the back side. they are then cinched up tightly using the winch or coffing hoists.

(5) The supervisor must determine that all persons are safely in the clear before binders or stakes are cut. Using only two people working

together, remove all standards on the unloading side of the truck except the one nearest each end. With all slack taken up in the two winch lines or (depending on which method is being used) binding guy wires, let one person stand beyond the load or under the truck for protection and cut or remove the two end standards. Binding wires will be cut with long-handled wire cutters. NO ONE WILL BE PERMITTED TO CUT BINDERS FROM THE TOP OF THE LOAD.

(6) If a winch line (or lines) is being used, the winch can then be let off gradually and the poles permitted to roll off without undue breakage. If a winch is not available then a handline must be attached to each of the guys just above the point where it is to be cut and the handline snubbed off to a tree or post this will prevent the free end of the guy wire, after being cut, from striking workers and will permit the poles to roll off more easily.

(7) Any poles remaining can be removed by two persons using cant hooks and working on the same pole.

(8) Once on the ground the poles can be positioned by the use of cant hooks. Special precautions should be taken while using the hooks.

(a) Hooks must be sharp and well protected when not in use.

(b) The hook bolt must be inspected occasionally to detect wear. When a worn hook bolt breaks in use, a sudden and severe fall can result.

(c) Injuries may result when the handle breaks or the hook comes out. Therefore, make sure the loose hook is firmly set in the pole.

(d) The cant hook is a one-worker tool and frequently breaks when two workers double up. If the job requires two workers, two hooks must be used.

(e) Before moving the pole, make sure that there are no tripping hazards behind the worker.

(f) Stand so the pole is rolled away from the worker. Pulling towards you can allow the pole to roll on a foot or even crush a leg. Also watch to see that the pole does not run up a hump, as the pole could run back while the grip and position of the hook is changed.

c. Transporting Poles:

(1) Poles must be held securely on trucks to make sure that binders will not be released during rough going.

(2) A red flag by day and a red light by night must be attached to the end of poles. The red light must be visible on both sides and rear.

d. Pole Treatment Hazards. To avoid creosote burns, the following precautions must be taken when handling creosote-treated poles and timbers:

(1) Keep skin protected by wearing a long sleeve shirt. Keep neck covered with a collar or handkerchief. Wear gloves to protect hands.

(2) Never rub the eye or wipe perspiration from them with hands or with shirt sleeves which have been exposed to creosote. Eye protection should be worn.

(3) Where direct contact with creosote is apt to occur, the hands, arms, and face may be rubbed with petroluem jelly or cold cream. When skin contact with creosote is made, first aid treatment should be obtained.

(4) The above applies when ground line treatment of poles is in progress. Compounds with trade names such as Osmose Plastic, Pol-Nu and other compounds must be handled with the same care as creosote. This also applies to other types of treatment materials.

e. Digging Holes:

(1) The digging of holes does not involve any great hazard but does contribute to a great number of minor injuries such as eye injuries from flying dirt and rock; blisters on hands from use of tools, which can be partially eliminated by using gloves; foot and leg injuries due to falls from tools left too close to the hole, particularly shovels that have been left turned up instead of down.

(2) Cover all open holes and deadman anchor holes as soon as dug. Hole covers must be at least 30 inches in diameter. They may be made with 1-inch lumber with two cross braces of lumber not smaller than 1 by 4 inches.

f. Setting Poles. The choice of method to use in setting poles is determined by the equipment and number of personnel available, the location of the pole, and the size of the pole. Regardless of the method selected, observe the following precautions:

(1) The supervisor must not under any circumstances assist in the setting of poles, but must give attention to ensuring that the work is being safely and correctly performed.

(2) Before setting a pole, remove all tools and other material from around the hole. Lay all digging bars and shovels on the ground at a reasonable distance. Never leave digging bars or shovels protruding from the ground.

(3) When ready to set the pole, arrange to have one person give all instructions and signals.

(4) As a pole is raised, always assume that there is a danger of something breaking. Keep all personnel not involved in the operation away from the base of the pole and at a distance of not less than the length of the pole being set.

(5) Never climb a gin pole while it is being used to set another pole.

(6) Never climb a pole that has just been set until it has been backfilled and tamped.

(7) When setting poles with blocks and gin pole, be sure that all rope slings are in good condition. Wrap the sling in such a way that there will be a turn on the pole for each sheave in the block being used and an extra turn to keep the sling from slipping on the pole. Attach the hook to as many turns in the sling as there are sheaves in the block.

(8) Gins must have sufficient teeth to accommodate the smallest pole.

(9) Where side guys are used in setting poles or structures, they must be attached to pencil bars driven into the ground. Tie lines or other guy wires must never be wrapped around the worker's bodies.

g. Pike Pole Method of Setting Poles:

(1) When erecting poles by piking, at least three experienced persons must be used in addition to the supervisor; one handling the butt of the pole and two piking the sides. Other persons used in this work must be thoroughly instructed as to the hazard of their work. Two legged "Dead Men" must be used in all cases possible and the supervisor is responsible for making sure that these tools are always in good condition. (See table 5-1.)

(2) Pikes must not be used in combination with a winch.

(3) Be sure crewmembers have a firm footing before lifting on pikes. The pike must be driven into the pole and held firmly at all times to prevent its falling on workers.

TABLE 5-1, Average Size of Crew Required to Raise Pole by Piking.

Pole Length in Ft	Crew Size	No. of Pikers	No. of Jinnyman	No of Butt Men
25	5	3	1	1
30	6	4	1	1
35	7	5	1	1
40	8	6	1	1
45	10	8	1	1
50	10	8	1	1

(4) The end of the pike must always be held in the palm of the hand. Lifting must be from the shoulder with the face toward the pole being piked.

h. Pole Setting Truck:

(1) Pole setting trucks must be positioned when possible so that the metal portions of the boom will not be dangerously close to energized conductors.

(2) Where work is being done and the boom or pole to be set or removed is in close proximity to energized conductors, all personnel engaged in the operation must stay clear of the truck. The truck must be grounded or considered as energized and must be barricaded. The truck operator must be insulated from the ground when operating the controls.

(3) A safety pole guard must be installed on the ground before setting a pole in an energized line. By wearing primary rubber gloves and sleeves and making use of dry rope and cant hooks near the butt of the pole, it can be guided safely into the hole. Persons not wearing the appropriate protective equipment must not touch any pole which is being set in an energized line. Climbers and tool belts must be removed before attempting to set poles.

(4) The truck operator must stay at the control and not leave them until the motor is stopped or the load is in a secured position.

(5) Only ONE person is to give signals which are thoroughly understood by all and any relaying of signals are done only by designated persons.

i. Removing Poles and Equipment:

(1) The dismantling of poles is a hazardous operation that must not be overlooked, as a great many people have been fatally injured or permanently crippled from such accidents. The following methods must be strictly followed. All poles must be guyed at least three ways by means of guy ropes before any work proceeds on the pole. This is done by:

(a) Making two turns around the pole with a sling and tying securely.

(b) Tying three guy lines around the sling at the proper angles.

(c) Snubbing off securely by means of pencil bars driven into solid ground or by any other substantial snub.

(2) Where trucks are equipped with an "A" frame, the truck can be backed up to the pole to be dismantled, tied off at the top by the winch line and the butt tied to the truck or pencil bars.

j. Pole Climbing:

(1) After arriving at the job and before starting work, all workers must inspect their body belt, safety belt, climber, and other tools.

(2) Before attempting to climb a pole determine by inspection or test that the pole is safe to climb. Poles must be tested for rot at the ground line, PIKES ARE NOT PERMITTED FOR SUPPORT WHILE WORKERS ARE ON THE POLES.

(3) Before going up a pole, determine the conditions on the pole and their relation to the job.

(4) When choosing the climbing side, make every effort to avoid weather-checks, knobs, knot holes, rotten spots, and places which have been cut badly by the gaffs of worker's climbers, nails, metal signs, and so forth so that the climber does not "cutout." When the poles are stepped, make use of such steps in climbing. The climber should not use the side of the pole where the ground wire is attached. Workers must avoid standing on mail boxes, telephone boxes, fences, crossarm braces, and similar objects. Workers must not use crossarm braces, secondary racks, conductors or insulator pins as hand holds.

(5) When climbing ice-covered or slippery poles where it is difficult to keep hands from slipping from the pole and causing a fall, place the safety belt around the pole before climbing is started to let the belt, instead of hands and arms, support the weight. At times it may be necessary to use a second safety belt, such as when climbing above crossarms.

(6) When a pole is raked or leaning, the climber should use the upper side if possible.

NOTE: The practice of racing up and coasting down poles is positively prohibited.

(7) When two or more workers are ascending a pole the second person must not start climbing until the first one is in a safe position or, when descending, until the first one is on the ground.

(8) Ordinarily, no worker is to work directly under another worker on the same pole, except in emergencies. When this condition is necessary, take extreme care to prevent tools or other objects from being dropped on the worker below.

(9) After arriving at the working position, the worker should put the safety belt around the pole or other suitable support and visually ensure that the strap is properly caught in the "D" ring before trusting any weight to the belt.

(10) Do not attach safety belts to insulator pins, crossarm braces, span wires, guy wires, or around crossbeams beyond the outside pin. Do not allow either end of the belt to hang loose when ascending or descending a pole or structure. Both ends of the safety belt should be fastened to the "D" ring.

(11) Linemen must not attach metal hooks, or other metal devices to body belts. Metal chains and keepers should not be used. Use leather straps or rawhide thongs with hard wood or fiber keepers. Care must be taken to prevent the snaps on the safety belts coming in contact with anything that may open a snap and thus release the safety belt. The tongue of the snap on the safety belt must face away from the body.

(12) Technicians' belt tools must be secured so that they will not fall out of the tool belt. Carry a minimum number of tools in the belt. Keep all other tools on the ground until they are required and then raised by means of a material bag attached to a handline. If a tool is too large to be safely raised in this manner, it should be raised by means of a handline.

(13) Carry handlines up a pole uncoiled, the end attached to the rear of the technician's body belt. When climbing with a handline, take care to prevent the line from fouling on any pole attachments.

(14) A separate compartment should be provided for storing rubber gloves and other rubber goods, and should not be used for any other purpose.

(15) All signs must be removed before the technician climbs or does any work above them on a pole to which they are attached. Where street signs are removed they must be replaced after all work is completed. It is not desirable to have any kind of signs on poles, but there may be times when it is necessary for street signs to be placed on them.

(16) If a fence post, sign post, or pipe standard is located near a pole, climb on the opposite side. Use good judgement in this matter. It may be necessary to cover the post or standard to provide the degree of safety required.

5-2. Working on Towers. Technicians may be required to climb towers to work on obstruction lights, marker lights and similar devices. Before climbing a tower the situation must be surveyed to get a good idea of what work is to be done and where the climbing will take place. The general rules of paragraph 5-1j should be followed. The great majority of falls from towers is due to slick work gloves or slick shoe soles. Ice or wet weather conditions increase the hazards. You must always make sure that your gloves and shoe soles are in good condition and free from grease or other inhibitors. Rough cord sole shoe or boots are recommended for tower work. Careful inspection and attention must be given the safety belt's condition and positioning, as the steel will cause it to wear out or break due to a cutting action. Climbing safety devices must be used when installed.

5-3. Crossing From One Side to the Other on a Structure:

a. Crossing Timbers. Workers must never walk on or across either single or double timbers in station structures unless there is some way to hold on for additional support. When inspecting middle phase insulators and it is necessary to climb half-way across an arm to get to the work, the worker may climb the rest of the way across, provided that, where practical, the safety belt be kept strapped around the timber as a safeguard. Where it is simply a matter of getting from one side of the structure to the other, the technician must descend to the ground and go up another pole unless there are adequate handholds and adequate clearances to live parts.

b. Crossing Open Air Switches. Under no circumstances is a technician to cross through an open air switch, one side of which is energized.

Energized portions of the structure must be blocked off with barriers and, if advisable, an employee should be stationed to watch for workers approaching the danger zone.

c. Balancing Support. Workers must not hold onto air switch arcing horns to steady themselves in walking timbers, as these horns break easily and a fall might result.

d. Climbing H-Frames. On line H-frames, climbing across the crossarm must never be done with the line energized.

5-4. Climbing Devices:

a. Climbers. Accidents resulting from pole climbing can be reduced if a few simple rules are applied. Although most cutouts are due to improper climbing techniques, a large number are due to improper care and maintenance of climbers. Well cared for climbers are safer and also reduce fatigue.

(1) The following precautions must be observed when using, storing, and transporting climbers.

(a) Each worker must be equipped with a pair of well adjusted climbers, and should not use another's.

(b) When climbers are being stored, they must be wrapped in pairs and fastened with their straps.

(c) Treat the leather straps with neatsfoot oil to keep the leather pliable and soft. Straps should be inspected frequently and maintained in good condition at all times. Straps which cannot be properly repaired should be replaced immediately.

(d) The use of pads is suggested. They must be maintained in satisfactory condition and be replaced when they become worn.

(e) While climbing poles, workers must be careful to put the gaffs only into sound wood and to avoid all knots, loose wood, checks, cracks, decayed spots, nails, ground wires, and similar hazards.

(f) When it is necessary to climb ice or sleet covered poles, special care must be taken to seat the gaffs in the wood of the pole securely.

(g) Steps should be used where provided.

(h) In working on a pole, a worker must be careful when using climbers to avoid injury to others who may be working nearby.

(i) Never wear climbers when working on the ground, while traveling in a vehicle, when working on a ladder, or on a stepped pole when the steps can be used instead.

(j) Don't use the gaff as a lever or pry.

(2) Climbers must be inspected before each use to detect nicked or dulled cutting edges on the gaff. Check them immediately if damage is suspected after striking them against hard objects such as pole hardware or nails. Upon receipt of the climbers, and at least weekly thereafter, the worker should inspect the climbers, associated straps, and pads for the following:

(a) Loose gaff.
(b) Nicks and depressions in the gaff.
(c) Ridge of gaff for alignment.
(d) Dull gaffs.
(e) Broken or distorted gaff points.
(f) Broken, loose leg or foot strap loop.
(g) Excessively worn, cracked, or torn straps and pads.
(h) Enlarged buckle holes in the straps.
(i) Broken or damaged strap buckles.
(j) Fractured or cracked leg irons and stirrups.
(k) Excessively worn stirrups.
(l) Fractured leg iron sleeves.
(m) Broken or loose rivets and screws on sleeves and straps.
(n) Defective strap rings.
(o) Broken or damaged loop clip-on straps.
(p) Gaff guards, if not in good condition.
(q) Improper length of gaffs.

When any of the listed conditions are revealed and cannot be readily repaired, new climbers, pads or straps must be secured.

(3) Restore damaged or dull gaffs to original shape by filing and honing (see figure 5-1). If gaffs cannot be restored, replace them. There are three methods that can be used to determine if gaffs are properly sharpened:

(a) Gaging. This method is used to determine the length, width, and thickness of the gaff and profile of the point. Reference lines are scored on the gage with slots provided to determine if the gaff length is satisfactory. Most gages also provide a contour test to determine if the

point is properly curved. Openings are provided for determining if the point is too keen. Each manufacturer makes a gaff gage to be used on their climbers. Gaff gages are, therefore, not interchangeable. Manufacturer's instructions should always be used if available.

1. The "thickness" slot in the gage is used to measure the thickness of the gaff at one-half inch from the point. These measurements are made with the outer ridge of the gaff resting flat against the part of the gage containing the scored lines. If the point of the gaff extends beyond the farthest line, the gaff is too thin. If it does not reach the nearest line, then it is too thick.

2. The "width" slot on the gage is used to measure the width 1/2 inch to 1 inch from the point. The same methods and reference line are used in measuring for thickness. The minimum length reference line is provided, intersecting the thickness measurements, to determine if the gaff meets minimum lengths.

(b) Plane Test. This method may be used with the gage or independently if the gaffs are sharpened by machine process. The test is made by using a soft board to determine if proper sharpness has been reached.

1. Place the climber with the gaff side down and parallel to the board without applying downward pressure above the gaff. Push the climber along the board. If the gaff is properly contoured and sharpened, it will dig into the wood and hold within approximately 1 inch. If the climber continues to glide along the board for more than 1 inch, additional honing is required.

2. After the "plane test" has been made, it can be supplemented by applying a cutout test. Jab the gaff into the board at about a 30-degree angle for approximately one-fourth inch. Bring the leg iron down against the wood while applying forward pressure--one hand holds the leg iron and the other holds the stirrup. If the gaff cuts out within 3 inches, it is improperly sharpened.

(c) Pole Cutout. After climbers have been machine sharpened or gauged (and as often as required thereafter), the gaffs may be tested on a pole.

