TM 5-682

TECHNICAL MANUAL

FACILITIES ENGINEERING
ELECTRICAL FACILITIES SAFETY

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION IS UNLIMITED

HEADQUARTERS, DEPARTMENT OF THE ARMY

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Facilities Engineering
Electrical Facilities Safety

*This manual supersedes TM 5-682 dated June 1983

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PART ONE
BASIC PRACTICES FOR ELECTRICAL SAFETY

CHAPTER 1
PURPOSE AND APPLICABILITY

1–1. Purpose

The purpose of this manual is to provide basic safety rules and instructions pertinent to electrical work in order to assist electrical workers in eliminating situations, practices and actions which can result in accidents to personnel and property. Safety hazards exist in any workplace. The risks of injury from unsafe handling of energy from electrical systems have increased considerably in the past few decades fro personnel involved in operating and maintaining electrical facilities. This safety manual was developed to meet the need for consistent and effective safety standards for electrical workers.

a. Accident prevention. Accidents do not just happen. Accidents are normally caused by the careless and thoughtless acts of workers. Using damaged tools or unsafe equipment or working inside unprotected environments are the main causes of accidents. Accident prevention is the responsibility of all workers. Your own safety, your co-workers' safety, and your community's safety depend upon your safe working practices, safe working procedures, and good personal protection.

b. Safe working practices. A copy of this safety manual will be given to each electrical worker. Each worker will be required to learn and become accustomed to the safe working practises recommended in this manual. Supervisors and foremen have the responsibilities to interpret the safety rules listed in the manual to their workers. A comprehensive test will be given to each worker. Any worker who fails to make a passing grade on the test will be restricted in the type of work permitted.

c. Safe working procedures. A working procedure must be prepared by the appropriate supervisor or foreman for each job. It includes the detailed instructions on how the job needs to be done. The worker has the responsibilities to follow the instructions in the procedure carefully step by step. However, the workers have the right to discuss the working procedures with their supervisor or foreman in case where they feel that the instructions are not clear or where safety is not adequate.

d. Personal protections. All electrical workers are required to use appropriate protective equipment such as hard hats, rubber gloves, gas masks, and goggles when exercising their jobs. Workers must also learn how to visually inspect and test their personal protective equipment. All unsafe protective equipment must be isolated, tagged, repaired, or discarded.

e. Training. All electrical workers must be trained, certified, and current in American Red Cross or American Heart Association cardiopulmonary resuscitation (CPR) and first aid.

1–2. Applicability

This manual is applicable to all U.S. Army facilities engineering electrical workers including military and civilian. Where the working conditions or job requirements are not covered by this manual, appropriate references listed in appendix A will apply.

a. Mandatory. The safety rules in this manual are mandatory for all U.S. Army electrical workers, including supervisors, foremen, linemen, and other crew members. Electrical workers have the right to ask questions if the safety instructions are not adequate or clear. Supervisors and foremen have the duty to interpret the safety rules for their workers. Supervisors and foremen will discuss the safety rules and procedures with his/her crew when it is necessary.

b. Emergency conditions. Under emergency conditions, supervisors and foremen may alter some safety procedures. However, they should discuss the alternative procedures with their workers and should be present at the scene all the time. Workers are not allowed to perform any work that they are not qualified for or where their personal protection is not adequate.

c. Documentation. Whenever a safety procedure is altered, an emergency written report should be prepared and documented. The report will describe the alternative method and the personal protection used for the job.

1–3. References.

Required and related publication and proscribed forms are listed in appendix A.

CHAPTER 2
CLASSIFICATIONS AND RESPONSIBILITIES OF ELECTRICAL WORKERS

2-1. Workers' classifications

Workers' classifications are based on the training, experience, and the quality of services they provided. No workers are allowed to do any work of a higher rated classification than that for which they have qualified. However, workers can do work in a lower classification when, in the opinion of the supervisor or foreman, such assignment is practical and economical.

a. Laborer. A laborer works only on the ground. Such work as clearing rights-of-way, digging pole holes, aligning poles, and similar duties. A laborer cannot work as attendant of a wire reel, handle in any manner conductors being pulled in near other energized conductors, or guide the butt of a pole being set in an energized line. No experience and training are required for a laborer.

b. Groundman. This classification requires a period of employment of at least 12 months.

(1) *First 6 months of employment.* During the first 6 months of employment, the groundman can work only on the ground under the direction of the foreman in charge. The groundman must become acquainted with the tools required by linemen as well as all materials necessary in line construction. The methods of making up the various assemblies, such as down guys, dead ends, and single and double crossarms must be learned. A groundman should observe closely the working methods of linemen on poles and structures, and assist them from the ground as they direct with the exception that he/she must not act as attendant of a wire reel, handle in any manner conductors being pulled in near other energized conductors, or guide the butt of a pole being set in an energized line. A groundman should diligently study this manual and the methods of handling the various jobs. At the close of the first 6-month period, after passing an examination on the contents of this manual, and at the direction of the foreman, the worker may be taught to climb.

(2) *Second 6 months of employment or longer.* After 6 months the groundman is allowed to work on de-energized equipment while learning to climb. However, no groundman is authorized to do any work that requires climbing. The groundman must learn the proper work methods from the foreman and follow exactly all instructions given by the foreman. This manual and other references listed in appendix A must be studied and applied diligently during this period.

(3) *After a full a full year of employment or longer.* After a full year of employment or longer, a groundman can become a candidate for promotion to lineman-C. However, the worker must take a higher level examination on the safety and methods of work pertaining to the facilities involved. If the candidate passes the examination, he/she could be advanced for promotion to lineman-C.

c. Lineman-C (or Junior Apprentice Lineman, MOS 52EU4 or MOS 52G). This classification requires a period of employment of at least 12 months.

(1) *First 6 months.* During the first 6 months a lineman-C is not allowed to do any work that requires climbing or working on energized conductors or equipment of more than 600 volts root mean square (RMS).

(2) *Second 6 months or longer.* A lineman-C having 12 months climbing experience (6 months as a groundman and 6 months as a lineman-C) may be allowed to do the following work:

(a) A lineman-C is allowed to work above energized circuits or on energized circuits on straight pole lines not exceeding 5,000 volts between conductors. However, before doing this work, the lineman-C must be judged capable of doing the job safely and must be assisted by a higher class lineman on the same pole. The more experienced lineman must supervise the handling of energized conductors. During the apprenticeship period, the lineman-C must learn all of the different circuits, the voltage each carries, and their relative positions on the poles and crossarms.

(b) A qualified lineman-C, with supervisor approval, may gain additional knowledge of live-line tools work by assisting in installing live-line tools and raising and lowering conductors in place, if accompanied on the same pole by a lineman-A. The lineman-C may be allowed to replace transformer fuses and tap-line fuses of any voltage using a hot line stick or fuse puller. Handling energized jumpers or untying and ty-

ing in conductors is not permitted. This work must be done by a lineman-A. The lineman-C will not be advanced to new or more hazardous duties until the foreman is satisfied with the worker's overall progress and ability to handle such duties.