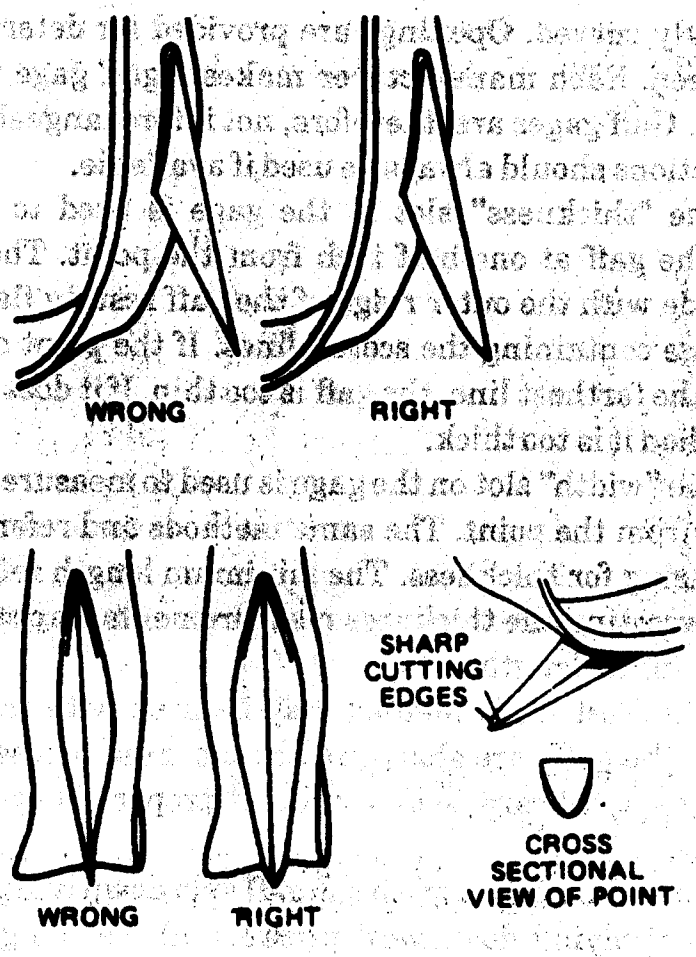

Figure 5-1. Comparison of Correct and Incorrect Gaff Shapes.

1. Put on the climber to be tested with only the foot strap fastened, and place the hand between the leg and the pad with palm toward the pole. With the leg at a 30-degree angle, jab the gaff about one-fourth inch (in depth) into the pole, about 1 foot above ground level. (See figure 5-2.)

2. Apply enough pressure downward on the climber to hold the gaff into the pole and maintain the same penetration. While in this position, use the other hand to maintain balance and move the knee toward the pole until the strap-loop of the leg iron rests against the pole. Gradually exert pressure (straight-downward) with the foot still maintaining

pressure against the pole with the knee. A properly sharpened and shaped gaff will cut into the pole and hold within 2 inches.

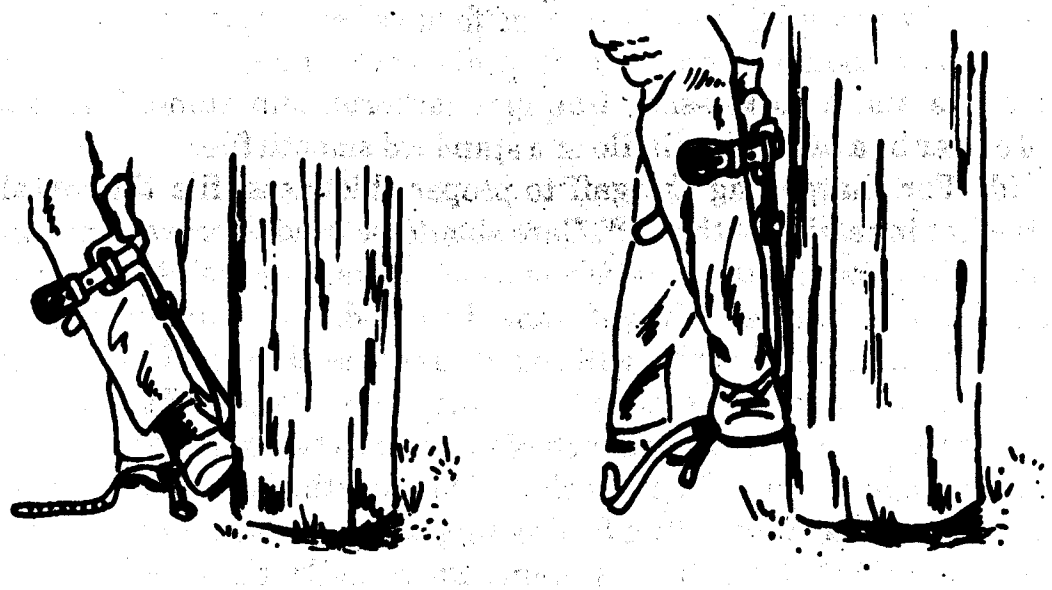

Figure 5-2. Pole Cutout Test For Gaff.

(4) Sharpening Climbers:

(a) Honing gaffs with a pocket-size, smooth carborundum stone is all that is necessary for machine-sharpened climber. (See figure 5-3.)

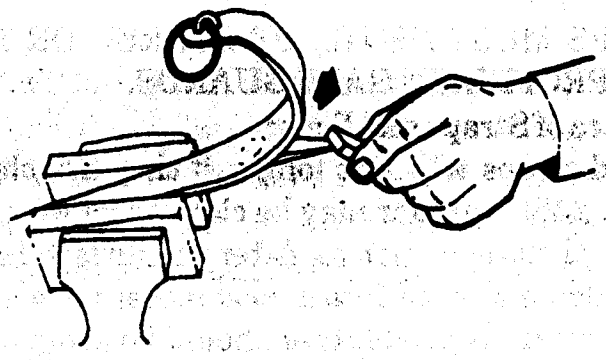

Figure 5-3. Honing a Gaff.

(b) If gaffs cannot be restored to a satisfactory condition with a hone in a short period of time, they must be returned for machine-

sharpening or replacement. The shortest length of gaff permitted is 1-1/4 inches as measured on the undersides. (The average life of a pair of climbers is 5 years or by the time both gaffs have been replaced twice).

(c) Two tools are required for field sharpening other types of gaffs: A file and a pocket-size, fine grit carborundum stone. The file should either be a bastard mill file or a standard smooth file.

(d) For sharpening the gaff to proper thickness, file the metal from the flat innerside of the gaff. Care should be used to prevent notching the leg irons or stirrup. Forward motions, toward the point and down to edges of the underside of the gaff should be used. Do not allow rocking motions of the file because this will round the edges of the gaff. After the proper thickness has been reached, the underside of the gaff should be straight to within one-sixteenth inch of the point, then rounded slightly toward the ridge of the gaff on a radius of one-fourth. Additional sharpness may be secured after filing by dressing the underside and rounded portion of the tip with the honing stone. Burrs along the edges should also be removed with the stone.

(e) The outer ridge of the gaff should never be filed. For securing proper width, the file may be used on the rounded portion. Strokes following the contour of the gaff should be used.

(f) To protect the gaffs, use gaff guards when climbers are not being used. They must also be used when other tools and materials are stored or transported along with the climbers.

NOTE: CLIMBERS MUST NEVER BE STORED OR TRANSPORTED WITHOUT APPROPRIATE GAFF GUARDS.

(5) Maintenance of Straps and Pads:

(a) Pads and straps will last longer if they are cleaned periodically (see TO 00-25-245). Leather may be cleaned by wiping the surface with a soft, dampened cloth or sponge. After the surface has been wiped, a neutral soap should be worked into a good lather with a clean cloth or sponge, then wiped clean. A good lather should be achieved with saddle soap, then wiped clean.

(b) After cleaning, and while the leather is still damp, apply a good leather dressing or neatsfoot oil.

1. Do not use excessive dressing and do not apply without first cleaning the leather.

2. After the leather has dried for at least 24 hours in a cool location, wipe off the excess dressing with a clean cloth.

3. Nylon or layered straps must be cleaned with an approved solvent.

b. Safety Belts. (Refer to AFOSH STD 127-31 for additional guidance.)

(1) Workers must use their belts and safety straps at all times when engaged in handling wires or apparatus on any pole, tower, or structure. Before a worker throws weight on the safety strap, determine that the snaps and fastening are properly engaged and secured. The only safe method to determine that the snap is securely fastened in the "D-ring" is to look each time. To rely on the sound of its snap, its feeling, or by leaning back for a test is dangerous, as the snap may be caught in something other than the "D-ring" and twist out. Workers must not fasten both safety belt snaps in the same "D-ring" to reach further out; either use an extension or take time to let the safety strap out if possible. Do not snap only one end of the safety strap onto a "D-ring" and the other end onto a pole or structure.

(2) Do not drop one end of the safety strap while working aloft with others, or climb or descend with one end unsnapped from the "D-ring."

(3) Special care must be exercised when placing a safety strap above a crossarm or timber where the pole does not extend well above such. Take care to see that the strap does not slip over the pole top. Keep strap more than 1 foot from pole top if possible.

(4) Inspection and Care:

(a) Each day before using a belt make sure that it shows no defects.

(b) If a belt is accidentally cut discard it immediately.

(c) Never punch extra holes in a belt or strap.

(d) Wipe the belt off with a clean rag after working in rain and snow and allow it to dry at room temperature.

(e) Never expose a safety belt to excessive heat.

(f) Belts should never be dropped or thrown from an elevation to the ground.

(g) Belts should be stored in special compartments or bags, or hung on a rack so that contact with hardware or sharp tools will be avoided.

(h) Inspect all safety belts thoroughly every 6 months in accordance with AFOSH STD 127-31 and TO 00-25-245. Leather belts should be given a thorough treatment of neatsfoot oil every 30 days. DISCARD ANY BELT AT ONCE IF THERE IS ANY DOUBT OF ITS SERVICEABILITY.

(5) ANSI A10.14-1975 and the National Safety Council indicate construction must be either of webbing or leather (modern web belts have leather pad coverings for comfort). Webbing offers some advantages over leather:

(a) Webbing is superior for any safety belt which may be called upon to take an impact load.

(b) Webbing has three to four times as much resistance to impact loading as the same size of leather.

(c) The leather belt width has no effect on its strength at the buckle.

(d) Leather requires special care and treatment to retain its strength; webbing does not.

(e) Only a leather expert can tell by visual inspection with any accuracy the condition and strength of leather. Webbing can be judged more accurately by visual inspection.

5-5. Handlines and Tool Buckets:

a. Using Handlines. When any work is to be done on a pole, tower, or structure that necessitates the raising or lowering of material or where the worker is subject to any unusual hazard, a handline or sheave line must be taken up and securely fastened. Precaution must be taken to see that the line does not become fouled or caught by a moving vehicle. The size of the rope to be used is determined by the kind of rope and work to be performed.

b. How to Use Handlines. Tools, insulators, and other materials must not be thrown to or from the worker on the pole or structure. Small items of hardware and small tools other than belt tools will be raised and lowered by means of an approved canvas tool bucket. Large items must be tied securely to the line. Workers must never attempt to carry wires up the pole that have been strung on the ground. The following are some rules and recommendations when using handlines:

(1) Workers must not stand where they might be struck by tools or material accidentally dropped. Should objects be dropped, the workers should shout "headache" as a warning to attract attention of ground workers.

(2) Handlines should always be dry and must not have wire reinforcements. Handlines must be at least twice as long as the height of the highest crossarm for the work at hand. Do not use metal on any handline, except for the use of a standard hook of not more than 4 inches in length.

(3) Where it is necessary to connect two handlines permanently by splicing, do not use metal, wire, or clamps in making the splices.

(4) Knots, friction tape, cord, or marline must not be used in joining the two parts of the line. Splices should not be bulky.

(5) Serve or sear each end to prevent the strands from unraveling. Handlines must be at least one-half inch in diameter. A handline must be strong enough to safely lower a person from a pole.

(6) Handlines with worn or frayed parts must be scrapped immediately and replaced with handline in good condition.

(7) Handlines must be carried up pole uncoiled and attached to the back of the body belt. When a worker is climbing with a handline, care should be taken to prevent the handline from catching on pole attachments.

(8) Handlines must not be pulled over sharp bends, sharp edges, or surfaces with splinters.

(9) Handlines must be kept free from solder, oil and grease, snarls and knots.

(10) When not in use, handlines must be rolled up and stored in the truck.

NOTE: This does not apply to handlines that are being dried out. Handlines must never be permitted to lie on the street or highway.

(11) Where handlines are being served out on the poles, at least one crewmember must be stationed at a safe distance from the base of the pole to take care of the loading and unloading of the handline, and to see that the ends are kept free from all street traffic.

(12) Handlines must not be stored while they are wet.

5-6. Tag Lines. In raising or lowering tools or material, obstacles such as crossarms or protruding construction are often encountered. Tag lines are recommended in such instances. A tag line is usually a rope attached to the item being moved in such a manner that workers pulling on the rope can guide it away from the obstacles. Safe clearance can be maintained, and efficiency and personnel safety are increased. Tag lines must be of a nonconductive type when used near energized equipment.

5-7. Care and Inspection of Rubber and Other Protective Equipment (also see AFOSH STD 127-31):

a. Care and Inspection. Line technician rubber protective equipment is used for personal protection and a serious personal injury may result if it fails in use. The ANSI/ASTM specifications for in-service care of rubber protective equipment stress visual inspection in the field as an important requirement in providing protection from electric shock.

(1) Rubber protective equipment manufactured of Type I natural or polyisoprene synthetic rubber is subject to ozone and corona deterioration. Salcore equipment made of Type II elastomeric compounds is not affected by this particular deterioration.

(2) Line technician rubber protective equipment may be subject to chemical deterioration and possible loss of insulating properties after prolonged exposure to ozone, heat, sun, oil and grease, or general weathering. Therefore, in addition to regular electrical tests and visual inspection for physical defects such as holes, tears, punctures and cuts, it should also be visually inspected at regular intervals for signs of possible chemical deterioration. These signs are: corona cutting, ozone or sun checking, texture changes such as swelling, softening, hardening, or becoming sticky or inelastic.

(3) Because of the potential loss of electrical resistance due to reversion or other deterioration, equipment should be withdrawn from service upon the first indication of chemical deterioration.

b. Specification References. The protective equipment is manufactured and color code labeled in conformance with applicable ANSI/ASTM specifications which include maximum use voltages and in-service inspection and retest requirements. Specifications on rubber protective equipment are as follows:

ANSI/ASTM D120
Rubber insulating gloves
ANSI/ASTM D178
Rubber insulating switchboard matting
ANSI/ASTM D1048
Rubber insulating blankets
ANSI/ASTM D1049
Rubber insulating insulator covers
ANSI/ASTM D1050
Rubber insulating line hose
ANSI/ASTM D1051
Rubber insulating sleeves
ANSI/ASTM F478
In-service care of insulating line hose and covers
ANSI/ASTM F479
In-service care of insulating gloves and sleeves

NOTE: ASTM publication PCN#06-411001-20 ASTM Specifications For Electrical Protective Equipment For Workers, is a compilation of all specifications in one booklet. Copies of individual specifications and the booklet may be obtained from ASTM, 1916 Race St., Philadelphia, PA. 19103.

c. Color Coding Standards. Proof, copy, color, code, and voltage relationship based on ANSI/ASTM specifications for personal insulating rubber protective equipment are shown in table 5-2.

TABLE 5-2. ANSI/ASTM Coding of Personal Insulating Rubber Protective Equipment

ANSI/ASTM COLOR CODE	ANSI/ASTM CLASS	Proof Test Voltage AC	Proof Test Voltage DC	Nominal Max. Use Voltage-AC Ph to Ph	Nominal Max. Use Voltage-AC Ph to Grd	Conventional Work Position
Red	0	5,000	20,000	1,000	600	Structure or
White	1	10,000	40,000	7,500	4,400	Basket

Basket						
Yellow	2	20,000	50,000	17,000	10,000	
Green	3	30,000	60,000	26,500	15,000	Electrically
Orange	4	40,000	70,000	36,000	20,000	Isolated
						Basket or
						Platform

d. Suggested Issue. Each worker should be equipped with a pair of insulating rubber gloves, leather protectors sized to match, a glove bag to carry and store them, and a squeeze bottle of dusting powder. An extra pair of gloves is required for retesting a program.

(1) Rubber gloves are made in hand sizes 9 through 12. Lengths are 11 inches and 14 inches for low secondary voltages; 14 inches, 16 inches and 18 inches for primary voltages.

(2) Leather protectors should be 2 inches to 5 inches shorter than rubber glove length, dependent of maximum use voltage. The difference may be less for protectors with rubber cuffs. For Classes 1 and 2, protectors match rubber gloves size for size. Classes 3 and 4 require larger dimension protectors made specially to match Classes 3 and 4 rubber gloves size for size.

(3) Glove bag length should be 2 inches longer than rubber glove length.

(4) Rubber sleeves are available in regular, large, and extra large sizes. Selection is based on the size of the person or maximum amount of clothing worn in cold weather.

(5) Dusting powder soothes hands, and helps prevent sticking of rubber surfaces.

e. Lineworker's Rubber Gloves and Sleeves:

(1) Lineworker's rubber gloves and sleeves must be carefully inspected before each use. Rubber gloves must be field air-tested before use each day and more frequently if there is cause to suspect damage. They must be inspected inside and out. Gloves and sleeves must always be stored with the bead on the outside, never inside out. Gloves must be stored in a glove bag, while sleeves are to be stored in a bag or rolled up to protect against mechanical and chemical damages. The in-service specifications require that rubber gloves and sleeves must be electrically tested initially upon receiving from manufacturer and retested at an interval not to exceed 3 months for rubber gloves (shelf life 12

months), and 12 months for rubber sleeves. A visual field inspection should also be made by the exterior electrical supervisor to determine if the gloves and sleeves are being maintained in satisfactory condition. This inspection should be made every 6 months.

(2) If contact has been made with any petroleum base products, such as inhibitors, hydraulic fluids and transformer oils, the gloves and sleeves must be wiped off with a rag as soon after the contact as possible. Failure to remove the petroleum base product promptly will result in the rubber swelling and ultimately deteriorating. The swelling will eventually disappear but it may result in considerable reduction of mechanical strength and possible chemical deterioration at the point where the swelling occurred.

(3) When inspecting sleeves, inspect the entire inner and outer surface to locate pinholes, cuts, scratches, abrasions, aging, corona cutting, oil markings, or other chemical injuries. Stretching or rolling the rubber between the fingers, or on a flat surface, will aid in revealing defects. If any of the above defects are found, the sleeve must be tagged and withdrawn from service.

(4) Rubber gloves are the basic protection from electric shock, because the hands are the most likely portion of the body to make initial contact with energized parts. For rubber gloves to provide protection they should be put on before a person is in a position where it may be possible to reach or fall into energized lines or equipment.

f. Rubber Blankets:

(1) Both Type I, Natural or Polyisoprene synthetic rubber and Type II, Salcore elastomeric compound blankets are subject to damage by petroleum based products. As in the paragraphs on rubber gloves and sleeves, prompt removal of the petroleum based products is important to eliminate or reduce the possible swelling and damage to the blanket. If swelling does occur and eventually goes down, the mechanical strength, that is, the resistance to snag, puncture and tear, may be greatly reduced and chemical deterioration may result. Depending on the type of petroleum based product involved in the contact, the area affected can become spongy and discolored. Blankets should be mutilated and discarded when damaged by petroleum products. Rubber blankets must be carefully inspected before each use.

(2) To locate swelling, scratches, tears, abrasions, snags, tracking, cutting or age-cracking the blankets must be rolled two times on each side so that the second roll is at a right angle to the first roll. Blankets that show any of the above reasons for rejections must be removed from service.

(3) The in-service specifications require that rubber blankets must be electrically tested initially upon receipt from manufacturer and retested at an interval not to exceed 1 year. In addition to the electrical test, a visual inspection of blankets should be made in the field by the exterior electrical supervisor to determine that the blankets are being maintained in satisfactory condition by the users. The frequency of this inspection should be at intervals of not more than 6 months.

(4) Blankets must always be stored flat or rolled in blanket roll-ups or canisters. They must never be folded, creased, or compressed in any way. Do not use tape of any type to hold the blankets in the rolled position. The adhesive plasticizer can damage the blanket surfaces.

g. Rubber Insulating Line Hose, Hoods, and Covers:

(1) Rubber insulating line hose, hoods, and covers must be inspected before each use. Inspect thoroughly for cuts, scratches, corona cutting, holes, tears and punctures, aging, rope or wire burns and aged rubber. Also, look for texture changes such as swelling, softening, hardening, becoming sticky or inelastic, which are signs of chemical deterioration. If the mechanical damage extends one-quarter of the wall thickness of the hose or hoods or if there is possible chemical deterioration, they must be removed from service. Line hoses, hoods, and covers must be wiped clean of any petroleum base product or other damaging substances as soon as practicable after contract. They should be stored in a relaxed position, that is, without distortion and mechanical stress. Tape must not be used to secure line hose, hoods or covers when shipped or stored.

(2) The in-service specifications require that rubber line hose, hoods, and covers be electrically tested initially upon receiving from manufacturer and retested at an interval not to exceed 1 year. In addition to the electrical test, a visual inspection of line hose hoods, and covers must be made in the field by the exterior electrical supervisor to determine that they are being maintained in satisfactory condition by the users. The frequency of this inspection must be at intervals of not

more than 6 months. However, frequent field inspection should be made by the individual users. Type I line hose, hoods or covers should not be left in service on energized lines any longer than necessary. Extended exposure may result in ozone checking, corona cutting, or excessive weathering.

(3) The exterior electrical supervisor must maintain a record showing the field inspection date and the electrical test date of all rubber and other protective equipment. This record must also include the next due date for field inspection and electrical test.

h. Equipping Support Vehicles. Each bucket truck and line maintenance truck must be equipped with ample rubber and other protective equipment normally required. These pieces of protective equipment must be further supplemented by such rubber goods as in the opinion of the electrical superintendent are desirable for carrying on the work with safety. Those rubber goods must be carried in an approved container, either built in or not, which will protect them from moisture, heat, light, and mechanical injury. If this container is of metal, the rubber goods should be kept from contact with the metal.

5-8. Hot-Line Tools:

a. Purpose. Hot-line tools can be used to perform a great variety of jobs on overhead power lines. When used properly they allow work to be done safely without interruption of power. Only employees who, through training and experience are properly qualified, are allowed to perform live line work using hot-line tools and equipment.

b. Specification Requirements. Use only hot-line tools having manufacturer's certification to withstand the following minimum test: 100,000 volts AC per foot of length for 5 minutes when the tool is made of fiberglass; or 75,000 volts AC per foot for 3 minutes when the tool is made of wood. Efforts should be made to replace all wooden hot-line tools with fiberglass.

c. Caring for Hot-Line Tools. Once the tool is received, workers must share responsibility for the continued, safe condition of hot-line tools. Epoxiglas hot-line tools are safe and dependable, and made to take demanding use. To ensure peak tool performance and safety follow the basic guidelines in storage, transporting, and handling of tools.

(1) During storage, keep tools enclosed in bins or racks. Always make sure tools are dry. Long exposure to moisture, dirt or ultraviolet attack can adversely affect the tool. Trailers or special areas on trucks must be set aside for tool transport.

(2) When in use on the job, place tools on portable racks or laid on clean, dry tarpaulins or plastic sheeting. All tools must be wiped with a clean cloth by the ground worker before being sent up the structure. The workers must avoid rough handling, such as banging the tools against the structure, as they are raised and lowered from the top of the structure.

(3) If it rains at the work site, make sure the tools are wiped dry before returning them to storage.

(4) All wooden hot-line tools must be tested for moisture level initially upon receiving from manufacturer and retested at an interval not to exceed 6 months, or when moisture penetration is suspected.

(5) Hot-line tools must be inspected before each use. The tools must be visually inspected for cracked or distorted end fittings, feathered rivets or ferrules that have visibly moved, hairline cracks or scars in the insulation, blisters in poorly applied coatings that could trap moisture.

(6) Tools that are accidentally dropped from the structure must be very carefully examined for the above problems.

(7) Carefully observe the manufacturer's recommendations for tool loading and clearances.

(8) Tools must not be left in line contact for extended periods of time.

(9) The in-service specifications require that all hot-line tools must be electrically tested initially upon receiving them from manufacturer and retested at an interval not to exceed 6 months. In addition to the electrical test, a visual inspection of hot-line tools must be made in the field by the exterior electrical supervisor to determine that they are being maintained in a satisfactory condition by the users. The frequency of this inspection must be at intervals of not more than 6 months. Hot-line tools stored for long periods of time, such as for mobility purposes, must be tested once a year.

d. Maintaining Hot-Line Tool Records. The exterior electrical supervisor must maintain a record showing the field inspection date, and the 6-month moisture level and electrical test dates. This record also must

show the next due date for field inspection, moisture, and electrical test. The exterior electrical supervisor also must plan a regular program for cleaning and repairing hot-line tools. The surface of the tools must be clean and glassy.

e. Hot-Line Tool Inspections and Repair. Inspect the fiberglass surface of each tool for dirt, creosote, grease, or any other foreign material before and after each use. If any of the above contaminants exist, the fiberglass surface must be cleaned. This cleaning process must involve as many of the following steps as needed in the sequence as outlined:

(1) Wipe fiberglass with clean rag.

(2) Clean fiberglass surface with hot stick pole cleaner. (CAUTION: Do not use this cleaner on painted surfaces). This is a nonconductive cleaner which will also remove surface wax on fiberglass. Presuming this Step #2 is successful, Step #3 is a must procedure.

(3) Wax fiberglass surfaces with hot stick wax.

(4) Should Step #2 fail in cleaning fiberglass surface (which should be infrequent), the tool must be taken out of use, tagged and referred to the supervisor for further evaluation. (CAUTION: Do not write on fiberglass surface).

(5) Do not use household or industrial soap detergents, abrasives and cleaners (liquid or powered form) to clean fiberglass tools under field conditions. Cleaning agents leave conductive residue unless rinsed with generous amounts of water (usually not available in the field). Abrasive cleaners destroy the surface gloss on the stick. All fiberglass tools that are subjected to such cleaning agents must be electrically tested to ensure complete removal of residue from soap type cleaners.

(6) Waxing the fiberglass surface of hot-line tools not only protects the glossy surface of the fiberglass, but also adds to the electrical integrity of the tool. Wax provides a protective barrier against foreign substances such as dirt amd creosote which is easily removed with hot stick pole cleaner. Waxing is not necessary after every use of the tool, but rather as needed to maintain a glossy surface. Exception: Wax must be applied after every cleaning with hot stick pole cleaner). Use only hot stick waxes as recommended by the hot-line tool manufacturer.

(7) Silicone cloths may enhance the electrical integrity of hot sticks and help protect the glossy fiberglass surface. However, they are not

approved for use because silicone has a migrating characteristic and over a period of time may hamper refinishing processes. Hot stick wax has all of the advantages of silicone without the suspected adverse effects.

(8) Clean and wax all hot sticks before electrically testing. Electrical tests must be performed by personnel thoroughly familiar with hi-pot test equipment and the procedures of this section. AC testing according to the manufacturer's specifications is permitted instead of the DC testing specified below. Safety precautions as outlined in the test set instruction manual and this section must be observed in this test. The test equipment and test specimen must be roped off to guard against accidental contact by persons in the vicinity. Sticks may be electrically tested using a DC hi-pot test set. (See figure 5-4.) Four 1-foot segment tests and one overall test is made on each stick. In some cases test segments may overlap. The test contacts must be two spiral springs, 5/8-inch to 1 inch in diameter or clamps which make contact with the entire circumference of the stick. Springs must be wound of spring steel, 40 $\pm$ 5 thousandths inch diameter.

f. Hot Stick Test Instructions:

(1) Suspend the stick in a horizontal position with clean polypropylene insulating rope about 4 feet above the floor.

(2) Place the DC test set on the floor 8 to 10 feet perpendicular distance from the center of the stick.

(3) Wrap the springs around the stick so spring contact is maintained on the entire circumference of the stick. (These springs may have to be shielded to reduce corona losses.)

(4) Attach the test leads to the springs so that sharp edges are inside the springs. The hot lead of the test set must be routed directly from the top of the test set resistor to the nearest test spring. Coil the excess lead in the center of the lead maintaining 2 feet ground clearance. Bag this connection with a plastic bag heavy enough to eliminate corona. Use shielded cable, similar to RG-58, for the ground lead. Attach the inner conductor of the shielded cable to the ground spring and to the ground return meter of the test set. Strip back 2 inches of the shield and float the shield on the spring end and attach the shield to the ground lug on the test set.

(5) Apply potential to the test segment. Increase the voltage gradually (10k per second) to 80 KV and maintain for 1 minute. Read the maximum leakage current in the ground return meter. A leakage in excess of 8 microamps signifies a failure of any test segment. Test the remaining three segments in the same manner as the first and record the four leakage current readings. Refinish any stick that fails the segment test and retest the stick.

(6) Reconnect the test leads to apply 100 kV DC for 1 minute to the entire length of the stick. A leakage current in excess of 10 microamps indicates an internal contamination problem and signifies a failure. Internal operating rod shotgun sticks and other hollow fiberglass sticks that fail the overall test must be recleaned internally and retested. The failure of a foam filled stick indicates a wicking problem in the foam. This problem is a very rare occurrence, and cannot be repaired.

g. Clampstick Test Procedures:

(1) Disassemble all clampsticks before cleaning and testing.

(2) Clean all exterior fiberglass surfaces of the clampsticks and the operating rod with fiberglass cleaner. Use the operating rod as a bore rod to clean the interior surface of the hollow sticks. When the cleaner has dried to a white residue, wipe the surfaces with a clean cloth.

(3) Inspect the fiberglass surface for nicks or abrasions and refinish the stick, if required.

NOTE: Do not attempt to refinish plastic surfaces.

(4) Wax all surfaces, including interior surfaces of hollow sticks with approved hot stick wax. When the wax has dried, wipe all surfaces with a clean cloth and test the stick as indicated below.

(5) While stick is disassembled, test two 1-foot sections on each end of the operating rod. Operating rods must be tested at 80KV DC. Leakage must not exceed 8 microamps.

(6) Test the stick according to the test procedures for hot sticks. The test segment of the stick nearest the handle end begins at a point 6 inches from the end of the ferrule. All guides must be in place on the stick during this test.

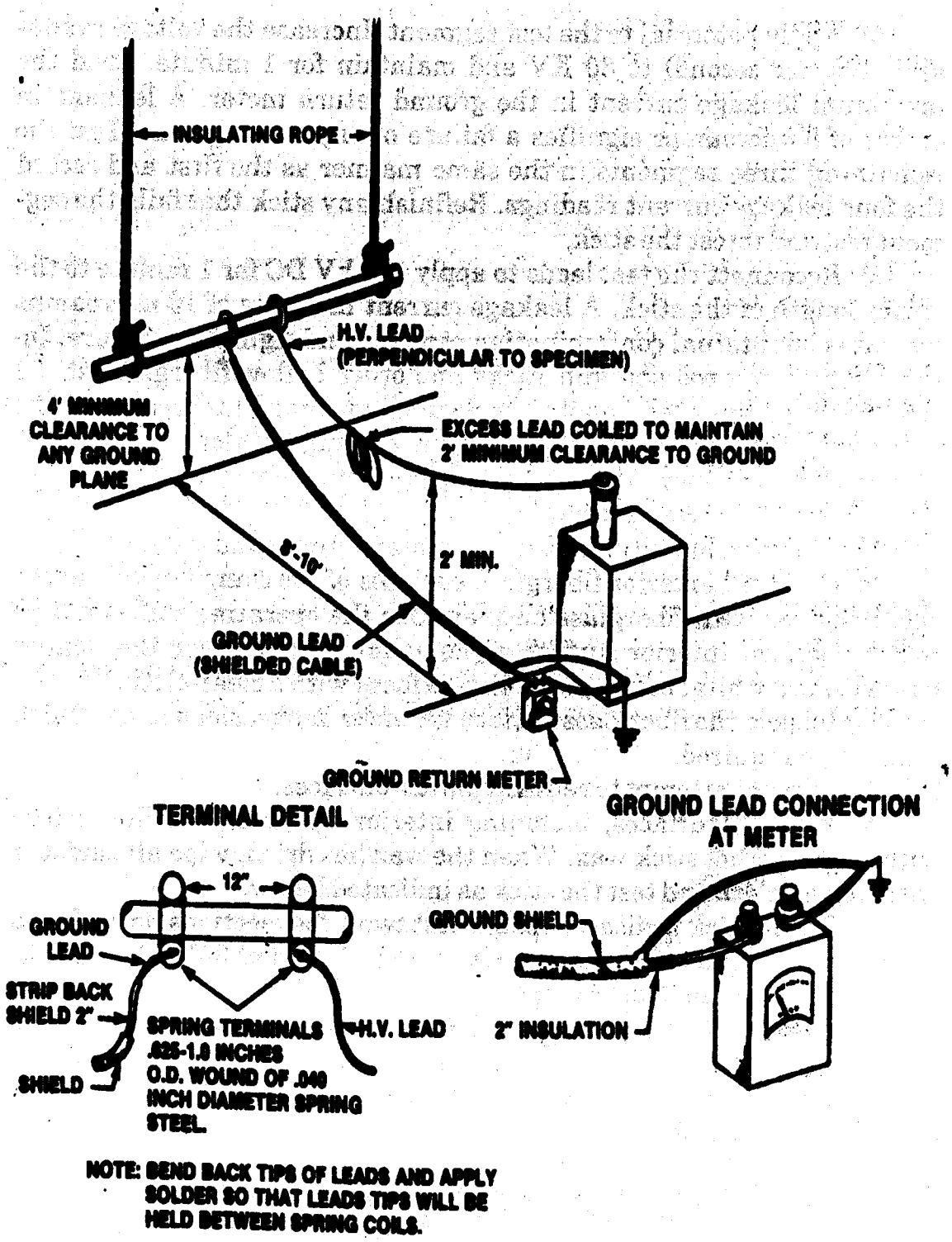

Figure 5-4. Typical Set-up for High Voltage Tests.

h. Instead of the above procedure, trade name hot stick tester (A.B. Chance LS-80) may be used every six months. The manufacturer's instructions should be followed. Hot-line sticks also may be tested by contract according to ANSI or ASTM standards.

i. Restoring Fiberglass on Tools. To completely clean and restore fiberglass, remove the old glass by sanding. Wipe the pole clean and refinish with fresh Epoxiglas Glass Restorer. The coating will dry in a few hours and the tool should be ready for use within 24 hours, but only after an application of hot stick wax.

(1) Small ruptures in the insulation portion of the tools can usually be repaired at the shop. This can be accomplished by removing the damaged fibers, cleaning the void with MEK or acetone, and applying the Epoxiglas Bond. After the patch has set, apply Epoxiglas Glass Restorer. When using MEK for this process, adequate mechanical ventilation or personnel protective equipment must be provided. Consult the base bioenvironmental engineer and AFOSH STD 161-1 before use.

(2) If bolts or studs are replaced, be sure to use high strength (Class 5) tempered steel hardware, the same as used on the original equipment. Do not use conventional bolts or studs.

(3) When a tool shows signs of major damage, it should be destroyed or returned to the factory for evaluation and possible repair.