(3) *After a full year of employment or more.* After a full year of employment or more, and after a thorough examination on this safety manual and the methods of work pertaining to the facilities involved, a lineman-C is qualified for-promotion to lineman-B if suitable progress has been made.

d. *Lineman-B (or Senior Apprentice Lineman).* This classification covers a period of at least 12 months employment.

(1) A lineman-B should be able to do all work that is required of a lineman-C. A lineman-B worker may work above energized distribution circuits regardless of voltage. A lineman-B may be permitted to transfer corner poles (ordinary type) when assisted by a foreman or lineman-A. However, this should not be taken as approval to work on any or all corner poles carrying lines not exceeding 5,000 volts between conductors. Ordinary corner poles are usually free of the major hazards that exist on the heavier loaded and more congested poles which are the responsibility of the lineman-A. During this service period a lineman-B should be permitted to assist in the use of live-line maintenance tools when the other worker on the job is a lineman-A. Only one lineman-B may actually handle energized conductors on one pole during this service period.

(2) After serving at least one full year and after a thorough examination on this safety manual and the methods of work pertaining to the facilities involved, a lineman-B is qualified for promotion to lineman-A if suitable progress has been made.

e. Lineman-A (or Journeyman). Only the most skillful and experienced linemen are to be classed in the grade of lineman-A. A lineman-A must have not less than ~e years experience before being advanced to this classification. A lineman-A is expected to be able to perform all duties of an electrical supervisor or a foreman. The advanced position of lineman-A carries with it the responsibility of helping to train the less experienced workers who are assigned to work on the job. The lineman-A should be capable of supervising the work of any part of the crew or even the entire crew when delegated to do so.

f. Foreman. A foreman is the head of a lineman's crew. A foreman must have not less than 3 years of experience on work pertaining to the facilities involved and 1 year experience in coaching. The foreman should be able to direct, control, and assign suitable workers to each electrical job. He/she should also be able to issue detailed instructions for each job. He/she should enforce his/her employees to apply the safety rules seriously.

g. Troubleman. No one rated lower than a lineman-B is permitted to work as a troubleman. The limitations of the work for a troubleman are the same as those outlined in subparagraphs **d** and **e** above, depending upon the troubleman equivalent rating as a lineman (lineman-B or lineman-A).

h. Patrolman. No one rated lower than a lineman-B can be assigned to work as a patrolman. The limitations of work for a patrolman are the same as those outlined in subparagraphs **d** and **e** above, depending upon the patrolman's equivalent rating as a lineman (lineman-B or lineman-A). A patrolman is tasked with patrolling and inspection of lines and electrical components such as power transformers, capacitors, and circuit breakers to determine whether, how much, and when maintenance is required. A patrolman must be particularly careful with lighted cigarettes, cigars, matches, and pipe ashes which may cause fires during tasking. A patrolman should also be extremely cautious to avoid injury from fences, briars, swollen streams, and animals. A patrolman should be provided with a pair of boots and a standard snake-bite kit.

i. Inside wireman. An inside wireman requires 2 years of study to master the complexities of the National Electric Code (NEC) and of control circuitry. Special training courses by outside educational agencies may be necessary to ensure that qualifications for servicing complex equipment have been met by an inside wireman. An inside wireman dealing with medium voltage circuits must have qualified as a lineman-A. For low voltage circuits, an inside wireman must have qualified as a lineman-C.

2-2. Responsibilities of workers

Responsibilities are the duties that an employee must be accountable for within his/her power and control.

a. Supervisors. Supervisors are persons who are in charge overall of electrical maintenance and operation. Supervisor's responsibilities include—

(1) Selecting suitable workers for the job required.

(2) Selecting a competent worker as the leader of each crew.

(3) Being responsible for the safety of his/her workers.

(4) Providing orientation to new workers. Orientation would include work schedules, safety work procedures, personal safety, safety of co-workers, safety in work places, safety in public environment, first aid, emergency and local hospitals, accident reports, and safety reports.

(5) Developing a job description and training program for each new worker.

(6) Issuing a copy of this safety manual to each new worker. Each new worker will be required to take an examination on this safety-manual. Any worker failing to make a passing grade will be restricted in his/her works.

(7) Interpreting the safety rules to his/her workers when asked.

(8) Testing the workers on safety issues.

(9) Issuing work orders and instructions to the foreman who in turn will issue orders and instructions to his/her employees.

(10) Conducting safety meetings to explain, review and upgrade safe working conditions, procedures, and discuss lessons learned.

(11) Asking the workers to stop work immediately if unsafe working conditions are found or when the workers are inadequate for the job due to sickness or lack of training.

(12) Reviewing all unsafe working reports and accident reports, analyzing the situations, and solving the problems as soon as possible.

(13) Coordinating with the supplied utilities and other agencies for the shut-down of the power systems for routine maintenance or repairs.

b. Foremen. Foremen will be in charge of the safety and performance of the workers directly under their supervision. Foremen's responsibilities include:

(1) Coordinating with his/her supervisor and other crew's leaders.

(2) Reporting immediately to his/her supervisor all unsafe situations, working conditions, procedures, equipment, tools, and machinery.

(3) Being directly in charge of his/her crew. That would include—assigning work to his/her workers, providing safety equipment and detailed instructions pertaining to each job, safety planning, direct coaching, and quality controlling.

(4) Being responsible for the safety of his/her crew. Asking his/her crew to stop work immediately and leave the area when a dangerous situation is found.

(5) Discharging immediately any worker who is suspected to be under the influence of drugs, alcohol, or mental illness.

(6) Providing new workers proper training. That would include: proper working methods, good shop/housekeeping, safe working practices, first-aid treatment, resuscitation, emergency calls, safety reports, accident reports, and inspecting/using/testing/ maintaining personal protective devices, tools, and equipment.

(7) Assigning qualified worker in the crew to coach new workers.

(8) Ensuring that the workers in his/her crew are physically able to do the work assigned. Any worker who appears to be sick or unfit for work will be relieved from all duties and not allowed to return to work until fully recovered.

(9) Conducting meetings to interpret the safety rules and working procedures in detail to his/ her workers.

(10) Remaining at the Job site for direct coaching and controlling as long as his/her crew is performing a job on energized lines' equipment, or apparatus.

(11) Preventing unauthorized persons from approaching places where work is being done by the placing of barricades, hole covers, warning signs, flags, red lanterns, and other means of protecting the public.

(12) Taking necessary steps to correct the defective lines, equipment or apparatus.

(13) Avoiding engaging in the actual work except where the crew is small or, in emergencies, when it becomes necessary to take an active part in the work.

c. *Crew members.* Crew members include all electrical and non-electrical workers. They have the responsibility to learn and apply all the safety rules

listed in this manual. Other responsibilities of crew members are as follows:

(1) Observing carefully all instructions given by their appropriate supervisors or foremen for each job.

(2) Understanding clearly what needs to be done and how to accomplish the job.

(3) Being responsible for their acts. Careless and uncontrollable acts are unacceptable. Smoking is allowed in permitted areas only. Taking drugs or drinking intoxicants while on duty is prohibited.