Chapter 6
WORK ON LINES AND EQUIPMENT

6-1. Safe Clearance. Work on transmission or distribution lines and equipment requiring the opening and closing of switches must be accomplished under the safe clearance procedures prescribed in this chapter. These procedures provide for the blocking, tagging, and grounding of electrical switching and controlling devices to clear lines and equipment for the safe accomplishment of work in the DEENERGIZED condition. The procedures have been developed to protect life and property.

a. Forms Used. Safe clearance procedures involves the use of AF Form 267, Electrical Danger - Men At Work; AF Form 268, Caution - Abnormal Conditions; AF Form 269, Electrical Facilities Safe Clearance (local reproduction authorized); AF Form 979, Danger Tag; and AF Form 980, Caution Tag. AFOSH STD 127-45 prescribes AF Forms 979 and 980. However, these forms are not compatible with the established safe clearance procedures. Therefore, fill out and display AF Form 267 with AF Form 979; and fill out and display AF Form 268 with AF Form 980. This is an interim measure until the present stock of AF Forms 979 and 980 is depleted and forms are modified. Switches bearing AF Form 979 must not be operated under any circumstances without specific authorization from the electrical superintendent or exterior electrical supervisor.

b. Records Retention. Dispose of safe clearance records according to AFM 12-50, Vol II, table 91-3, and danger tags according to table 127-1.

c. Filling Out AF Form 267. AF Form 267 must only be used for the protection of personnel. This tag can be used by itself or in conjunction with AF Form 269 which is discussed later in this chapter. Complete the front side of this form using the following instructions:

(1) Installation. Place the name of the installation, annex, or facility where the form is to be used in the space.

(2) Safe Clearance Number. When this tag is used in conjunction with AF Form 269, this space and the record number of the safe clearance must be the same. When used by itself, leave this space blank.

(3) Line or Equipment Involved. This space must contain a brief but concise description of the circuit or equipment which this tag affects.

(4) Individual Ordering Tag on Equipment. When this tag is used in conjunction with a safe clearance, this space must bear the signature of the individual who received the clearance. When used by itself, this space must bear the signature of the individual directly in charge of the work at the site where the tag is to be used. The date and time opposite this block is for the current time and date the individual ordered placement of the tag.

(5) Individual Placing Tag on Equipment. This space is for the signature of the person actually placing the tag on the disconnecting device. This signature and the signature of the person ordering tag on equipment may be the same in some cases. The date and time opposite this block is for the actual time and date the tag is placed on the device.

(6) Individual Ordering Tag Removed. This signature must be the same signature of the person ordering the tag on the equipment. Time and date blocks opposite the signature block must bear the time and date the individual ordered tag removed.

(7) Individual Removing Tag. This space is for the signature of the person actually removing the tag from the disconnecting device. The date and the time opposite this block is for the actual time and date the tag was removed.

d. Filling Out AF Form 268. AF Form 268 is used to identify abnormal operating condition of the lines or equipment. For instance, a normally open switch which has been closed tying two lines together before taking a section of one circuit out of service is to be tagged with AF Form 268. THIS TAG MUST NEVER BE USED FOR PROTECTION OF PERSONNEL. The following instructions apply:

(1) Installation. (See 6-1c(1) above.)

(2) Safe Clearance Number. (See 6-1c(2) above.)

(3) Line and Equipment Involved. (See 6-1c(3) above.)

(4) Abnormal Condition. This must be a brief but concise description of the abnormal condition.

(5) Special conditions. These are the conditions that are created by the abnormal condition. Example: Closing a normally open switch is the abnormal condition and the tying or back feeding is the special condition created.

(6) Individual Ordering Tag on Equipment. (See 6-1c(4) above.)
(7) Individual Placing Tag on Equipment. (See 6-1c(5) above.)
(8) Individual Ordering Tag Removed. (See 6-1c(6) above.)
(9) Individual Removing Tag. (See 6-1c(7) above.)

e. Filling Out AF Form 269. AF Form 269 must be used by all Air Force installations to control and record all blocking and tagging action performed within the scope of this chapter. The following instructions apply:

(1) Record Number. Assign consecutive numbers from records maintained by the superintendent.

(2) Other Clearance Numbers. If more than one safe clearance (AF Form 269) is to be issued on the same line or equipment, these numbers will be consecutive with the other clearances and entered here.

(3) Issued By. The safe clearance must be issued by the electrical superintendent or a designated safe clearance manager. Fill in the name of person, the time, and the date of issuance. This person is responsible for making any necessary arrangement for interruption of service. This person is also responsible for notifying the utility company supplying power to the installation prior to the performance of any operation which may affect the utility company's system.

(4) Name of Person Receiving Clearance. The safe clearances must be issued to the Supervisor of the exterior electric section. However, in the absence of the shop supervisor, the safe clearance is to be issued only to authorized personnel of which the superintendent maintains a current list. Generally, only one safe clearance will be issued; however, if more than one crew is assigned to the work and due to the distance separating the various crews or the extent of the work, as many safe clearances as required may be issued. In such cases, the supervisor of the exterior electric section must act as coordinator between all the issued safe clearances.

NOTE: No individual is required to work on lines or equipment under unsafe conditions.

(5) Line Equipment Involved. This space is for a brief but concise description of the lines or equipment on which the work is to be performed. This information should be entered in advance of actual issuance of the safe clearance, but be filled in by the individual receiving the clearance.

(6) Details of Blocking and Tagging. The person who has received the clearance is responsible for listing all blocking and tagging details. Before work can be accomplished under a safe clearance a visible line break must be provided at all points of possible feed when possible. Record the procedures required to provide this visible line break in this section of the form. Enter all details in their proper sequence reading down on the form, and include all switching, blocking, tagging, and grounding operations.

f. Blocking Procedures. Blocking is defined as preventing a prime mover valve, switch, or other circuit opening device from becoming accidentally altered. This is best accomplished by the use of padlocks which will be controlled by the person receiving the safe clearance.

(1) When a transmission or distribution circuit breaker is opened for a safe clearance, a set of disconnecting switches or an air switch in series with a circuit breaker must be opened. It is a strict violation of all safety rules to work on high voltage lines or equipment with only an open circuit breaker between the worker and the source of power. Precaution should be taken to see that the circuit breaker is open before opening the disconnect switch or air switch in series with it.

(2) When a three-pole air switch (the term "air switch" embraces gang-operated disconnecting switches) is opened, it must be locked in the open position and then inspected to see that all blades have opened fully. If an air switch is opened and the arc holds after the switch is in the wide open position, the switch must be closed immediately and the exterior electrical supervisor advised.

(3) When air switches are equipped with motor operator, the motor operator must be mechanically deenergized from the air switch operating rod. The coupling must be locked in the open position.

(4) Stick-operated disconnecting switches must not be operated in any way except by use of approved insulated sticks provided for that purpose. Where they have latches, care must be taken to see that the disconnect is left with the latches holding the blades in position as intended because on a short circuit, severe stresses are set up by the electromagnetic forces which tend to throw the disconnects open.

(5) Disconnects should be operated quickly and surely. Switch person should not look at operation as this might cause eye injury.

(6) For switches on underground circuits, the switch must be operated first, then place the elbows (if present) on parking bushings to ensure an open circuit.

(7) On opening a switch, disconnects, cutouts, primary jumpers, or breakers for the beginning of work on a line or equipment, place the danger tags in a conspicuous place.

g. Tagging Procedures. Tagging is defined as the placement of an appropriate tag directly on the circuit opening device. Tags are applied to such devices for additional safety and to ensure that their positions will not be altered by unauthorized personnel. When tagging:

(1) Air Switches. Place tag on operating handle.

(2) Feeder Breaker. Place tag on operating mechanism that raises or lowers the breaker. On feeder breakers having line and load side disconnects, tag both sets.

(3) Padmount. Place tag on operating handle or other conspicuous place.

(4) Disconnects or Cutouts. Place tag on operating side of structure or as high up on the pad as tagger can reach from the ground.

(5) Network. Place tag on feeder breaker and associated disconnect switches.

(6) On underground distribution systems when it is not practical to provide a visible line break, an oil disconnect switch or subway switch must be blocked mechanically and locked, and a tag attached to the operating handle. The AF Form 267 and AF Form 268 must always be applied under a safe clearance (AF Form 269) except when secondary lines or equipment are involved. When the AF Form 267 and 268 are applied on secondary lines or equipment, do not use AF Form 269.

(7) Danger and Caution tags (AF Forms 267 and 268) applied under each safe clearance must bear that safe clearance number and the name of the person to whom that safe clearance is issued.

(8) Time Applied. The person who has received the safe clearance enters opposite each detail of switching, blocking, tagging, and grounding, the actual time each item is performed, progressing downward in proper sequence.

(9) Released By. The exterior electrical supervisor releases the safe clearance to the electrical superintendent after the work has been completed. The supervisor is responsible for making sure that all personnel

and temporary ground are clear, and the line or equipment is ready for service. "Clearance released by," must reflect the signature of the exterior electrical supervisor as certification of accomplishment.

(10) Accepted By. The electrical superintendent accepts release of the safe clearance. The approval of acceptance must be indicated by the superintendent's signature. If the electrical superintendent issues more than one safe clearance, the superintendent is responsible for ensuring that all clearances have been released and accepted before any change is made in the blocking and tagging to put the line or equipment back in service.

(11) Time Removed. The on-site supervisor is responsible for performing switching operations in the reverse order. Beginning with the last detail of switching, blocking, and tagging operation, perform the opposite operation, progressing upward on the safe clearance form, and enter the time each operation is performed. For instance, if a detail of switching, blocking, and tagging reads "Open Switch No. 501 and Attach Danger Tag," the opposite operation is "Remove Danger Tag and Close Switch No. 501." The switch must not be closed with a slam, but it must be closed firmly to ensure good contact. Immediately upon closing a switch, the switch person must inspect all blades, and if an arc or poor contact is found, contact the exterior electrical supervisor for further instructions. Once the switch is closed, it must not be opened for a second closing without first consulting the exterior electrical supervisor.

6-2. Live Maintenance by Gloving or Hot Sticking:

a. General Instructions:

(1) Overhead lines should be worked "dead" when this can be done. However, live line maintenance must be performed when certified by the base civil engineer, or a designated subordinate supervisor from the organization, as necessary to support service requirements for a critical mission, prevent injury to persons or protect property.

(2) Live line maintenance, carefully done by industry approved standards, has proven to be an effective method for work on electric power circuits. The lines must be recognized as energized, demanding maximum respect by all personnel. Maximum utilization of insulating equipment and application of the basic principle of isolation are required to the greatest degree possible.

(3) Today's workers have a variety of field proven methods and equipment available to them for repairing and rebuilding circuits while energized. These methods by voltage class are listed in table 6-1.

(4) When live line maintenance is to be performed, it is the exterior electrical supervisor's responsibility to plan each job thoroughly. The supervisor must make certain that there is an adequate supply of the proper tools and equipment to do the job safely.

(5) Before starting a job, the supervisor must hold a "tail-gate conference" with all members of the crew present. All aspects of the job must be discussed. The supervisor must make sure that each person clearly understands the procedures to be followed and clearly knows what to do and how to do it. Particular attention must be given to all hazards that may be encountered during the course of the job.

(6) While the job is in progress, the supervisor must closely supervise the workers, checking them constantly to make certain that they are in safe working positions and handling tools safely. Work must not be performed on energized lines and equipment except as permitted herein. This restriction does not necessarily apply to contractor personnel.

TABLE 6-1. Approved Work Methods by Voltage Class.

Minimum	Typical Nominal AC Voltage 00	Conventional Method and Work Position	ANSI/ASTM Rubber Goods Class, Color Code, Proof Test KV AC	Working and Hot Sticking Clearance (OSHA)
	2.5 *7.5 KV	Gloving from Structure and Basket	Class 1 White Label 10 KV	2' 0"
*ANSI/ASTM Maximum Use Voltage for Rubber Equipment Class Indicated	12 *17 KV	Gloving from Electrically Isolated Basket or Platform. Hot Sticking from Structure and Basket	Class 2 Yellow label 20KV	2' 0"
	22.	Gloving from	Class 3	2' 4"

*26.5	Electrically Isolated Basket or Platform. Hot Sticking from Structure and Basket	Green Label 30 KV	
*36 KV	Gloving from Electrically Isolated Basket or Platform. Hot Sticking from Structure from Basket	Class 4 Orange Label 40 KV	2'4" (35.1 KV) 2'6" (36 KV)

b. Secondary Voltage (0-750 Volts nominal phase-to-phase). Secondary work must be performed under the following conditions:

(1) When working on energized secondaries either primary or secondary rubber gloves (Class 0) with leather protectors must be worn.

(2) Each employee working on energized lines and apparatus must be qualified for the voltage class involved, including other conductors within reach.

(3) Work is performed on only one conductor at a time.

(4) All other energized or grounded conductors and equipment within reach must be covered with rubber or other approved protective equipment.

c. Distribution voltage (751 Volts-36 kV):

(1) Nominal phase-to-phase. Primary distribution voltage levels continue to move upward. In the future, there will be increasing usage of higher primary distribution voltages, including several voltages in the 20 to 25 kV range and 34,500 Y/19,920, with some expectation of even higher levels. The distribution voltage classification is divided into the voltage groups listed below.

(2) 2.4-7.5 kV (nominal phase-to-phase). Work, other than the replacement of fuses and switching, on energized lines or apparatus operating in this voltage range is prohibited except in cases of actual necessity. Primary energized work in this voltage group must be performed under the following conditions:

(a) Must be approved by the electrical superintendent.

(b) Work performed must be under the direct supervision of a qualified foreman or work leader devoting full time and attention to the workers and the safety of their work.

(c) At least two employees, fully qualified for the voltage range (including other conductors within reach) must be available.

(d) Work in this voltage range may be performed on energized lines and apparatus using the gloving method either from structure or aerial basket. Wear 10kV rubber gloves (with leather protectors) when performing live line work belonging to this voltage range group.

(e) Only one wire on the same structure is to be worked on at a time, although it is recognized that three-phase lifting tools may be used.

(f) Normally, no employee is permitted to approach or take any conductive object closer to exposed energized parts than shown in table 6-1. Exceptions are:

1. The tool or object has an approved insulating handle.

2. The employee is insulated or guarded from energized parts. (Gloves and sleeves rated for the voltage involved are considered insulation of the employee from the energized part).

3. The energized part is insulated or guarded from employee and any other conductive object at a different potential.

4. Employee is insulated or guarded from any other conductive object.

(g) For lines and apparatus belonging to this voltage group, use protective equipment of the proper voltage rating. Before starting work, carefully inspect the protective equipment to make sure that it is in good serviceable condition. The employees must begin their work of covering up on the lowest, or nearest conductor as the case may be. They must never work over or reach past unprotected conductors or energized equipment, either in covering up other conductors or in connection with the work itself.

(h) When working on energized conductors or parts, such conductors within the working area must be covered with approved protective equipment. Grounds within the working area must be covered or removed from the work area when work is being done which exposes the workers to a phase-to-ground contact. The working area is considered as

the area wherein contact can be made with any conductors or parts by the workers or any conducting object or tool the workers are handling.

(i) Work above energized conductors is permitted only where these conductors can be adequately covered with protective equipment or where they can be moved a sufficient distance to allow safe working space.

(j) When protective equipment is to be removed, that farthest away must be removed first, and that closest to the workers last, so that the workers will not have to reach past unprotected conductors or parts.

(k) Do not remove any protective equipment until all workers are in a position where it is impossible for them to make contact with live conductors or parts after protective equipment has been removed.

(l) When the work is being done using the aerial bucket, ground the truck or barricade the truck and work area when the bucket is to be used near energized conductors. Establish a definite method of communication between the workers in the bucket and those on the ground. Do not move the boom when anyone is in contact with the truck.

(m) During inclement weather do not perform any live maintenance work. Only emergency repairs are to be made during inclement weather. Do not perform any work on power lines when lightning storms are in the vicinity.

(n) Wear the 10kV or 20kV rubber gloves (with leather protectors) when operating switch handles belonging to this voltage group.

(3) In the 12-36kV range, (nominal phase-to-phase) work, other than the replacement of fuses and switching on energized lines or apparatus, operating in this voltage range, is prohibited except in cases of necessity. Primary energized work in this voltage group must be performed under the same conditions listed in (2)a through m above with the following exceptions:

(a) Work in this voltage range may be performed on energized lines and apparatus using the gloving method from an electrically isolated basket or platform. Appropriate voltage class gloves (with leather protectors) and sleeves must be worn when performing hot line work belonging to this voltage group (see table 6-1).

(b) Work in this voltage range may be performed on energized lines and apparatus using the hot stick method either from structure or aerial basket.

NOTE: In general, use of rubber gloves is not required when using hot line tools.

(c) For lines and apparatus belonging to this voltage group, hot-line tools and equipment of the proper voltage rating are used.

(d) Before starting work, the hot-line tools and equipment must be carefully inspected to make sure that they are in good serviceable condition.

(e) Appropriate voltage class rubber gloves (with leather protectors) must be worn when operating switch handles.

6-3. Transmission Voltage. (Above 36kV nominal phase-to-phase):

a. Work Restrictions. Work, other than the replacement of fuses and switching, on energized lines or apparatus operating at this voltage range is prohibited.

b. Work Requirements. Switching and fusing energized circuits in this voltage classification must be performed under the following conditions:

(1) Must be approved by the electrical superintendent.

(2) Must be under the direct supervision of a qualified supervisor devoting full time and attention to the workers and the safety of the work.

(3) Must have at least two qualified employees available.

(4) Must use hot-line tools of the proper voltage for lines and apparatus belonging to this voltage class.

(5) Must carefully inspect hot-line tools before starting work.

(6) Maintain the minimum clearance from live parts as listed in table 6-1.

6-4. Grounding of Lines and Equipment:

a. Performing Circuit Safety Checks. All deenergized transmission and distribution lines and equipment must be checked open, tested for voltage, and grounded before being touched for work. If not grounded, they must be worked as energized conductors. For this purpose, use grounding devices consisting of ground clamps permanently attached to cable. Never use hot-line clamps instead of ground clamps. Grounding devices must be of such size as to carry the induced current and maxi-

mum fault current that could flow at the point of grounding for the time necessary to clear the line. Some line terminals are provided with grounding switches. These switches should be used for preliminary grounding, but their use does not waive application of cable or clamp grounding devices.

b. Grounding Clamp Requirements. Clamps used in grounding sets must be of the best construction, and maintained properly. Clamps on the "hot" end of the cable may have insulated sticks permanently attached or be operated by using an insulated "shotgun" or rigid splice stick. Cables must be 600 volt insulated rubber or synthetic covered flexible copper.

c. Installing Grounding Devices. Grounding devices to be applied must be securely grounded before connections are made to the conductor. This is done by firmly clamping the ground clamp to a good ground, such as the static wire, primary neutral wire, pole ground wire, or steel tower. After this has been accomplished, attach the free clamps of the device to the nearest conductor, using an insulated stick and making the contact firmly. Phase-to-phase jumpering is the best protection after one phase has been grounded. As a further safeguard, one should stand away from an arc should the equipment be energized. All phase wires must be grounded on the circuit being worked on. In removing grounds, the clamps must be detached from the conductors first, beginning with the conductor the farthest away. Never place a ground clamp over an armor rod.

(1) Grounds must be placed on the same pole, tower or structure on which work is being done.

(2) When performing work at more than one location in a line section, ground and short circuit one location in the line section. The conductor being worked on must be grounded at each work location.

(3) The exterior electrical supervisor must be advised when and where the grounds are placed and when removed.

d. Grounding Equipment in Partially Energized Substations and Vaults:

(1) Ground clamps with insulated and flexible cable must meet specifications in 6-4b above. This applies to outdoor and indoor work equipment.

(2) It is often impractical to leave the equipment being worked on grounded. In the case of indoor equipment, it may be possible to permanently ground the equipment on the outside. This would be possible where oil circuit breakers are being inspected one at a time with disconnects open between the circuit breaker and the bus. By grounding on the outside and closing the oil circuit breaker, everything in the bay is grounded. In other instances, it may be practical to ground on the dead side of the open disconnects. Care must be taken to avoid confusion in tracing out the feeder being worked on between the outside and inside construction; where the feeder is grounded on the outside the equipment to be worked on should be checked with an approved high voltage testing device and then grounding cables attached before touching it.

(3) Where it is practical to leave the equipment grounded while work is in progress, it is mandatory that each phase of the equipment to be worked on is tested to see that it is dead and then touched with a grounded cable before the work begins. This should be done even though all disconnects or other devices for clearing the equipment or jumpers to be worked on are in plain view.

(4) A good method of testing a supposedly dead circuit or piece of equipment is by using a "high voltage phasing tester," or similar device.

6–5. Overhead Wires:

a. Stringing or Removing Deenergized Conductors:

(1) Before stringing operations a briefing must be held to set forth the plan of operation and specify the type of equipment to be used; grounding devices and procedures to be followed; crossover methods to be employed; and the clearance authorization required.

(2) Where there is a possibility of the conductor accidentally conducting an energized circuit or receiving a dangerous induced voltage buildup, the conductor being installed or removed must be grounded or provisions made to insulate or isolate the worker.

(3) If the existing parallel or crossover line is deenergized, proper clearance authorization must be secured and the line grounded on both sides of the crossover. The line being strung or removed is considered energized and worked as such. IF AT ALL POSSIBLE, DEENERGIZE AND GROUND NEARBY ADJACENT LINES.

(4) When crossing over energized conductors in excess of 600 volts, rope nets or guard structures must be installed unless provisions are made to isolate or insulate the worker or the energized conductor. Any automatic reclosing feature of the circuit interrupting device must be made inoperative. In addition, the line being strung must be grounded on either side of the crossover, or considered and worked as energized. When possible, deenergize the line being crossed.

(5) Conductors being strung or removed must be kept under positive control using adequate tension reels, guard structures, tielines, or other means to prevent accidental contact with energized circuits.

(6) One method of stringing across an energized circuit is to erect guard structures on either side of the energized circuit to hold the wires being strung well above it. When existing poles are not properly located to support guards, temporary poles must be erected to support the guards. Crossarms of equal length or longer than the regular crossarms of the line must be installed on these temporary poles and left thereon until the wires have been strung, sagged, and permanently tied in.

(7) Wires being strung across streets must be kept high enough in the air to prevent vehicles running into them. Traffic should be blocked if this is not possible.

(8) While stringing, care must be taken not to put kinks into any part. Kinks reduce the strength of the wire and may result in fallen wires later.

(9) In handling and stringing weather-proof covered wires, care must be taken not to damage the weather-proof covering.

(10) When pulling a wire over or near energized conductors, the worker attending the payout reel must wear rubber gloves and be insulated from ground.

(11) Both in pulling wire and in sagging it, the pulling must be slow and steady to prevent swinging the wires into energized conductors. The wire must be watched carefully to prevent its hanging on tree limbs, weeds, and other obstructions.

(12) Do not permit a worker to touch or attempt to handle any conductors or wires on the ground without rubber gloves.

(13) Before changing the strain on a pole by adding wires, engineering guidance should be obtained to make sure that the pole will safely stand the altered strains.

(14) The general precautions for stringing wires apply equally to the removing of wires. However, where possible, the wire to be removed must be pulled out and laid flat on the ground before any attempt is made to reel it up on a take-up reel or coil it by hand.

b. Installing, Removing, or Repairing Services:

(1) Service wire may be installed near overhead energized lines if the following operations are carried out in this order:

(a) Connect service wires to building.

(b) Attach handline to other end of wires and carefully raise to position on pole.

(c) Attach service wires to bracket or crossarm.

(2) Primary or secondary rubber gloves must be worn when installing, removing, or repairing services from energized secondaries. Should it become necessary to work in proximity to an energized primary, primary rubber gloves and sleeves must be worn.

(3) Secondaries not being worked on but close enough to present a hazard to a worker must be covered with rubber or other protective equipment as much as possible, such equipment being line hose, insulated hoods, secondary blankets and so forth.

(4) Never install service wires on transformer poles unless a minimum separation of 16 inches can be maintained between the service wires and the energized primary conductors. If the primary has a voltage of 8.7 kV phase-to-ground, or greater, a minimum of 40 inches is required.

(5) A minimum of two persons must be used in stringing services from a transformer pole where energized jumpers extend below the secondary wires.

(6) When the connection is made to secondary buses, the neutral wire must be connected first and the connection to the hot wires last. The procedure must be reversed when disconnecting services.

c. Tying in Wires:

(1) Wires must be securely tied-in at all insulators to prevent the possibility of wires becoming lose at points of support and possibly falling to the ground. Where double arms are provided, line wires must be firmly tied-in to insulators on each arm. This applies to pin type insulator work.

(2) When it is necessary to tie-in two parallel circuits which are connected at one or more points on the line, the several phase wires must be tested with a potential transformer or other means, to make sure that the phase wires of one circuit are being connected to the corresponding phase wires of the other circuit.

(3) Care must be taken to see that phase wires are not crossed when turning a vertical angle on three-phase lines. Phase wires should take the same position leaving an angle as coming into it.

d. Cutting Lines:

(1) A worker must never change the strains on a pole by removing wires until it is certain that the pole will safely stand the altered strain. Where a pole will be weakened by the removal of the wires, it must be guyed as necessary before wires are removed. All wires must be lowered with a handline. However, if this is not possible before a worker cuts a wire aloft, care should be used to avoid contact with other wires.

(2) Lines which are being cut or rearranged must not be allowed to sag so they will fall directly on, or be blown against any other lines, such as signal lines, signal equipment, metal sheaths of cables, metal pipes, ground wires, metal fixtures on poles, guy wires, or span wires.

(3) Wires which have been cut, or which are being arranged must not be allowed to fall near or on a roadway where there is danger to traffic. Where it is not possible to keep these wires clear of the roadway by at least 10 feet or more, all street and highway traffic must be guarded in one or both directions as necessary. All persons working on lower levels of poles where cutting is taking place and all personnel on the ground must be notified well in advance of the cutting so that they may stand clear.

6–6. Ground Wires and Grounded Neutrals. Remember that when working on energized distribution primaries or secondaries, the presence of a grounded neutral, ground wire, grounded transformer cases, or a piece of grounded apparatus, may constitute a hazard to the worker. (The neutral may or may not be at zero potential.) Rubber and other protective devices must be used in covering such wires or apparatus. Workers must avoid cutting an overhead ground wire or neutral wire of any kind, or opening joints in them without first bridging the section to be opened with a jumper of sufficient conductivity.

6-7. Street Lighting:

a. Safety Precautions. Street lighting wires, unless grounded, should be considered live at all times. The voltage of street lighting circuits should be considered as being that of the highest voltage wires occupying one or more poles on which the street lighting circuit is run, where this voltage is more than the street lighting voltage.

b. Installing Fixtures and Devices:

(1) Install street lighting fixtures clear of the climbing space. All bolts, lag screws, and other hardware used in securing the fixtures must be carefully trimmed.

(2) When winding the time switches or working on automatic time switches, do not trip the switch "on" without first pulling the transformer disconnects or making sure that lighting circuits will not be energized. Always wear rubber gloves when working on time clocks with high voltage connections.

(3) Multiple street light circuits are considered to be of the same voltage as the circuits to which they are connected and worked on as such, unless the circuit or portion of it is on the same crossarm with a primary or series street light wire.

(4) In relamping series street light luminaries, there is danger of an arc developing and causing serious damage and possible injury if the spring clips in the receptacle do not make contact. It may be that these springs have been heated to the extent that they have lost their temper, or for some other reason do not close the circuit when the lamp socket is pulled out. Approved changers with at least 6-foot handles must be used for replacing lamps on series street light circuits.

6-8. Installation and Removal of Guy Wires:

a. Installation Procedures. When guy insulators are used they should be connected into the guy wire line before the guy wire is set in place. In new work, guys should generally be installed before line wires are strung. In reconstruction work, guys should be installed before changes are made in the line wire and care must be taken not to place excessive pulls on the pole and wires already in position.

(1) Guys should be installed so as not to interfere any more than necessary with the climbing space and should clear all energized conductors as far as practicable.

(2) Guy strain insulators should be provided when necessary to secure the required amount of insulation.

(3) Where possible install all guys so that the guy does not interfere with street or highway traffic. Where these guys are located near streets, or highways, they should be equipped with traffic guards. Traffic guards are sometimes called "guy guards."

(4) Install guy wires so that they will not rub against messenger or signal cables.

(5) Guy wires containing snarls or kinks must not be used for line work. Use guy wires of the correct length to avoid unnecessary splices.

b. Removal Procedures:

(1) Determine the condition of the pole before removing wires and guys. If the pole is found to be weak, it must be securely braced before making any changes in pole strains.

(2) Where the removal of wires from a pole will change the strain and present a dangerous condition, the pole must be braced temporarily to make such change conditions safe.

6-9. Disconnecting and Connecting or Testing Transformers:

a. Disconnecting:

(1) When disconnecting transformers that are to be relocated, disconnect the primary first. Remember that in cases where transformer secondaries are paralleled, the secondary leads are still energized even though the primary leads of one back may be disconnected.

(2) With all of the secondary neutrals tied together, there is a greater possibility of a backfeed from the secondary which has accidentally become energized from some source. One such source would be contact with a multiple street light circuit on the same pole lead if the controls contain a malfunctioning relay. Another source could be the breakdown of insulators separating the secondary from that of another transformer. To prevent injury from these causes, the secondary must be grounded after it has been deenergized.

b. Connecting:

(1) Do not connect oil filled transformers to the circuit unless they contain a sufficient amount of good quality oil.

(2) Where a three-phase bank of transformers is replaced, the new transformers must be carefully checked for phase rotation before ser-

vice is restored so that the new service connections will be the same as before the change. This is particularly important where the service load consists of elevators and some types of power machinery where a change in motor rotation may cause serious injury.

(3) In the installation of a distribution type transformer, the primary leads from the transformer to the primary cutouts must be connected first; second, make sure that the secondary leads from the transformer are in the clear; third, make connections from cutouts to primary line; fourth, close primary cutouts; fifth, make polarity tests on secondaries and connect permanently. When removing transformers, open cutouts and disconnect secondaries to prevent danger of "backfeed." Use rubber gloves or hot sticks in performing this operation.

(4) Where two or more transformers feed into a common secondary or are paralleled on the secondary side, use caution in re-fusing as the high voltage terminals will be energized by stepping up the secondary voltage which is supplied by another transformer.

c. Inspection and Maintenance:

(1) Only qualified workers and trouble persons are allowed to climb poles to inspect and test pole type transformers.

(2) Before changing or replenishing oil, all live wires leading into transformers must be disconnected and safe clearance provided from all live circuits. When opening transformers, do not use lighted matches or open flames of any kind.

d. Testing. Performance of tests on transformers, auto-transformers and similar equipment must only be performed by seven-level electric power technicians, qualified five-level specialist, or civilian workers of an equivalent rating. Tests should be performed under proper engineering guidance. All temporary leads used in testing, such as secondary leads of potential transformers, thermometer leads and recording voltmeter leads, must be securely supported on the pole and traffic in the area should be cleared. The positions of these leads must not interfere with the climbing space or with maintenance work which may be required while the testing is in progress.

6-10. Tree Trimming:

a. Tools:

(1) Required tools such as saws, pruning shears, ladder, belts, ropes, rubber, and other protective devices must be available in ample quantity.

(2) All tools must be maintained in good condition.

b. Climbing and working in trees:

(1) Workers may wear tree climbers while climbing, descending, or working trees, if ladders or aerial baskets cannot be used.

(2) Select safe places to drop limbs--clear of all wires.

(3) Make provisions to warn all pedestrians and motor vehicles of danger of falling limbs either with suitable signs or by stationing a guard.

(4) Select the best place to climb and use a ladder to ascend to the first substantial branch or crotch.

(5) Place the ladder so that both rails are supported at the top, not just one rung.

(6) Make sure the ladder is secure. Lash it into place if there is the least danger of its slipping on the ground or swinging around the tree trunk.

(7) Watch constantly for unsound limbs. Cut them off as you go up to lessen the danger when you descend.

(8) Keep slack out of the safety line--do not burn it by allowing it to slide through crotches rapidly. Never allow the running end to reach the street where it might be caught by vehicles.

(9) Place only one hand on each limb when climbing.

(10) Carry sharp edged tools in sheaths or cases.

(11) If necessary to work near conductors, have them deenergized if possible, but consider them energized. Have a supply of rubber protective equipment (rubber blankets, rubber gloves and rubber line hose) on hand. Be especially careful in wet weather.

(12) Tools, such as saws, axes, bush hooks, and pruning shears, must not be left hanging in bushes or trees.

(13) Most people are susceptible to poison ivy, poison oak, and poison sumac. If you accidentally come in contact with these poisonous vines, promptly wash the affected parts thoroughly.

(14) Approved eye protection must be worn when working in brush or tree branches.

6-11. Electrical Feedbacks:

a. Primary Substation Precautions. In many primary substations there is the possibility that current to the apparatus being worked on is fed from some other source. This source may be another circuit fed from the same station or an accidental connection with wires fed from another station. Therefore, the apparatus must always be grounded with whatever class of grounding equipment applies. When working on an apparatus at such stations on the bus side of the distribution breakers, the likelihood of a feedback can be materially lessened by opening these breakers.

(1) When a recloser is opened to deenergize a line, and before grounds are placed on the line, the jumpers on at least one side of the recloser must be opened. This will prevent the line from becoming energized should the breaker reclose.

(2) Workers should remember that there is always a possibility of feedback or cross on any primary or secondary on which they may be working.

b. Distribution Work Precautions. In distribution work, there is a distinct possibility that lines may be energized from some distant source. Where a blown sectionalizing fuse must be replaced, remember that normally one side is energized and both sides may be energized. Safety precautions must be exercised in replacing this type of fuse. In many cases, one side of fuses in secondaries of transformer banks may be energized even though the fuse is blown.

6-12. Shorting Out Pole Ground-Wire Gaps. Workers must always short out pole ground wire gaps with the line energized. Use grounding clamps for this purpose. In grounding a line equipped with pole ground wire gaps, the gaps must be shorted before the grounding devices are applied to the conductors.

6-13. Phasing or Tying Circuits Together. When it is desired to phase two or more circuits together, check the phasing with potential transformers or phasing tools. Never tie two circuits together without

first checking the phase relationship. All three phases must be checked for positive phasing. Appropriate eye protection must be worn.

6-14. Handling Capacitors, Power Transformers, and Regulators:

a. Capacitors:

(1) Due to the characteristics of capacitors, they may retain their charge for days after being disconnected, if there is no discharge circuit or if the discharge circuit has burned out. Therefore, any disconnected capacitor must be considered as fully charged until grounded and shorted.

(2) After capacitors have been disconnected from the circuit, wait 5 minutes to permit the units to discharge through the discharge device before terminals are grounded and shorted. If hot-line tools with insulated conductors are not available to do the grounding and shorting, wait 10 minutes more before using ordinary ground clamps with bare conductors.

(3) Safe practice requires that the ground and short placed on capacitors be left on until all work has been completed. When working on or testing capacitors in the shop, the work area must be roped off as a safety measure for other workers.

b. Coupling Capacitors:

(1) A little known characteristic of coupling capacitors makes them especially hazardous to personnel if not properly grounded. This characteristic is the extremely high resistance which results in a long discharge period.