(4) Applying safe working practices. Safety procedures and precautions , must be taken at all times. When working in a group, a worker must notify his/her co-worker what the worker is planning to do, such as before energizing or de-energizing a circuit.

(5) Reporting immediately to their supervisors or foremen all unsafe situations found in the electrical distribution systems, working places, or public areas.

(6) Stopping work immediately if they feel unable to handle the job because of their health condition, weather, hazardous location or situation.

(7) Taking charge of their own safety, their coworkers' safety, and their environmental public safety.

(8) Learning how to react when an accident occurs (First hid treatment, resuscitation, victim handling, and emergency calling).

(9) Refusing to work when they feel unqualified for the job.

(10) Keeping the vehicles, tools, equipment, and working place always clean, safe, orderly, and ready for use at all times.

d. All workers. The following responsibilities are for all workers, including supervisors, foremen, and all crew members.

(1) *Accident prevention.* Accident prevention is the most important action in which all workers must participate. This includes—

(a) Good shop/housekeeping. Keeping floors, steps, walkways, driveways, aisles, stairways and exit routes always clean and clear of obstacles, blocks, and slippery matter. Keeping exit lights always on and complying with National Fire Protection Association (NFPA) 101 requirements. Keeping exit doors unlocked from the inside and free of rust and all kinds of obstructions. Removing snow and ice from the outdoor walkways, driveways, stairways, and steps. Placing tools and equipment in a safe and secure position upon completion or suspension of work. Placing small parts in containers when dismantling equipment. Keeping tools in chests or convenient racks when not in use or storing them where they will not create hazards. Removing stacked materials from walkways, driveways, aisles, stairways, and exit routes unless barricades are erected. Not exceeding safe floor loadings, nor placing material on or against any support unless it is known that it can carry the additional weight. Stacking material so that it cannot be overturned easily. Watching the stockpiling: inspecting for stability and for objects which may fall or be dislodged. Fastening the stacked material securely when needed. Using suitable racks for storing pipe, piling, and other materials which cannot be readily formed into stable stacks. Placing timbers and other heavy objects on suitable blocks or sleepers to ensure necessary hand holds. Stacking wire reels with three strips of wood between reels. Not leaving nails projecting from boards or walls where they may cause personal injury. Not removing materials from packing cases or removing concrete forms without removing all projecting nails.

(b) Safe working areas. Before starting any electrical work, the following safety checks must be made for all working areas. Area must be clean and free of all slippery materials. Accessible routes for emergency exit must be available. All obstacles must be removed. All unsafe situations must be fixed, such as unstable platforms where the workers stand, loosened electrical parts, and uncovered energized lines. Illumination should be adequate. Working space clearance must be sufficient. Warning equipment such as barriers, traffic cones, and warning signs must be located. Unsafe personal apparel such as neckties, jewelry, and watches must be removed.

(2) *Fire prevention and protection.* This is the duty for all workers, including supervisors, foremen, and all crew members.

(a) Fire prevention. Workers must not smoke where smoking constitutes a fire hazard. Workers must not accumulate combustible materials, since they create fire hazards. Material will be deposited in metal containers; containers must be emptied at the end of each day and the contents disposed of in such a way as not to create a fire hazard. Soiled rags must not be kept in lockers. Rubbish or waste must not be burned within 50 feet of a combustible struc-

ture, or within 5 feet of any building. In burning waste and rubbish, heavy smoke must not be allowed to blow into energized equipment. No burning will be done out-of-doors during high winds. Local civil laws banning open fires will be obeyed. Weeds or other rank vegetation must not be permitted to grow in substation yards or pole yards, around oil tanks or other structures, or near buildings.

(b) Fire protection. Fire protection includes fire detection and fire extinguishing equipment. All fire detection devices such as smoke detectors, heat detectors, and fire alarm systems should be physically checked and in good operating condition monthly and should be tested the manufacturers instructions every 6 months. Appropriate types of extinguishing equipment must be used for each location, depending on the classes of fires and material stored at the location. There are three main classes of fires (see NFPA 10). Class A involves normal combustible material such as wood and paper. Extinguishing agents for class A fires include water, soda-acid, and multipurpose dry chemicals. Class B involves oils and flammable liquids. Extinguishing agents for class B fires include CO_2, and dry chemicals. Class C involves electrical equipment. Extinguishing agents for class C fires include CO_2 and dry chemicals. The extinguishing agents Halon 1301 and Halon 1211 are being replaced with either CO_2 or dry chemical and are suitable for combating both Class B and Class C fires, especially at indoor locations. These two Halon agents are slightly toxic in low concentrations (less than 5 percent). Concentrations above 15 percent will cause unconsciousness in a short period of time. Therefore, when these extinguishing agents are used precautionary measures similar to those for toxic agents in a confined spaces should be employed. Workers should not enter confined spaces after using CO_2 or other toxic extinguishers until areas have been thoroughly ventilated. Carbon tetrachloride fire extinguishers should not be used because they are extremely toxic. Fire extinguishing equipment must be inspected NFPA 10.

(3) *Accident reporting.* Upon the occurrence of the accident, the worker involved in the accident must immediately inform his/her supervisor.

(a) Job related injury report. If the accident results in either injury to personnel or damage to property, the worker must prepare a written report describing in detail the circumstances of the accident, personnel involved, injured personnel, damaged properties, and problems caused by the accident. The report must be completed within 24 hours after the accident. In addition, the worker must fully cooperate with the authorities who conduct the investigation of the accident. All items involved in the accident should be identified as evidence and preserved until after the investigation has been completed.

(b) Vehicle/equipment accident report. The worker involved in the accident should verbally inform his/her supervisor immediately after the occurrence of the accident. The worker should also provide a written report describing in detail the circumstances of the accident and the extent of the damage within 5 days of occurrence. If the accident causes injuries to the worker or other persons, then the job related injury report described in paragraph 2-2**d**(3)a above should be applied. The worker should also comply with all local and state traffic laws when required.

(c) Misuse of authorization report. No worker can be assigned to do any work of a higher rated classification. However, the worker can be assigned to do any work in a lower classification when, in the opinion of the supervisor or foreman, such assignment is practical and economical. It is the responsibilities of the worker to report to his/her supervisor any misusage or abuse of authorization.

2-3. Safety meetings

Safety meetings consist of scheduled meetings and special meetings for specific jobs.

a. Scheduled meetings. Scheduled safety meetings should be held at least once a month. The supervisor will personally conduct these meetings. However, the leader of a crew may also be assigned the chairmanship duties on a rotational basis. Topics of discussion include—

(1) Two or three safety rules from this manual, using the manual as a textbook, until completed. Then, starting over again.

(2) Safety rules, methods, and hazards connected with the work in progress .

(3) Lessons learned. Discussion of any accidents that may have occurred recently.

(4) Safe driving.

(5) Accident reports, safety bulletins, posters, and other material -furnished by the installation safety director.

(6) Safe use of motorized equipment.

(7) Working on underground lines.

(8) Working on or near machinery.

(9) Working in elevated positions.