(2) During shipping or storage a coupling capacitor must always have a shorting wire.

(3) During maintenance, a grounding wire must be connected to each exposed metal terminal that personnel can contact. Grounding wire must be left in place for the entire duration of maintenance to ensure discharge.

c. Power Transformers and Regulators. When power transformers and regulators are maintained as spares in substations, the bushings must be short-circuited and grounded.

6–15. Oil Switches. The consequences of operating a faulty oil switch, or closing into a faulted circuit with an oil switch are likely to be devastating and possibly fatal. Switching procedures must be developed at each base to make sure that no energized oil switch is operated while workers are in the vicinity. Equip the switch to operate from a remote location (at least 20 feet) or completely deenergized before switching. Several utility companies have fitted their oil switches with a rope and pulley system which allows switching with the operator protected by a remote location. Installation of this type of remote operating system may be practical in some cases. Switch position and grounding conditions must be verified before operation. In addition, no high voltage oil switch is to be operated unless routine maintenance, including oil testing, has been performed within the past year. Oil switches controlling lighting circuits must be tested every 2 years. (See AFM 91-3.) Oil switches must incorporate a mechanical stop to prevent inadvertent operation to ground. Any abnormalities or defects discovered in any oil switch, should be reported to HQ AFESC/DEMM, Tyndall AFB FL 32403-6001.

6–16. Aerial Lifts:

a. General Instructions. This section describes the operation of hydraulic booms with aerial baskets when used for electric maintenance work.

(1) Lift controls must be tested each day before use to determine that such controls are in safe working condition.

(2) The insulated portion of an aerial lift must not be altered in any manner that might reduce its insulating value.

(3) The vehicle may become energized (or grounded) when the boom or the aerial basket itself comes in direct contact with energized (or grounded) conductors or equipment.

(4) Neither truck, boom, nor aerial basket will be depended upon to be "ELECTRICALLY INSULATED." No one will be permitted to touch the truck or equipment when aerial equipment is operating in or near energized conductors. The vehicle must be grounded or considered as energized and barricaded.

(5) The rules governing the requirements for use of rubber or other protective equipment while working on poles and structures also apply to work from aerial baskets.

(6) A body belt having a secured safety strap (or an approved equivalent) must be used for any work from an aerial basket and must be attached to the boom.

(7) Basket liners must be used (if the basket is designed to be used with a liner) and tested according to TO 36C-1-4.

(8) A safety hat and suitable clothing must be worn at all times when working from the aerial basket and by all ground personnel.

(9) Do not allow unauthorized or unqualified persons to operate the boom carrying an aerial basket.

(10) Insulated aerial lifting devices used for working on energized electrical systems must be specifically designed for that sole function. The aerial lift must be used only for electrical related work.

(11) All personnel must stay clear of pressurized oil or air which is escaping from a ruptured line or fitting. The pump, compressor or engine must be stopped as soon as a leak is detected.

(12) The manufacturer's load limits of the boom or baskets must be posted on the unit and they must not be exceeded.

(13) All hydraulic and pneumatic tools that are used on or near energized equipment must have nonconducting hoses rated for normal operating pressure.

(14) An aerial crew must include a minimum of two qualified workers.

b. Travel Procedures:

(1) Drivers of aerial basket trucks must be constantly alert to the fact that the vehicle has exposed equipment above the elevation of the truck cab and provide the necessary clearance.

(2) Moving the truck into the opposing traffic stream is hazardous and must be avoided when possible by planning the order of the work.

(3) Any backing of the truck must be done slowly and under the direction of one person on the ground who has an unobstructed view of the intended path of the vehicle and its driver.

(4) A truck must not be moved with the boom elevated in working position.

(5) When traveling to and from job sites, pin-on type buckets must either be removed and stored on the truck or secured in a horizontal position to the boom to avoid obstructing the driver's vision.

c. Setting Up and Knock Down at the Job Site:

(1) The truck upon arriving at the work area, must be legally parked while the vehicle and pedestrian warning signs, lights, and barricades are being placed.

(2) Give careful consideration to the location of overhead conductors and the surrounding conditions before the truck is moved into the work position.

(3) Make every effort to place the truck so that all work areas at that location may be reached by the boom without movement of the truck.

(4) Available footing for the truck wheels and outriggers must be examined carefully and extra caution exercised if there is snow, ice, mud, soft ground, or other unusual conditions. Blind ditches, manholes, culverts, cesspools, wells, and other similar construction must always be considered as additional possible hazards.

(5) Before lowering the stabilizers, outriggers, or hydraulic jacks, the operator must be certain that no one is close enough to be accidently injured. Chocks or cribbing may be needed to ensure stability of the truck body.

(6) When working on an inclined road or street each outrigger or jack must be checked to make sure a stable setup has been achieved. The truck should sit approximately level as viewed from the rear.

(7) A warm-up period is needed at the beginning of each day's work. This time may vary with different makes and models, also to temperature range in various locations.

(8) When lowering the boom to a cradled position, employees will stand clear of the path of the bucket and boom.

(9) When work is completed the bucket must be lowered and the boom cradled and secured by an approved tie-down.

d. Operating at the Job Site:

(1) Before Raising the Bucket:

(a) One employee must be responsible for all operations required to place the basket in operating position, using the bucket, and restoring it to the traveling position.

(b) The operator must check to be sure that the outriggers or stabilizers are in the down position, the truck hand brake set, and the rear wheels of the truck chocked where necessary.

(c) The outriggers or stabilizers must be checked for safe operation before a load is lifted if the operator has any doubt as to the stability of the truck due to terrain.

(d) When the boom must be maneuvered over a street or highway, necessary precautions must be taken to avoid accidents with traffic or pedestrians. A flagger must be used when necessary.

(e) Enter the bucket only with the bucket resting in the position for which it is designed.

(2) Raising the Bucket:

(a) The location of all obstructions should be noted, so that the bucket or boom will not contact such obstructions when it is raised, lowered, or rotated.

(b) The operator should always face in the direction in which the bucket is moving.

(c) The operator must follow the proper sequence prescribed by the manufacturer in raising the boom section.

(d) Before reaching any area containing obstructions, the operator must test controls of the boom and bucket to ensure that they are in proper working order.

(e) The operator must suspend operations if test indicates the unit is not working properly.

(f) Raising the bucket directly above energized conductors or equipment should be kept to a minimum.

(3) Working Aloft:

(a) Buckets should be located under or to the side and must not contact any conductors or equipment.

(b) If necessary to get within reach of energized conductors or equipment, the employee must wear proper primary rubber gloves and rubber sleeves.

(c) Energized conductors and equipment must be covered with protective devices, if deemed necessary to perform the work safely.

(d) Adequate clearance must be maintained so that protruding tools will not come in contact with conductors, limbs, or other obstructions.

(e) The worker must not stand on top of the bucket or on planks placed across the top of the bucket, while performing work.

(f) The worker must not belt into an adjacent pole, structure, or equipment while performing work from the basket.

(g) The operator must make sure that handlines and tools do not become entangled with the levers that operate the boom.

(h) When working aloft, all tools must be secured when not in use.

(4) Ground Operations. When the bucket is being used in any manner which might result in contact with an energized conductor with the basket or boom, or anything attached to them, the vehicle must be considered energized at line potential, and the following safe practices observed:

(a) Materials or tools must not be passed between a worker on the vehicle and a worker on the ground unless both workers wear primary rubber gloves and use the other required protective devices.

(b) Employees operating ground controls must be on the vehicle or insulated from the ground using primary rubber gloves and other protective equipment.

(c) Before entering or leaving the vehicle, the employee must make sure that the boom or bucket is not in contact or near energized equipment.

(d) Employees on the ground must not work directly below the work area of the bucket.

(e) Do not throw tools or materials to or from the elevated basket.

e. Lift Inspection. The assigned operator must inspect the aerial bucket equipment daily before operating according to manufacturer instructions. Report and repair any defects. Give special attention to the following:

(1) Inspect hydraulic hoses and remote controls for twisting, chafing, and proper alignment.

(2) With oil lines under pressure, inspect for evidence of leakage.

(3) Check oil level of hydraulic and remote control reservoirs. Oil recommended by the manufacturer should be added when required.

(4) Check unit for proper operating speed and rate of drift.

(5) Check operation of all controls through their maximum working range.

(6) Visually check booms for cracked welds, distorted members, or any defects.

f. Maintenance. Necessary periodic maintenance schedules are in the maintenance and operation manual which the manufacturer provides with each unit. Only standard parts furnished by the manufacturer should be used. The following items must be given consideration:

(1) Keep all fiberglass coated or wrapped; booms and buckets clean. This may be accomplished by hand washing with a mild detergent and hand rinsing. Do not use a water hose under pressure.

(2) Perform electrical tests on insulation every 6 months or more frequently when the need is indicated according to TO 36C-1-4.

(3) When the weather is below freezing at a job location operate the hydraulic pump 5 to 10 minutes before operating the boom.

(4) Refer to operation manual for grade and maintenance of hydraulic fluid so that unit may be put in operation with minimum warm-up time.

(5) Any repair of the hydraulic pressure system involving opening of the pressure lines must only be done by a qualified person.

(6) Purging of air from the pressure lines must be performed only by a qualified person.

(7) Check maximum allowable load operation through all positions periodically.

(8) Check boom and leveling wire rope cables for frayed strands, security of terminals and correct adjustment.

g. Rental Units. The BCE must be notified if the insulated personnel lifting device becomes inoperable and estimated return to service date is more than 10 calendar days. Upon notification, the BCE should forward a request to the Transportation Squadron Fleet Manager for rental/lease vehicle support. (See AFM 77-310, Vol I, para 4-11). Rental vehicles must be thoroughly inspected and tested before initial use.

Chapter 7

FIRST AID

7-1. Principles of First Aid:

a. Purpose of First Aid. First aid is the immediate temporary treatment given the victim of an injury or sudden illness. All 542XX personnel must be well trained in the procedures involving emergency situations and first aid fundamentals.

b. Fundamentals of First Aid:

(1) Keep the injured lying down in a comfortable position with the head level, at least until the extent of injuries has been determined.

(2) If the injured is unconscious, try to place face down with the head turned to one side. However, be sure of the extent of injuries before any movement, as the situation could be made worse.

(3) Look for hemorrhage, stoppage of breathing, poisoning, wounds, burns, fractures, and dislocations.

(4) Stoppage of breathing and serious bleeding takes precedence over everything else. Remember the order, BREATHING, HEART, BLEEDING.

(5) Keep the injured warm, maintaining normal body temperature. This is essential in preventing serious shock. If the weather is cool, place covers over the patient and also underneath for protection from cold surfaces.

(6) Pain is an important indication of injury. Let the patient guide you to possible injuries.

(7) Never give an unconscious person water or other liquid to drink, as it may enter the windpipe and cause strangulation.

(8) Do not give stimulants in case of severe bleeding, suspected internal bleeding, or head injuries.

(9) If the injured is conscious and there is no sign of severe abdominal injury, give all the water wanted slowly and in sips.

(10) Keep onlookers away from the injured unless they can be helpful.

(11) Ease the injured in any way possible. A proper mental attitude on the injured's part is extremely important.

(12) Avoid letting the injured see the injury, and in severe cases do not let the injured know how serious the injury is.

7-2. Physical Shock. Shock is present in all injuries, it may be slight, lasting only a few seconds, or serious or even fatal. It may occur immediately or be delayed, coming on several hours later. In shock, the brain and other parts of the body do not receive a sufficient supply of blood. Shock usually results from injury or from severe nervous upset such as fright, pain, or grief. Shock is so serious that it should be treated even before the injury, unless the injured is bleeding profusely or not breathing.

a. Symptoms of Shock:

(1) The face is pale. Eyes have a glassy and vacant expression.

(2) Cold perspiration appears, particularly on the forehead and palms of the hands.

(3) The pulse is rapid and weak.

(4) A severe chill often develops.

(5) Usually the patient lies quietly and takes little interest in what is taking place.

(6) Nausea and vomiting are frequent.

(7) Breathing is irregular.

b. Shock Treatment:

(1) Heat. Keeping the body warm, maintaining a normal body temperature is the most important thing both in treating and preventing shock. Wrap the patient in blankets or anything else available. Do not remove clothing except when absolutely necessary to treat an injury, replace it as soon as possible.

(2) Position. Lay the injured with back down and head lower than the rest of the body. Do not have the injured sit up, unless the injury is to the chest or there is a nose bleed.

(3) Stimulants. Ammonia, coffee, or tea have no value in treating shock. Fluids have value. However, they should not be given if the person is only partly conscious, if nauseated, or has a penetrating abdominal wound. Plain water, neither hot nor cold, given in small quantities is recommended.

7-3. Control of Bleeding. Most external bleeding can be controlled by applying pressure directly over the wound. Use a clean cloth, if available, or part of the clothing in extreme emergencies. Application of the bare hand or finger may be necessary for quick action in stemming a major blood loss until effective cloth material can be brought to use. After the bleeding has been controlled, apply additional layers of cloth to form a good size covering, and the bandage snugly or firmly. Do not remove the dressing. If blood saturates the dressing, apply more layers of cloth, perhaps tighten the bandage. If significant bleeding continues after bandaging, reapply direct pressure.

7-4. Use of a Tourniquet. Tourniquets should be used for only a severe life-threatening hemorrhage that cannot be controlled by direct pressure. They should be used only when severe bleeding involves an extremity in which large arteries are severed, or in cases of partial or complete severance of a body part.

a. Applying a Tourniquet:

(1) Place tourniquet above wound, between body and wound.

(2) Tighten just enough to stop the bleeding.

(3) Note the location of and time the tourniquet was applied.

(4) Releasing the tourniquet should be done by a physician or by medical personnel to control hemorrhage and replace blood volume adequately.

b. Improvised Tourniquets. Improvised tourniquets should be made of flat material about 2 inches wide (for example, a cravat bandage, stocking or belt). Avoid using rope, wire or sash cord, as they may cause injury to underlying tissue and blood vessels.

7-5. Electrical or Heat Burns. If a considerable area is involved, get to the doctor as quickly as possible. Cover the burn with a clean dry bandage. Do not apply medication except as directed by a physician. The use of cold water or ice in treating burns of small dimension is recommended by some doctors. The burned area should be submerged if possible, running cold water over the area will suffice. All electrical burns should be seen by a physician as they may be more severe than they appear.

7-6. Chemical Burns (Acids, Lime, Cement). Wash away the chemical completely with large quantities of water for a minimum of 15 minutes. Then follow instructions as in 7-5 above. Obtain medical help as quickly as possible. Do not rely on temporary first aid procedures.

7-7. Choking (Heimlich Maneuver). Choking on food or foreign objects can cause death in 4 minutes. Early recognition of the symptoms of choking is essential to the successful application of the Heimlich Maneuver.

a. Symptoms. The victim:

(1) Cannot speak or breathe.

(2) Turns blue.

(3) Usually grasps throat.

b. Maneuver:

(1) Standing Position:

(a) Stand behind victim and wrap your arms around the waist.

(b) Place the thumb side of your fist against the victim's abdomen, slightly above the navel and below the rib cage.

(c) Grasp your fist with your other hand and press into the victim's abdomen with a quick upward thrust (repeat if necessary).

(2) Sitting Position. The rescuer stands behind the victim's chair and performs the maneuver as in b(1)(a) through (c) above.

(3) Prone Position:

(a) Place victim face up.

(b) Kneel close to the side of victim's body or straddle victim's hips.

(c) Place one hand on top of the other with the heel of the bottom hand in the middle of the abdomen, slightly above the navel and below the rib cage.

(d) Press the victim's abdomen with a quick upward thrust.

(e) Check victim's airway.

(f) Repeat if necessary.

7-8. Eye Injuries. Only a minimum amount of first aid should be given in case of an injury to the eye.

a. Treating For Foreign Bodies. If a foreign body has entered the eye, try to remove it by washing the eye with an eye wash. If such efforts fail

to remove the foreign body, the eye should be covered and the patient immediately transported for professional medical help. No attempt should be made to remove a foreign body which is embedded in any portion of the eye. If the foreign body is readily accessible and is on one of the eyelids, try to remove it by using clean cotton and a sterile eye solution, if available. Injuries involving cuts and lacerations in or near the eye, or injuries caused by a blow on the eye, require bandaging only, after which the injured should be taken to a doctor.

b. Treating For Chemicals. If a chemical (such as acid, alkali, caustic agent or other such agents) enters the eye, immediate first aid treatment is essential. Irrigate the eye with large quantities of clean water, a minimum of 15 minutes, until all of the agent has been thoroughly removed. This is very important. Cover the eye and transport patient for medical attention.

7-9. Fainting or Unconsciousness From Any Cause. If the patient's face appears pale, lay the patient level (face up) and raise feet higher than head. Loosen tight or restrictive clothing. If the patient is not breathing, immediately begin cardiopulmonary resuscitation (CPR).

7-10. Fracture or Suspected Fractures. If an attempt is made to administer first aid in case of fracture, more harm is often done than good. For this reason, the injured should be made as comfortable as possible and medical assistance summoned. If circumstances are such that medical assistance is not readily available and it is thought advisable to remove the patient, handle patient as gently as possible, keeping in mind that movement of the fractured member might do more damage.

7-11. Heat Stroke. The symptoms and treatment of heat stroke (commonly known as sunstroke) are quite different from those of heat prostration or exhaustion. Heat stroke is caused by prolonged exposure to direct rays of the sun or to excessive heat indoors.

a. Symptoms:

(1) Unconsciousness occurs in most cases.