(10) Grounding systems.

(11) First aid. Practicing various methods of artificial resuscitation: cardiopulmonary resuscitation (CPR), chest pressure-arm lift (Silvester), and mouth-to-mouth artificial respiration. Red Cross or American Heart Association certification is required for all workers.

b. Special meetings. Special meetings are normally held by the supervisor or leader of a crew before beginning a particularly difficult job. All details of the job and difficulties will be discussed. Crew members must understand the precautions to be observed and the procedures to be followed. Members must understand what needs to be done, and know how to accomplish the job. They should be aware of the safety hazards, and learn how to eliminate the hazards by using specific safety equipment such as grounding equipment and protective measures such as body protective devices. Posters, pictures, diagrams and other aids may be used in conducting the meetings. Written work procedures should be prepared for complicated activities which involve access to locations where the electricity cannot be de-energized.

2–4 Safety rule violation penalties

Any worker who fails to observe the safety rules in this manual will be subject to penalties. The severity of the penalty will be related to the seriousness of any previous offenses.

a. First offense.

(1) Verbal reprimand.

(2) Called off the job to study safety rules. +:

(3) Discharge (Applicable to cases of deliberate or willful failure to observe any written regulations where safety of persons and/or property is endangered thereby).

b. Second offense.

(1) Official reprimand.

(2) Lay off without pay, 1 day.

(3) Discharge.

c. Third offense. Discharge.

CHAPTER 3
BASIC PERSONNEL SAFE WORKING PRACTICES

3-1. Basic safe working practices

Basic safe working practices require that the worker be in good health, not under the influence of drugs or alcohol, free of major emotional, psychological, and financial problems, familiar with the fundamentals of Safety, familiar with equipment and tool use, well prepared for each job, and always alert and responsible for his/her acts.

3-2. Fundamentals of safety

The fundamentals of safety include accident prevention and hazardous work elimination.

a. Accident prevention. ACCIDENTS DO NOT "JUST HAPPEN"—Accidents are the result of unsafe acts, unsafe conditions, or both.

(1) Unsafe acts, which cause almost 9 out of every 10 accidents, include—

(a) Operating without authority or warning, such as opening or closing switches, circuit breakers or reclosers without permission; operating hoists, trucks, or other motor-operated devices without giving a proper warning; failure to place warning signs or guards or to give signals where needed; and violation of "red tagging" rules.

(b) Making safety devices inoperative unnecessarily or without an adequate reason, such as removing guards, using oversize fuses, and blocking protective devices.

(c) Using unsafe equipment or using equipment improperly, such as using tools and chisels that are damaged, using pipe extensions on wrenches not designed for them, using the wrong tools for the job, and using your hands instead of hand tools.

(d) Unsafe loading or placing objects, such as carrying or lifting heavy loads, placing objects where they are likely to fall, unstable packing of loads, and failure to block or guard equipment against unexpected movements.

(e) Taking unsafe positions, such as working or lifting from an improper position; casual walking under suspended loads, through hazardous work areas, or close to openings; entering areas contaminated by gases or fumes without taking proper precautions; and riding in unsafe locations in or on motor vehicles.

(f) Working near live equipment, moving machinery, apparatus, or moving parts thereof, without observing prescribed safety precautions or regulations, or without using required protective devices and equipment.

(g) Distracting or startling acts, such as practical joking, horseplay, teasing, quarreling, and annoying behavior.

(h) Failure to use personal protective equipment or safe clothing, such as rubber gloves, aprons, and leggings where required.

(2) Unsafe conditions, include—

(a) Lack of shields or guards and unbarricaded floor openings or excavations.

(b) Insufficient warning signs, inadequate guards for the job, makeshift barriers, and "red tags": not properly applied.

(c) Defective material or equipment, such as broken pieces, stripped threads, split handles, and damaged tools.

(d) Hazardous arrangements, resulting from poor housekeeping or lack of planning.

(e) Unsafe personal apparel, such as neckties, jewelry, and loose sleeves, when worn near moving machinery.

(f) Improper illumination or inadequate ventilation when working in a manhole or utility room.

b. Hazardous work elimination. Hazardous work can be eliminated when workers are instilled with the habit of being cautious:

(1) Do not begin work around energized machinery or equipment or at any place where a hazard exists until adequate lighting and all proper safety measures are provided. When finished, disconnect and remove all extension power cords. Never leave extension cords which are not in use.

(2) Place DANGER signs where conditions require their use.

(3) Remove DANGER signs from places where the danger no longer exists; do not use such signs unnecessarily.

(4) Inspect all tools and equipment before using them and report promptly any defect noticed.

(5) Never work so closely to fellow workers that they may be endangered by swinging picks, shovels, or similar tools.

(6) Use nail pullers when removing nails from boxes or crates.

(7) Do not use files without proper handles.

(8) Use cribbing or other approved means to support objects raised above a working position. Do not depend upon a lifting jack for support.

(9) Do not stand or allow others to stand near ropes or cables under strain.

(10) Stop portable gasoline engines or electric motors propelling equipment such as concrete mixers, compressors, pumps, blowers, and cranes, before refueling, greasing, oiling, or repairing.

(11) When burning insulation off scrap wire:

(a) Use an incinerator, if available. If an incinerator is not available, burning should be done in the open away from buildings and flammable material. Obey local civil laws regarding open fires.

(b) Use iron forks to handle wire.

(c) Let the fire burn out before removing the wire.

(12) Report promptly and establish guards over any hazardous condition which might cause injury, property damage, or interference with electric services. This includes all hazards, such as fallen wires, open holes or ditches, and broken poles or crossarms.

(13) Keep away from dangerous places unless the work requires you to be there.

(14) Treat all electric wires and apparatus as dangerous and do not touch such equipment unless you are qualified and authorized to handle such work.

(15) Do not install fuses which are of an improper type or capacity.

(16) Do not operate portable electric hand drills, hand grinders, hand buffing wheels, or other similar equipment unless the motor casing is effectively grounded or the tool is properly labeled as “double insulated.”

(17) Casings of electric motors mounted on work benches or mounted on metal bases fastened to concrete, wood, or metal floors must be effectively grounded before operation.

(18) Do not remove broken light bulbs while working inside tanks, heaters, boilers, and other such enclosed spaces unless the cord is disconnected from the supply outlet. Empty sockets are not permitted in such places.

(19) After a natural disaster such as flood, fire, tornado, hurricane or earthquake all electrical components and devices such as switchgear, circuit breakers, fuses, transformers, reclosers, generators, electric machines, electric equipment and electric circuits must be checked and tested by professionals before re-energizing.

(20) Before starting an electrical job the working areas must be checked for safety. Accessible routes for emergency entrance and exit should be available. All obstacles must be removed and all unsafe situations must be fixed before job can be started. Unsafe personal apparel such as neckties, jewelry, watches, and loose clothes should not be worn. Personal protective devices such as safety gloves, rubber blankets, hot sticks, goggles should be available and ready for use. The workplace must be protected from unauthorized access and unforeseen accidents by one of the following means:

(a) Warning equipment. Adequate barriers, warning signs, traffic cones, and lights must be located on approaches to and at the work areas, excavations, open manholes, parked equipment; and other hazards. Special precautions must be taken for any areas where reduced visibility occurs such as night operations or in fog. Warning devices must be removed when the work is completed.