(2) Body temperature is well above normal, often 106 to 109 F.

(3) The skin is hot and dry.

(4) The pulse is rapid.
(5) There may be dizziness and nausea.
(6) The face is red and flushed in most cases.
(7) Breathing is sometimes labored.

b. Treatment:

(1) Bring patient indoors, unclothe, and provide rest.
(2) If fully conscious, give small amounts of water frequently.
(3) Reduce temperature by wetting the patient with alcohol or lukewarm water, and fanning vigorously.
(4) Give no stimulants; administer fluid and salt in small doses when full consciousness is evident.
(5) Get the victim to a doctor.

7-12. Heat Prostration. The symptoms and treatment of heat prostration are quite different from those of sunstroke. The basic problem is a lack of water and salt.

a. Symptoms:

(1) The patient is usually conscious.
(2) The face is pale and anxious looking.
(3) The skin is covered with clammy perspiration.
(4) The breathing is shallow and feeble.
(5) The pulse is weak and rapid.
(6) The patient is chilly and often has the cramps.
(7) Questions are answered slowly.
(8) There is a dull headache, dizziness, and a feeling of sickness--perhaps vomiting.

b. Treatment:

(1) Remove to a quiet place.
(2) Loosen tight clothing.
(3) Lay flat on back with head low.
(4) Remove foreign objects from mouth.
(5) When able to drink, give small amounts of water as tolerated.
(6) Transport to a doctor.

7-13. Poison Ivy and Poison Oak. Learn to recognize and avoid the hazard of poison ivy, poison oak, and poison sumac (see figure 7-1). If

you touch them, wash your hands at once and use plenty of soap and water. Seek medical assistance.

a. Preventions. Rubber or heavy leather gloves afford some protection from these poisons, but the sap picked up by clothing can be easily transmitted to the hands and other parts of the body even after considerable time. Have all garments exposed to these poisons dry cleaned.

b. Burning Poisonous Vegetation. When burning poisonous vegetation, the smoke can cause serious irritation to the eyes and face. Wash your face and eyes with clear water and promptly seek medical assistance.

7-14. Poisonous Snake Bites:

a. Treatment When Medical Help is Near. If medical attention can be secured in less than an hour do the following:

(1) Keep the victim quiet.

(2) Apply a constricting band from 2 to 4 inches above the bite, between the wound and the victim's heart. The band should only be tight enough to restrict the flow of venom, not the flow of blood.

(3) Apply ice to the bite. Guard against frostbite.

(4) Treat victim for shock.

(5) Transport to a medical facility.

b. Treatment When Medical Help is not Immediately Available. If medical attention is over an hour away, then consider the incision or suction method. However, it is highly unlikely that a worker will ever be more than an hour from medical assistance.

7-15. Treatment of Splinters. Under no circumstances attempt to "dig out" imbedded splinters or foreign substances. Refer patient to medical assistance.

7-16. Sprains or Injuries That Do Not Bleed. Use a bandage type compress if suitable material is available. Place pad over injury. Bandage, but not so tightly as to stop circulation. Elevate the injured part and keep it free from motion.

NOTE: Application of a cold pack during the first half hour could reduce swelling.

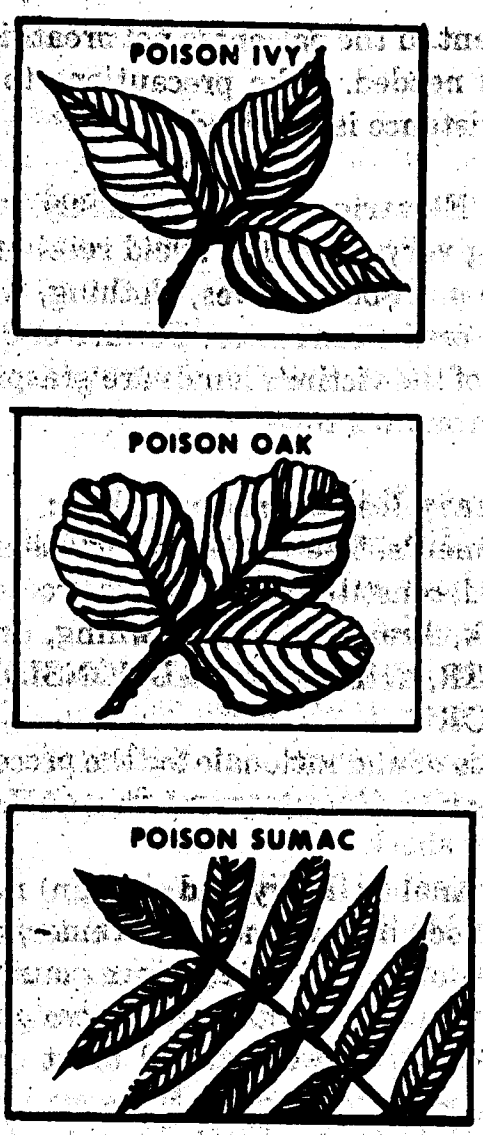

Figure 7-1. Poisonous Plants.

7-17. Gas Poisoning:

a. Rescuing a Victim. When a person is overcome by gas, or lack of oxygen, quickly move the victim to fresh air. The rescuer should be careful when entering a gas filled area without appropriate precautions. Fresh air does not necessarily mean cold air. Many have walked from a warm gas filled room into the cold outside only to collapse.

b. First Aid Treatment. If the patient is not breathing or is breathing weakly, apply CPR as needed. Take precautions to keep the patient warm until medical assistance is provided.

7-18. Rescue From Electric Shock. Quickly release the victim from the current, being very careful to avoid receiving a shock. Use a dry nonconductor such as rubber gloves, clothing, wood or rope to remove either the victim or the conductor. Beware of using any metal or moist material. If both of the victim's hands are grasping energized conductors, try to free them one at a time.

7-19. Cardiopulmonary Resuscitation (CPR):

a. Training Requirements. The procedures for heart and lung resuscitation, when combined, constitute CPR. These procedures apply to victims of electrical shock, heart failure, drowning, drug overdose, and other causes. HOWEVER, THE ORIGINAL CONSIDERATION HERE IS ELECTRICAL SHOCK!

(1) The performance of and rationale for the procedures in CPR are as described by the American Heart Association (AHA) and the American Red Cross (ARC).

(2) All 542xx personnel (military and civilian) must receive training in CPR, bleeding, shock management, and emergency care of a person having open wounds or burns. This training must be accomplished as soon as possible after an individual has been assigned to work. Until proper training is provided, this individual must not work any shift which may provide exposure to working voltages unless there are at least two other persons present who have been trained in CPR.

(3) Unit CPR instructors are usually trained by host base medical personnel. If the host base cannot provide medical personnel, they can arrange for certification of unit personnel through the ARC or AHA.

(4) All personnel must be reexamined for certification annually, regardless of the length of time for which the certification is valid.

b. Procedures for CPR in Situations not Described by the AHA and the ARC. Remember that if a victim is on a pole, cardiac compressions are very ineffective. If the victim requires cardiac compressions, it is most important that the victim be removed from the pole as quickly as

possible. After removing the victim from the pole, proceed with the standard CPR procedures.

c. Cardiac Massage Precautions. Care must be taken in administering closed chest cardiac massage. Follow the procedure carefully regarding the placement of the hands and the force applied to avoid complications such as fractured ribs or injury to the spleen, liver, or other organs.

d. Care of the Patient. An unconscious person becomes cold very rapidly, and chilling means a further strain on vital functions that are already weakened. Keep the patient covered and warm during and after resuscitation as much as possible. Do not permit the patients to exert themselves. If it becomes necessary to move the patient, keep the patient in a lying down position.

7-20. Treatment of Hypothermia. Prolonged exposure to cold conditions may result in a lowering of the body temperature below normal. This is always serious and can be fatal. It is a preventable condition by proper planning of activities and proper selection and care of protective clothing. The risk of this injury is related to the temperature, and is increased by wind and dampness. Clothing should be loose, layered, clean, and dry.

a. Symptoms:

(1) Mild hypothermia produces shivering and muscular rigidity with cold skin.

(2) Moderate hypothermia causes confusion and loss of coordination, and shivering may be absent.

(3) Severe hypothermia causes severe drowsiness or coma, weak pulse and is followed by death.

b. Treatment:

(1) Remove wet clothing and keep victim dry.

(2) Prevent conductive heat loss by not allowing the victim to rest against cold or wet surfaces.

(3) Prevent convective loss by shielding the victim from the wind.

(4) Insulate all exposed parts by wrapping with blankets, or other dry bulky material.

(5) Alcohol has no place in treatment.

(6) If the victim has mild hypothermia, or medical help is not available for a prolong period, external rewarming with warm water bottles or using the rescurer's body heat may be attempted.
NOTE: Burns may result from rewarming attempts with radiant heat, such as, fires or heat sources with a temperature over 110F (43C). Attempts to perform external rewarming of severely hypothermia patients may worsen shock and cause death.

(7) Prompt medical referral is essential for all but the mildest cases.

7-21. Local Cold Injury. Local cold injury usually occurs on exposed parts such as the hands, face, or on the feet. Prevention is almost always possible by following the rule; keep moving, keep warm, and keep dry. Give special attention to the risks of windy conditions, or cold metals or liquids, such as fuels. The risk is increased by past cold injury, smoking and alcohol. A "buddy" system checking each other for white exposed areas is helpful.

a. Symptoms:

(1) Frostbite (freezing of tissue). Affected part white, numb and waxy, or hard. With thawing, affected part may be swollen, painful, or black.

(2) Chilblain (cold injury without freezing). Red, itchy skin lesions on cold exposed parts, may have swelling or blisters.

b. Treatment:

(1) Once rewarmed, the part should be dried and wrapped in a bulky dry covering. It should be expected that the body part will not be functional and must be carefully protected from rubbing or further cold. If this cannot be ensured, rewarming should be delayed until the individual has been removed from the cold environment.

(2) Treatments such as alcohol or rubbing the affected part are dangerous and ineffective.

(3) Prompt referral to a medical facility is essential.

BY ORDER OF THE SECRETARY OF THE AIR FORCE

OFFICIAL

LARRY D. WELCH, General, USAF
Chief of Staff

EDWARD A. PARDINI, Colonel, USAF
Acting Director of Information Management

SUMMARY OF CHANGES

Revised work rules for energized circuits (para 1-7); deleted task illumination and added new general safety precautions (para 2-2); revised listing of AFOSH Stds (para 2-1a); added additional information on capacitors (para 3-2d); added section on storage batteries (para 3-5); deleted carbon monoxide tester and pole storage; added alternative to hot stick testing (para 5-8); revised approval authority on working energized lines (para 6-1e(3); clarified safety grounding procedures (para 6-4); and revised bucket truck rental procedures (para 6-16g).

GLOSSARY OF COMMONLY USED TERMS

-Active Use. To be used frequently, such as, the daily use of rubber gloves.

-Alive or Live (Energized). Electrically connected to a source of potential difference, or electrically charged to have a potential significantly different from that of the earth in the vicinity. The term "live" is sometimes used in place of the term "current-carrying," where the intent is clear, to avoid repetition of the longer term.

-ANSI. American National Standards Institute.

-Approved. Sanctioned, endorsed, accredited, certified, or accepted as satisfactory by a duly constituted and nationally recognized authority or agency.

-Authorized Person. A person approved or assigned by a supervisor to perform a specific type of duty or duties or to be at a specific location or locations at the job site.

-Automatic Circuit Recloser. A self-controlled device for automatically interrupting and reclosing an alternating current circuit with a predetermined sequence of opening and reclosing followed by resetting, hold, hold closed, or lockout operation.

-Barricade. An obstruction to deter passage of persons or vehicles.

-Barrier. A physical obstruction which is intended to prevent contact with energized lines or equipment.

-Blocking. The placing of a switch in the open or closed position and ensuring by mechanical means that the position of the switch will not be changed accidentally.

-Bond. An electrical connection from one conductive element to another for the purpose of minimizing potential differences or providing suitable conductivity for fault current or for mitigation of leakage current and electrolytic action.

-Bonding Jumper. A conductor to ensure the required electrical conductivity between metal parts required to be electrically connected.

-Bushing. An insulating structure including a through conductor, or providing a passageway to such a conductor, with provision for mounting on a barrier, conducting or otherwise, for the purpose of insulating the conductor from the barrier and conducting current from one side of the barrier to the other.

-Confined or Closed Space. Any space having limited means of egress, which is subject to the accumulation of toxic or flammable contaminants or has an oxygen deficient atmosphere. Confined or enclosed spaces include, but are not limited to storage tanks, process vessels, bins, boilers, ventilation or exhaust ducts, sewers, underground utility vaults, tunnels, pipelines, and open top spaces more than 4 feet in depth such as pits, tubs, vaults, and vessels.

-Cable. A conductor with insulation, or a stranded conductor with or without insulation and other coverings (single-conductor cable--or a combination of conductors) insulated from one another (multiple-conductor cable).

-Cable Sheath. The protective covering as applied to cables.
NOTE: A cable sheath may consist of multiple layers of which one or more are conductive.

-Cardiopulmonary Resuscitation. Cardiopulmonary resuscitation (CPR) includes opening and maintaining an airway, providing ventilation through rescue breathing, and providing artificial circulation through the use of external cardiac compression.

–Certified or Certification. The accomplishment of curriculum as specified in this publication.

–Circuit. For the purposes of this regulation only, a circuit is a conductor or system of conductors through which an electric current is intended to flow.

–Circuit Breaker. A device designed to open and close a circuit by manual means, and to open the circuit automatically on a predetermined overload of current, without injury to itself, when properly applied within its rating.

–Communication Lines. Conductors and their supporting or containing structures which are used for public or private signal or communication service, and which operate at potentials not exceeding 400 volts to ground or 750 volts between any two points of the circuit, and the transmitted power of which does not exceed 150 watts. When operating at less than 150 volts, no limit is placed on the capacity of the system.
NOTE: Telephone, telegraph, railroad signal, data, clock, fire, police-alarm, community television antenna, and other systems conforming with the above are included. Lines used for signaling purposes, but not included under the above definition, are considered as supply lines of the same voltage and are to be so run.

–Competent Person. One who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt, corrective measures to eliminate them.

–Conductor. A material, usually in the form of wire, cable, or bus bar, suitable for carrying an electric current.

–Conductor Shielding. An envelope which encloses the conductor of a cable and provides an equipotential surface in contact with the cable insulation.

–Current-Carrying Part. A conducting part intended to be connected in an electric circuit to a source of voltage. Noncurrent-carrying parts are those not intended to be so connected.

–Dead Deenergized. The term means free from any electrical connection to a source of potential difference and from electrical charges: Not having a potential difference to earth.
NOTE: The term is used only with reference to current-carrying parts which are sometimes alive (energized).

–Defect. Any characteristic or condition which tends to weaken or reduce the strength of the tool, object, or structure of which it is a part.

–Designated Employee. A qualified person delegated to perform specific duties under the conditions existing.

–Effectively Grounded. To be intentionally connected to earth through a ground connection or connections of sufficiently low impedance and having sufficient current-carrying capacity to prevent the buildup of voltages which may result in undue hazard to connected equipment or to persons.

–Electric Line Trucks. A truck used to transport workers, tools, and material, and to serve as a traveling workshop for electric power line construction and maintenance work. It is sometimes equipped with a boom and auxiliary equipment for setting poles, digging holes, and elevating material or workers.

–Electric Supply Lines. Conductors used to transmit electric energy and their necessary supporting or containing structure. Signal lines of more than 400 volts to ground are always supply lines within the meaning of the rules, and those of less than 400 volts to ground may be considered as supply lines, if so run and operated throughout.

-Employee. Any individual involved in maintaining, operating, or constructing an electrical system or facility.

-Enclosed. To be surrounded by a case, cage, or fence, which will protect the contained equipment and prevent accidental contact of a person with live parts.

-Equipment. This is a general term which includes fittings, devices, appliances, fixtures, apparatus, and the like, used as part of, or in connection with, an electrical power transmission and distribution system, or communication systems.

a. Equipment--Climbing. To include body belts, safety and climber straps, climbers and ladders.

b. Equipment--Electrical Inspecting and Testing. Electrical and mechanical devices such as voltmeters, ammeters, ohm meters, phase meter, and similar devices.

c. Mobile and Portable--Large Equipment. This pertains to relatively large apparatus that may be easily transported for use in maintenance and must include line trucks, aerial lift trucks, motor-generator sets, pole hole diggers, and similar apparatus.

d. Equipment--Protective. Protective equipment includes rubber gloves, line hose, matting, blankets, insulator hoods, and sleeves, in addition to barricades and warning devices.

-Exposed (as applied to live parts). A live part which can be inadvertently touched or approached nearer than a safe distance by a person. This term applies to parts not suitably guarded, isolated, or insulated.

-Guarded. To be protected by personnel, covered, fenced, or enclosed by means of suitable casings, barrier rails, screen mats, platforms, or other suitable devices according to standard barricading techniques designed to prevent dangerous approach or contact by persons or objects.

-Ground (reference). The conductive body, usually earth, to which an electric potential is referenced.

–Ground (as a noun). A conductive connection, whether intentional or accidental, by which an electric circuit or equipment is connected to reference ground.

–Ground (as a verb). To connect or establish a connection, whether by intention or accident, of an electric current or equipment to reference ground.

–Grounding Electrode. A conductor embedded in the earth, used for maintaining ground potential on conductors connected to it, and for dissipating into the earth current conducted to it.

–Grounding Electrode Resistance. The resistance of the grounding electrode to earth.