(b) Flagmen. Flagmen are necessary when warning devices are not adequate such as in traffic control. Flagmen must wear safety warning vests, operate two-way radios and carry warning signs for their protection and work area protection.

3-3. Normal environmental impacts

The environment may cause impacts on the work to be performed and potential health hazards for workers when careless or lack of site preparation exists.

a. Working in elevated positions. A safety rope should be used to attach to the worker's body when he/she is in an elevated position. To prevent the possibility of dropping materials or tools from the elevated position onto people underneath, appropri-

ate signs and guards must be used to keep people away. The supporting platforms for workers, tools, and materials must be strong and balanced for the loads they carry to prevent the risk of breaking or falling.

b. Working in confined spaces. A confined space is an enclosed space with restricted access and insufficient ventilation such as vaults, manholes, or tanks. Insufficient ventilation can result in dangerous air contamination and an oxygen deficient atmosphere. Dangerous air contamination results when there is a flammable gas or vapor exceeding 10 percent of its lower explosive limit. An oxygen deficient atmosphere contains less than 19.5 percent oxygen by volume.

(1) *Before entering into a confined space.* Prior to entering a confined space, the atmosphere will be tested by qualified personnel to determine its safety using approved combustion gas/oxygen detectors and recording the results. Where tests indicate an unsafe atmosphere, forced ventilation will be provided and no work will be started until safety has been assured by additional tests. An adequate continuous supply of air will be provided while work is being done.

(2) *Emergency case.* Entry may be made into a confined space with an unsafe atmosphere if required in an emergency but only if the worker is using a supplied air respirator or gas mask if there is adequate oxygen. Always use a safety lifeline and have a second worker standing by when an emergency entry is made.

(3) *Safety protection.* When working in a confined space that contains exposed energized parts, a worker must use protective shields, protective barriers, and insulating materials as necessary to avoid inadvertent contact with these parts. Doors, hinged panels, and the like should be secured to prevent contact with exposed energized parts.

c. Working in noisy areas. Protection against the effects of noise exposure should be provided for facility workers whenever the noise level exceeds the permissible limits shown in table 3-1.

(1) *Noise level equivalents.* As a rule of thumb, for a normal conversation that can be heard at about 2 feet (0.6 meters) distance, the noise level is probably less than 90 decibels, the point at which prolonged exposure can cause a gradual decay in hearing ability. Noise which is similar to the sound of firing from a rifle or shotgun is considered as an impulse type when maximum variation in sound level exceeds 1 second.

(2) *Occupational Safety and Health Administration (OSHA) requirements.* Table 3-1 provides the permissible noise exposure expressed in decibels (for sound levels) versus hours (for time duration). Exceeding these limits, OSHA requires that engineering noise controls, administrative controls, or personal hearing protective equipment be used. Only those hearing protectors that have been tested according to American National Standards Institute (ANSI) S3.19 will be acceptable. Ear insert devices will be fitted individually by a competent person. Plain cotton is not acceptable as a protective device. When the sound pressure level in a working area exceeds 115 decibels steady state, personal ear protection equivalent to the combination of earplugs and ear muffs shall be required.

(3) *Noise level measurements.* Noise level measurements should be made by qualified personnel using calibrated instruments.

(4) *Caution signs.* Hazardous noise level areas (greater than 85 decibels continuous or 140 decibels impulse) should be marked with caution signs indicating both the presence of hazardous noise levels and the need for hearing protection.

Table 3–1. OSHA Permissible Noises Exposures

Duration per Day (Hours)	Sound Level (Decibels)
8	90
6	92
4	95
3	97
2	100
1+1/2	102
1	105
1/2	110
1/4 or Less	115

Note: When the daily noise exposure is composed of two or more periods of noise exposures of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: $C_1/T_1 + C_2/T_2 + ... + C_n/T_n$ exceeds unity; then, the mixed exposure should be considered to exceed the limit value. C_n indicates that total time of exposure at a specified noise level, and T_n indicates the total time of exposure permitted at that level.

d. *Working in insufficiently illuminated areas.* Safety rules require adequate illumination for the work area. Where natural or installed artificial illumination is not sufficient temporary lighting must be provided. Ensure that temporary lighting is not

powered from the same circuit as temporary receptacles. The use of matches or open flames to provide such illumination is forbidden. OSHA requires a minimum of a 5 footcandle (or 54 lux) level in construction areas and a 10 footcandle (or 108 lux) level in electrical equipment rooms.

(1) *Spaces containing exposed energized parts.* Do not enter spaces containing exposed energized parts unless illumination is provided. Do not perform tasks near exposed energized parts where lack of illumination or an obstruction precludes observation of the work to be performed. Do not reach blindly into areas which may contain energized parts.

(2) *Temporary lighting.* All lamps for general illumination will be protected from accidental contact or breakage using approved guards. Guards are not required for flashlights. Flashlights will not have metal cases. All light metal case sockets will be grounded. Temporary lights will not be suspended by their electric cords unless cords and lights are designed for this means of suspension. Portable electric lighting used in wet or other conductive locations will be operated at 12 volts or less. However, 120-volt lights may be used if protected by a ground fault circuit interrupter. Only explosion-proof lighting equipment will be used in confined or enclosed spaces unless atmospheric tests have proven the space to be nonexplosive.

3-4. Hazardous environmental impacts

Serious bodily harm can result from contact with hazardous materials such as asbestos, polychlorinated biphenyls (PCB), and sulfur hexifluoride (SF_6). These hazardous materials can be found in old building insulation material, utility substation, old transformers, capacitors, circuit breakers, switches, and voltage regulators. They should be treated and handled Environmental Protection Agency (EPA) regulations. Wood preservative treatment products would also require special handling because of their toxicity. The following paragraphs will describe the dangers of these hazardous materials, where they are used, and how to handle them. Protective apparel and accessories are covered in paragraph 4-3. The effects of electromagnetic fields (EMF) created by high voltage electric lines will also be discussed. Requirements for protection against nuclear radiation are beyond the scope of this manual.

a. Working in asbestos areas. Asbestos had been used in years past as insulation and fire protection material. However, cutting asbestos materials will release asbestos fibers to the atmosphere. These fibers will become harmful if they are breathed into the lungs. The cells within the lungs will try to remove these fibers but will not succeed. Scar tissues will form in the lungs. Studies have shown that significant quantity of asbestos fibers in the lung can cause lung cancer. For these reasons asbestos containing products are banned from the market. However, electrical workers still have a chance to be exposed to such fibers if the existing asbestos containing products such as ceiling tiles or cement-asbestos conduits in some old buildings are accidentally cut. Therefore, before starting a job in an area where asbestos is identified, a written plan detailing compliance with Occupational Safety and Health Administration (OHSA) and the Environmental Protection Agency (EPA) asbestos abatement requirement should be developed and submitted to the Government's designated authority. No asbestos work shall be permitted without approval from the Government's authority. The disposal of asbestos containing products shall be handled by qualified personnel or contractors according to all Federal, State and local regulations.

b. Working with polychlorinated biphenyl lPCB) containing products. Because of their insulating and nonflammable properties, PCB has been used in years past as heat exchange and dielectric fluid in power transformers, capacitors, voltage regulators, and circuit breakers. Trade names for PCBs include Aroclor, Askarel, Eucarel, Pyranol, Chlorextol, Nepolin, among others. PCBs can enter the air by vaporization from a leaking container. When in air PCBs will travel by wind. PCBs will then enter the soil and water. Studies have shown that PCBs can cause serious skin diseases, liver failure, birth defects, and retardation. In 1977 the U.S. Environmental Protection Agency (EPA) banned the production of PCBs. The National Institute for Occupational Safety and Health (NIOSH) recommends that the workers not be in any workplace where the air contains more than 0.001 milligrams of PCB per cubic meter for a 8-hour workday, 40-hour workweek. Workers should be aware of all locations having PCB containing products and who to contact if there is a spill. The transportation, storage, and disposal of PCB containing products should be according to the current EPA regulations.

(1) *Handling.* PCB is a “strong solvent” and a prolonged contact will result in removing the natural skin oils. All PCB fluid shall be placed in closed containers and handled by qualified personnel.

(2) *Personal protection.* Nonabsorbent gloves (neoprene, teflon, viton, etc.), footwear, masks, and appropriate protective clothing should be worn when handling PCBs. All exposed parts of the body should be greased with either petroleum jelly (vaseline), ol-

ive oil, cold cream, or another approved skin compound. At locations where there is not sufficient ventilation, workers must, in addition, use organic vapor respirators and goggles.

(3) *Emergency case.* In case of emergency when a worker comes accidentally in contact with PCB liquid he/she should immediately wash it off with soap and water.

c. Working with sulfur hexifluoride (SF6) containers. In its pure state, SF_6 is a colorless, odorless, tasteless, nonflammable, nontoxic, and noncorrosive gas shipped in liquid form. Since it is five times heavier than air, it can act as an asphyxiant, and in a liquid state, it can cause tissue freezing similar to frost bite. Its decomposition products, which result from an electric arc or short-circuit, can be toxic. These decomposition products will recombine to form SF_6 gas or be removed by an absorber provided for that purpose within such equipment as circuit breakers and switches. SF_6 gas can leak and should always be treated as hazardous.

(1) *Handling.* Only qualified workers trained to deal with SF_6's hazardous effects can analyze, fill, and reclaim this material. Only when spills and leaks occur, should facility personnel be involved to protect the public and the workplace.

(2) *Dispersing.* No employee will work alone when dispersing SF_6. Wear approved insulating gloves, safety glasses, and appropriate protective clothing to prevent any skin contact. Remove all sources contributing to electrical arcing and heat. Provide adequate ventilation to prevent the atmosphere from becoming oxygen deficient (19.5 percent by volume of oxygen minimum). Wear a hood with an air supply line when entering an oxygen-deficient atmosphere or where an oxygen detector is not available to test air. Chemical cartridge respirators will not be used. Provide a safety line and a standby worker having another hood with an air-line as backup for the worker in the hazardous SF_6 atmosphere.

(3) *In case of fire.* Though a non-inflammable gas, SF_6 can decompose at high temperatures to yield toxic and corrosive byproducts. If a fire occurs, use an appropriate fire extinguishing agent. All fire fighters should wear correct breathing apparatus.

d. Working with wood preservative treatment products. Creosote and water-borne or oil-borne preservatives used for wood treatment can only be handled by certified pesticide applicators. Copper naphthenate preservative treatment does not require certification for its use.

e. Work around electric and magnetic fields. This section covers safety measures when working around electric and magnetic fields produced by high-voltage electric lines. A 60-hertz electric line emits an extremely low frequency (ELF) electromagnetic field (EMF) which has nonionizing rays. So far, no conclusive evidence has been proved that the EMF from ELF sources are harmful. OSHA and EPA have not concurred that “prudent avoidance” which consists of taking steps to keep humans out of such fields, is necessary.

(1) *Electric field.* Whenever there is a voltage difference between two conductive objects such as two conductors, an electric field will be developed in the space between these two conductive objects. The magnitude or strength of the electric field is proportional to the difference of voltages between the two conductive objects and inversely proportional to the distance from the object. Electric fields are measured in volts per meter (v/m). The higher the difference of voltages between two conductive objects and the shorter the distance from the object the stronger will be the electric field.

(2) *Magnetic field.* Whenever there is a current flowing through a conductor or a coil of wire wound around a piece of iron (or a permanent magnet called the “electromagnet”) , a magnetic field will be developed in the space around the conductor and between the two ends of the coil. The magnitude or strength of the magnetic field is proportional to the magnitude of the current flowing through the conductor (or the coil) and inversely proportional to the square of the distance from the conductor or the coil. Magnetic fields are measured in Gauss (G), or Tesla (T) (where one Tesla is equal to 10,000 Gausses). The larger the current flowing through the conductor or the coil and the shorter the distance from the conductor or the coil, the stronger will be the magnetic field.

(3) *Effects on human body.* Electric fields will be greatly reduced in strength by obstacles such as buildings, trees, vehicles and so on. Magnetic fields on the other hand cannot be blocked by obstacles but can be greatly reduced by the distance. Some recent studies have shown that the risks of cancer and leukemia are higher for people living near high voltage transmission lines. These health problems are suspected to be caused by the magnetic fields generated by the electric lines. However, no scientists are certain of the cause of the disease because the energy radiated by the magnetic field is very small as compared to the energy radiated by X-rays. The magnetic field energy does not have enough strength to break the bonds in the cells of human body to cause cancer or death.

(4) *Personnel protection.* The most commonly used method to protect electrical workers against electric field effects is conductive shielding. Forms of shielding include conductive clothing, gloves, insulation, and bucket liners. Another method of protection is to avoid unnecessary proximity to electric sources and reduce time of exposure to the electric fields. There is no method for magnetic field protection, except distance from the field source.

(5) *Electric and magnetic field exposure guidelines.* There are no official federal limits or guidelines on electric and magnetic fields produced by electric power lines. However, there are six states in the United States which have set some guidelines on electric and magnetic fields for electrical workers (See table 3–2).

3-5. Electric shock hazards

Electrical energy cannot be sensed by human body until contact is made. Therefore, electrical workers must always be aware of electric shock hazards. Electric shock hazards can be caused by: accidentally touching an energized line or a metal object which has different potential from ground; connecting two circuits which have phase differences, or working on an apparatus

Table 3–2. U.S. Guidelines on Electric and Magnetic Field Exposures

States	Electric Fields		Magnetic Fields		Notes
	On ROW	Edge ROW	On ROW	Edge ROW	
Florida	8kV/m	2kV/m		150mG(*)	69-230kV lines
	10kV/m			200mG(*)	231-500kV lines
				259mG(*)	500kV 2-lines
Minnesota	8kV/m				
Montana	7kV/m	1kV/m			
New Jersey		3kV/m			
New York	11.8kV/m	1.6kV/m		200mG(*)	
	11kV/m				Highway crossing
	7kV/m				road crossing
Oregon	9kV/m				

Note: ROW is the right-of-way for which a utility company acquires permanent rights that allow the utility to build, operate, and maintain its transmission lines, and the right-of-way clear of trees, obstacles, and structures for the reliability of lines and the safety of electrical workers and the public. (*) Under maximum load carrying conditions.