–Grounding Electrode Conductor (grounding conductor). The conductor used to connect equipment or the grounded circuit of a wiring system to a grounding electrode.

–Grounded Conductor. A system or circuit conductor which is intentionally grounded.

–Grounded System. A system of conductors in which at least one conductor or point (usually the middle wire, or neutral point of transformer or generator windings) is intentionally grounded, either solidly or through a current-limiting device (not current-interrupting device).

–Hazard. Considered to include casualty, fire, and shock when applicable.

–Hotline Tools and Ropes. Those tools and ropes which are especially designed for work on energized high voltage lines and equipment. Insulated aerial equipment especially designed for work on energized high voltage lines and equipment is considered hotline.

-Insulated. To be separated from other conducting surfaces by a dielectric substance (including air space) offering a high resistance to the passage of current.
NOTE: When any object is said to be insulated, it is understood to be insulated in a suitable manner for the conditions to which it is subjected. Otherwise, it is for the purpose of this subpart, uninsulated. Insulating covering of conductors is one means of making the conductor insulated.

-Insulation (as applied to cable). That which is relied on to insulate the conductor from other conductors or conducting parts or from ground.

-Insulating Sheathing. An envelope which encloses the insulation of a cable and provides an equipotential surface in contact with cable insulation.

-Isolated. Not readily accessible to a person unless special means of access are used.

-Lanyard. A rope, suitable for supporting one person. One end is fastened to a safety belt and the other end is secured to a substantial object or safety line.

-Lifeline. A rope, suitable for supporting one person, to which a lanyard or safety belt (or harness) is attached.

-Manhole. A subsurface enclosure that personnel may enter; it is used for installing, operating, and maintaining equipment or cable.

-Liveline (Hotline) Work. The performance of maintenance or repair on energized high-voltage electrical conductors or equipment using approved hotline tools and rubber protective goods. This does not include routine operations such as opening and closing hook switches and fuse cutouts, or the installation of hotline clamps. Nor does it include working in manholes on dead circuits.

–Mishap. An unplanned or unsought event or series of events, that results in death, injury, occupational illness, or damage to, or loss of equipment or property.

–Primary Circuits. Circuits in the 751 through 36,000 volts group are referred to as primary or feeder circuits.
NOTE: The NEC states that low voltage is 600v and below.

–Pulling Tension. The longitudinal force exerted on a cable during installation.

–Qualified. One who, by possession of a recognized degree, certificate, or professional standing, or who by knowledge, training, and experience has successfully demonstrated the ability to solve or resolve problems relating to the subject matter, the work, or the project.

–Secondary Circuit. Circuits of 0 through 600 volts are referred to as low voltage or secondary circuits. (The NESC refers to voltages above 750 volts as high voltage.)

–Safe Body Clearance. This is the minimum distance between any exposed energized part of the circuit and any unprotected portion of the employee.

–Safety Belt. A device, usually worn around the waist, which by reason of its attachment to a lanyard and lifeline or a structure, will prevent a worker from falling.

–Safety Factor. The ratio of the ultimate strength of a member or piece of material or equipment to the actual working stress or safe load when in use.

–Shock Hazard. Considered to exist at an accessible part in a circuit between the part and ground, or other accessible parts if the potential is more than 42.4 volts peak and the current through a 1,500-ohm load is more than 5 milliamperes.

-Signals. Moving signs, provided by workers, such as flaggers, or by devices, such as flashing lights, to warn of possible or existing hazards.

-Signs. The warnings of hazard, temporarily, or permanently affixed or placed, at locations where hazards exist.

-Suitable. That which fits and has the qualities or qualifications to meet a given purpose, occasion, condition, function, or circumstance.

-Superintendent. The head of all electrical sections, normally identified by AFSC 54200, 54299, or civilian equivalent grade.

-Supervisor--Foreman. Refers to the supervisor of the exterior electric section normally identified by AFSC 54151/71 or civilian of equivalent grade.
NOTE: A list of shop foreman alternates must be kept by the superintendent for the sole purpose of issuing safe clearances.

-Switch. A device for opening and closing or changing the connection of a circuit. The term "switch" as used here is rather broad and embraces oil circuit breakers, air switches, network protectors, disconnects (either fusible or plain), hot clamps, and other devices by which an electrical circuit may be opened.

-Tag. A system or method of identifying circuits, systems, or equipment to persons that the circuit, system or equipment is being worked on.

-Tagging. The placement of a safety tag directly on a circuit opening device or equipment for additional safety, to ensure that it is not used or its position altered.

-Tags. Temporary signs, usually attached to a piece of equipment or part of a structure, to warn of existing or immediate danger.

–Tools. This classification includes hand, digging, hotline, special tools, and tackle.

–Unstable Material. Earth material that, because of its nature or the influence of related conditions, cannot be depended on to remain in place without extra support, such as would be furnished by a system of shoring.

–Vault. An enclosure above or below ground which personnel may enter; is used for the purpose of installing, operating, or maintaining equipment or cable.

–Voltage. The effective RMS potential difference between any two conductors or between a conductor and ground. Voltages are expressed in nominal values. The nominal voltage of a system or circuit is the value assigned to a system or circuit of a given voltage class for the purpose of convenient nomenclature. The operating voltage of the system may vary above or below this value.

a. Secondary Voltage. Lines and equipment operating at and below 600 volts (Nominal Phase-To-Phase).

b. Distribution Voltage. Lines and equipment operating above 600 volts (Nominal Phase-To-Phase) up to and including 36kv (Nominal Phase-To-Phase). Note that the NESC refers to high voltage as being above 750v.

c. Transmission Voltage. Lines and equipment operating above 36 kv (Nominal Phase-To-Phase).

–Voltage of an Effectively Grounded Circuit (phase voltage). The voltage between any conductor and ground unless otherwise indicated.

–Voltage of a Circuit Not Effectively Grounded (line voltage). The voltage between any two conductors. If one circuit is directly connected to and supplied from another circuit of higher voltage (as in the case of an auto-transformer), both are considered as of the higher voltage, unless the circuit of the lower voltage is effectively grounded, in which case its voltage is not determined by the circuit

of higher voltage. Direct connection implies electric connection as distinguished from connection merely through electromagnetic or electrostatic induction.

–Weatherproof. So constructed or protected that exposure to the weather will not interfere with normal operation.

NEMA Device Numbers for Use on Schematic and Wiring Diagrams

Device Number	Definition and Function
3	Checking or interlocking relay is a device which operates in response to the position of a number of other devices; or to a number of predetermined conditions in an equipment to allow an operating sequence to proceed to stop, or to provide a check of the position of these devices or of these conditions for any purpose.
5	Stopping device functions to place and hold equipment out of operation.
8	Control power disconnecting device--such as a knife switch circuit breaker or pullout fuse block--used for the purpose of connecting and disconnecting.
9	Reversing device is used to reverse a machine field or to perform any other reversing functions.
12	Over speed device is usually a direct-connected speed switch which functions on machine overspeed.
21	Distance relay is a device which functions when the circuit admittance, impedance, or reactance increases or decreases beyond predetermined limits.
25	Synchronizing, or synchronism-check, device operated when two A-C circuits are within the desired limits of frequency, phase angle or voltage, to permit or to cause the paralleling of these two circuits.
27	Undervoltage relay is a device which functions on a given value of undervoltage.
32	Directional power relay is one which functions on a desired value of power flow in a given direction or upon reverse power resulting from arc back in the anode or cathode circuits of a power rectifier.

35 Brush-operating or slip-ring short-circuiting device is used for raising, lowering, or shifting the brushes of a machine, or for short-circuiting its slip rings, or for engaging or disengaging the contacts of a mechanical rectifier.

37 Undercurrent or underpower relay is a device which functions when the current or power flow decreases below a predetermined value.

40 Field relay is a device that functions on a given or abnormally low value or failure of machine field current, or on an excessive value or the reactive component of armature current in an A-C machine indicating abnormally low field excitation.

41 Field circuit breaker is a device which functions to apply or to remove, the field excitation of a machine.

42 Running circuit breaker is a device with a principal function to connect a machine to its source of running voltage or operating voltage.

46 Reverse-phase or phase-balance current relay is a device which functions when the polyphase currents are of reverse-phase sequence or when the polyphase currents are unbalanced or contain negative phase-sequence components above a given amount.

47 Phase-sequence voltage relay is a device which functions upon a predetermined value of polyphase voltage in the desired phase sequence.

48 Incomplete sequence relay is a device which returns the equipment to the normal, or off, position and locks it out if the normal starting, operating, or stopping sequence is not properly completed within a predetermined time.

49 Machine or transformer thermal relay is a device which functions when the temperature of an A-C machine armature or of the armature or other load carrying winding or element of a D-C machine or converter or power rectifier or power transformer exceeds a predetermined value.

50 Instantaneous overcurrent or rate-of-rise relay is a device which functions instantaneously on an excessive value of current or on an excessive rate of current rise, thus indicating a fault in the apparatus or circuit being protected.

51 A-C time overcurrent relay is a device with either a definite or inverse time characteristic which functions when the current in an A-C circuit exceeds a predetermined value.

52 A-C circuit breaker is a device which is used to close and interrupt an A-C power circuit under normal conditions or to interrupt this circuit under fault or emergency conditions.

53 Exciter or D-C generator relay is a device which forces the D-C machine field excitation to build up during starting or which functions when the machine voltage has built up to a given value.

55 Power factor relay is a device which operates when the power factor in an A-C circuit becomes above or below a predetermined value.

56 Field application relay is a device which automatically controls the application of the field excitation to an A-C motor at some predetermined point in the slip cycle.

59 Overvoltage relay is a device which functions on a given value of overvoltage.

60 Voltage balance relay is a device which operates on a given difference in voltage between two circuits.

61 Current balance relay is a device which operates on a given difference in current input or output of two circuits.

62 Time-delay stopping or opening relay is a time-delay device which services in conjunction with the device which initiates the shutdown, stopping, or opening operation in an automatic sequence.

64 Ground protective relay is a device which functions on failure of the insulation of a machine, transformer or of other apparatus to ground, or on flashover of a D-C machine to ground.

NOTE: "This function is assigned only to a relay which detects the flow of current from the frame of a machine or enclosing case or structure of a piece of apparatus to ground, or detects a ground on a normally ungrounded winding or circuit. It is not applied to a device connected in the secondary circuit or secondary neutral of a current transformer, or current transformers, connected in the power circuit of a normally grounded system."

65 Governor is the equipment which controls the gate or valve opening of a prime mover.

67 A-C directional overcurrent relay is a device which functions on a desired value of a A-C overcurrent flowing in a predetermined direction.

70 Electrically operated rheostat is a rheostat which is used to vary the resistance of a circuit in response to some means of electrical control.

75 Position changing mechanism is the mechanism which is used for moving a removable circuit breaker unit to and from the connected, disconnected, and test positions.

76 D-C overcurrent relay is a device which functions when the current in a D-C circuit exceeds a given value.

77 Pulse transmitter is used to generate and transmit pulses over a telemetering or pilot-wire circuit to the remote indicating or receiving device.

78 Phase angle measuring or out-of-step protective relay is a device which functions at a predetermined phase angle between two voltages or between two currents or between voltage and current.

79 A-C reclosing relay is a device which controls the automatic reclosing and locking out of an A-C circuit interrupter.

81 Frequency relay is a device which functions on a predetermined value of frequency--either under or over or on normal system frequency--or rate of change of frequency.

84 Operating mechanism is the complete electrical mechanism or servo-mechanism, including the operating motor, solenoids, position switches, etc., for a tap changer, induction regulator or any piece of apparatus which has no device function number.

85 Carrier or pilot-wire receiver relay is a device which is operated or restrained by a signal used in connection with carrier-current or D-C pilot-wire fault directional relaying.

86 Locking-out relay is an electrically operated hand or electrically reset device which functions to shutdown and hold an equipment out of service on the occurrence of abnormal conditions.

87 Differential protective relay is a protective device which functions on a percentage of phase angle or other quantitative difference of two currents or of some other electrical quantities.

89 Line switch is used as a disconnecting or isolating switch in an A-C or D-C power circuit, when this device is electrically operated or has electrical accessories, such as an auxiliary switch, magnetic lock, etc.

90 Regulating device functions to regulate a quantity, or quantities, such as voltage, current, power, speed, frequency, temperature, and load, at a certain value or between certain limits for machine, tie lines, or other apparatus.

91 Voltage directional relay is a device which operates when the voltage across an open circuit breaker or contactor exceeds a given value in a given direction.

92 Voltage and power directional relay is a device which permits or causes the connection of two circuits when the voltage difference between them exceeds a given value in a predetermined direction and causes these two circuits to be disconnected from each other when the power flowing between them exceeds a given value in the opposite direction.

93 Field changing contactor functions to increase or decrease in one step the value of field excitation on a machine.

94 Tripping or trip-free relay is a device which functions to trip a circuit breaker, contactor, or equipment, or to permit immediate tripping by other devices or to prevent immediate reclosure of a circuit interrupter in case it should open automatically even though its closing circuit is maintained closed.

Case Studies of Typical Mishaps

1. Troubleshooting Energized Circuits:

a. Narrative. Two electricians were replacing a cover on an electrical raceway when the insulation on an energized 480 volt split bolt connection was damaged, causing the circuit to ground and burn a hole in the cover which in turn caused burns to the craftmen's arms, chest, and face.

b. Cause. Troubleshooting energized circuits in a raceway filled to capacity with wiring that had deteriorated insulation.

c. Unsafe Act or Condition. There was no direct unsafe act, however, a possible lack of notice of insulation condition could have caused an accident. Maintenance action should have been taken to upgrade the raceway to prevent deteriorated condition.

2. Testing Transformers:

a. Narrative. Two transformers were being put on line and were being tested to see if they were in-phase. A voltmeter was used to check between "A" phases. The meter leads were not long enough to reach so an extension was used. The connection was not insulated and contacted the switch near the gear case. Arcing resulted, one of the leads was dropped across the three buses resulting in arcing and flashing, causing burns to a worker's arm and hand.

b. Cause. Leads of insufficient length were used and extension was not insulated properly.

c. Unsafe Act or Condition. There were several in this case that could be summed up with the worst possible words: "I thought that..." NEVER ASSUME! The supervisor failed to adequately review work-order and system drawings to determine proper feeder direction. This system was not safety grounded nor line tested after taps were removed to see if system was dead. Also, the crew assumed feed direction based on previous work in that area.

3. High Voltage Power Supply:

a. Narrative. A shield was being replaced on a high voltage supply cabinet. A wing nut dropped into the cabinet. An attempt

was made to remove wing nut while cabinet was energized. A 5-inch arc jumped from stacked diodes sending 4000 to 5000 volts DC at 3 amps into one arm, across shoulders and out the other arm.

b. Cause. The humidity and temperature were very high and the worker was sweating.

c. Unsafe Act or Condition. The equipment was not deengergized and proper grounding procedures were not used.

4. Unknown Dual Feeders:

a. Narrative. An emergency crew tried to restore power to a facility only to have a fuse in the oil switch continue to blow. Thinking the oil could be dirty, the plan was to drain the cylinder and clean. The "A" circuit was disconnected and work started. During cleaning a worker contacted an energized lug in the cylinder resulting in burns.

b. Cause. The oil switch had a second feeder which could be automatically switched in when problems occur on "A" circuit. This allowed oil switch to remain hot.

c. Unsafe Act or Condition. Inadequate procedures were used. There was apparently no procedure written to check both feeders. It was felt that the only place to check was within the oil switch, which is a dangerous procedure. It would also appear that if the presence of the secondary feeder had been researched, it could have been disconnected.

5. High Reach Operation:

a. Narrative. A tree trimming operation was underway when the 65 foot reach bucket contacted a 7600 volt line, damaging the boom.

b. Cause. Changing position of bucket resulted in contact with feeder.

c. Unsafe Act or Condition. The operator was inattentive to operation and misjudged clearance.

6. Pole Movement:

a. Narrative. Shipment of poles were being placed on racks. During operation, boom shifted and truck overturned.

b. Cause. A hydraulic cylinder failed causing boom to shift. The truck was the old A-frame type which is top heavy. The added weight of the pole caused the truck to overturn.

c. Unsafe Act or Condition. It appears this was unavoidable, however, inspection of hydraulics may have prevented this accident.

7. Auger Truck Operation:

a. Narrative. Auger truck was being used to remove a pole from the ground when a pole fell onto the truck.

b. Cause. The equalizer line was misplaced allowing the pole to become top heavy.

c. Unsafe Act or Condition. This was a case of supervisor misjudgment of line attachment location.

8. High Reach Cable Break:

a. Narrative. While operating a high reach the leveling cables broke pitching the bucket forward. Workers were thrown to the ground.

b. Cause. The leveling cables broke for various reasons--from being installed improperly to wearing out.

c. Unsafe Act or Condition. While the cable condition contributed considerably to the accident, injuries occurred because the workers were not using the safety harness. Indications were that the harnesses were disconnected prematurely. Had the harness been used, serious injuries probably would have been avoided

9. Falling From Pole:

a. Narrative. Worker, descending utility pole, fell.

b. Cause. Failed to gaff properly and cut out.

c. Unsafe Act or Condition. There are numerous accidents of this sort. It can happen to a beginner or experienced person. The accidents usually result from improper climbing techniques caused by not paying attention to what they are doing.

10. Unsafe Pole:

a. Narrative. Worker fell when pole on which he was working broke.

b. Cause. Pole was not properly treated, or due to age, dry rot had set in.

c. Unsafe Act or Condition. There have been several accidents of this nature. Proper checking of pole before climbing could have uncovered the problem. Always suspect an old pole.

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