The International radiation Protection Association (IRPA) has also set some guidelines on electric and magnetic fields exposures for electrical workers (See table 3–3).

Table 3–3. IRPA Guidelines on Electric and Magnetic Field Exposures

Exposures	Electric Fields		Magnetic Fields	
	50Hz	60Hz	50Hz	60Hz
Occupational:				
-Whole working day	10kV/m	10kV/m	5G	5G
-short-term (*)	30kV/m	30kV/m	50G	50G
General Public				
-Whole working day	5kV/m	5kV/m	1G	1G
-Short-term (*)	10kV/m	10kV/m	10G	10G

Note: (*) For short term, electric field strength (kV /m) x hours of exposure should not exceed 80. Whole body exposure to magnetic fields up to 2 hours per day should not exceed 50G.

The American conference of government Industrial Hygienists (ACGIH) has also set some guidelines for pacemaker workers. (See table 3–4).

Table 3–4. ACGIH Guidelines on Electric and Magnetic Field Exposures for Pacemakers

Exposures	Electric Fields		Magnetic Fields	
	50Hz	60Hz	50Hz	60Hz
Occupational:	15kV/m	15V/m	10G	10G
Cardiac Pacemaker	15kV/m	15kV/m	1G	1G

Note: Protective devices such as shielded clothing, gloves, insulation bucket liners and so on, should be used where the electric field is 15kV / m or larger.

In the United Kingdom, the National Radiation Protection Board has also established some guidelines on electric and magnetic fields for electrical workers (See table 3–5).

Table 3–5. United Kingdom Guidelines on Electric and Magnetic Field Exposures

Exposures	Electric Fields		Magnetic Fields	
	50Hz	60Hz	50Hz	60Hz
Occupational:	15kV/m	15V/m	10G	10G
Cardiac Pacemaker	15kV/m	15kV/m	1G	1G

However, these guidelines are not officially approved by U.S. Government yet. It is recommended that appropriate protection measures by applied when the worker experiences discomfort in the fields.

which can have feedback currents. Prejob planning should be determined before starting work. Prejob planning includes reviewing the electrical system diagrams, inspecting the system and understanding the system's operation. All apparel, tools, and equipment needed for the job should be determined and ready for use.

a. Working near energized circuits. Electrical maintenance performed near energized circuits should be done with proper rubber blankets or other suitable guards provided as a safety measure. Safe working distance from the live apparatus or conductors should also be applied (See paragraph 3-9).

b. Potential differences. The potential differences between an energized conductor and ground, or between two energized conductors, are equally hazardous. The metal frames or enclosures of electrical components may not be at the same potential with the ground. Therefore, they should be considered as hazardous. The potential difference between conductors (including phase conductors, grounded conductors, and grounding conductors) to ground should be checked and measured. The potential difference between metal frames of electrical components to ground should also be checked and measured before starting a job.

c. Phase differences. Before connecting two or more circuits together the phases of the circuits should be checked. A short circuit will occur when two circuits having different phases are connected to each other. Only circuits of same phase can be connected. When two circuits are in-phase the voltages across the circuits will be zero. For a power system less than 600 volts a voltmeter can be used for phase testing. For a power system larger than 600 volts a hot stick and high voltage voltmeter should be used (See figs 3–1 and 3–2).

d. Feedback currents. There is always a possibility of a feedback current when working on apparatus. A feedback current can result from improper disconnection or accidental connection to a stored energy power source or electric power source. A thorough understanding of the circuitry is necessary along with proper disconnection and grounding provisions.

3-6. Electrical work

Work should be performed on de-energized electrical circuits except when continuous power is required for critical services. In all instances, electrical workers should be qualified for the work. Safety procedures should be applied and personal protective equipment should be used. Where work on an ener-

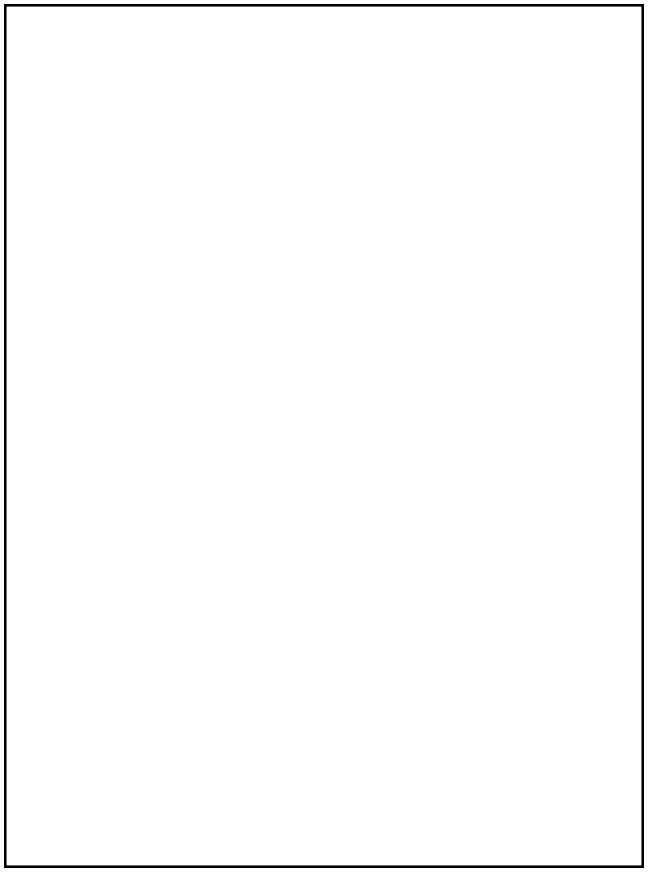

Figure 3–1. Phasing check using hot-line stick and phasing testers

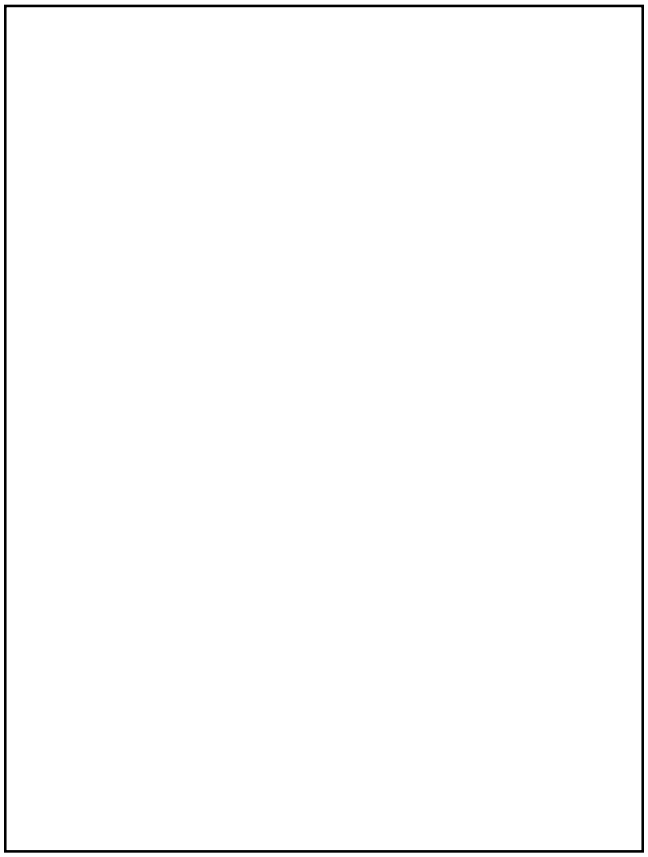

Figure 3–2. Phasing check using existing voltage transformers.

gized electrical circuit is required the worker must receive approval from his/her supervisor and the work must be performed under direct supervision of a qualified foreman.

3–7. De-energized line work

All lines are considered energized until they are completely disconnected and isolated from all electrical power sources. All stored energy sources such as power factor capacitors shall be discharged to ground through a proper grounding system before starting the job. Safety clearance should be applied. Barriers and warning signs should be used when it is necessary to prevent access of unauthorized persons to the work areas.

3–8. Safety clearance for de-energized line work

This safety clearance provides standard performances that must be applied by all electrical workers when working on de-energized lines and equipment operating above and below 600 volts.

a. Definitions of commonly used electrical terms. The most commonly used electrical terms are—

(1) *Switching.* The action of shifting, turning, or changing the existing position or direction of an electrical interrupting device such as a switch' circuit breaker or recloser to an opposite position or direction in order to connect, disconnect, or re-connect a circuit or electrical device to an electrical power system.

(2) *Blocking.* Placing a barrier to obstruct the operation of an electrical interrupting device such as a switch, circuit breaker, or recloser to prevent accidental operation.

(3) *Lockout.* The application of a locking device to the operating handle of an electrical interrupting device such as a switch, circuit breaker, or recloser to prevent the reposition of the device except when the reposition is specifically intended.

(4) *Tagging.* The action of attaching a danger tag or caution tag to an electrical interrupting device such as a switch, circuit breaker, or recloser or to an electrical rotating device such as a motor, generator, or fan or to an electrical tool such as an electric drill or screw driver.

(5) *Personnel protection ground.* A grounding system (including grounding conductors, grounding electrodes, and other grounding hardware) installed and connected into an electrical power system for the purpose of discharging electrical energy to ground to protect personnel from accidental exposure to voltage.

(6) *Clearance (danger) and caution details.* The explanation in detail of the actions or tasks associated with the application of the danger or caution tags.

(7) *Main Hold Tag.* The front side of a DA Form 7408 (Danger Tag) is designated as a "Main Hold Tag" when it is attached to a main electrical system or equipment to hold its position until the tag is removed by authorized personnel. The Main Hold Tag should not be used for any purpose other than the protection of personnel under a safety clearance.

(8) *Auxiliary Hold Tag.* The back side of a DA Form 7408 (Danger Tag) is used as an "Auxiliary Hold Tag" when it is used to disable a subsystem or equipment disconnecting devices which may affect the system or equipment covered by the Main Hold Tag.

(9) *Caution Tag.* A DA Form 5140 Caution Tag) used as a stand-alone or in conjunction with a Danger Tag. The Caution Tag is attached to a system or equipment to direct attention of electrical workers to its abnormal conditions or unusual operating characteristics.

(10) *Task.* A statement consisting of a single action verb which indicates a specific accomplishment such as "Block Switch A Open", "Lockout Switch A", or "Tag Switch A".

b. Safety clearance duties and responsibilities. The duties and responsibilities of supervisor and workers engaged in the application of a safety clearance are as follows.

(1) Supervisor duties and responsibilities. The supervisor is responsible for—

(a) Designating individual(s) authorized to receive, request, approve, issue, apply, maintain, temporary release, and terminate a safety clearance.

(b) Supervising and being responsible for the application of safety clearances.

(c) Making all necessary arrangements for interruption of electrical power service such as notifying customers and the utility company.

(d) Providing direction for the management, preparation, application, and maintenance of safety

clearance records.

(e) Conducting safety clearance training and briefing to ensure a qualified and informed work force.

(2) *Worker duties and responsibilities.* The duties and responsibilities of workers will vary depending upon duty position assignments as determined by the supervisor.

(a) Workers authorized to approve and issue safety clearances must—

1. Be technically qualified in all aspects of the electrical system and equipment operation and specifically the paths for current flow and the required positioning of the system control devices such as disconnect switches, circuit breakers, and reclosers to de-energize the system, or place other equipment into operation when it is necessary;
2. Receive requests for safety clearances;
3. Verify that the requestor is authorized to initiate a request and receive a safety clearance;
4. Review the accuracy of information entered on the Safety Clearance an or Caution Order form relative to the system or equipment involved;
5. Review the adequacy, sequence, and effectiveness of individual tasks listed on the Safety Clearance and or Caution Order form;
6. Provide guidance or correction when it is necessary;
7. Make all necessary arrangements for power interruption required for the job;
8. Notify customers and utility company when it is necessary (these arrangements must be made prior to performing any switching which may affect the customer's services and utility company's system);
9. Ensure a complete understanding of the requirements for the clearance order on the “Detail of the Clearance Procedures" including the verbal restating of the details of each individual task listed on the Safety Clearance Order to the requestor;
10. Determine and assign a Safety Clearance Order number;
11. Annotate (on the Safety Clearance Order form) the numbers of all other clearance orders which are on the related systems or equipment;
12. Fill out the DA Form 7408 (Danger Tag)
13. Issue the DA Form 5168-R (Safety Clearance Order (Electrical Facilities)) and Danger or Caution Tag to requester;
14. Issue DA Form 7407-R (Caution Order (Electrical Facilities)) and DA Form 5140 (Caution Tag) in conjunction with the Safety Clearance Order when requested;
15. Receive, review, and approve requests for temporary lift, release of temporary lift, and termination of clearance including the review of the system's or equipment's status to determine if other workers will be affected and determine the appropriate action to be taken in such a case;
16. Maintain safety clearance records including documenting clearance orders and other information relative to issuing and releasing of clearances and filing of closed-out clearance orders.

(b) Workers authorized to receive safety clearances must—

1. Meet the technical knowledge requirements specified for the individual authorized to approve and issue a clearance;
2. Be technically qualified to perform all methods necessary to accomplish the tasks required by the "Details of Clearance Procedures" on the Safety Clearance Order form;
3. Determine paths of current flow and potential feed back circuit(s) relative to the system or equipment involved;
4. Determine tasks or actions required to achieve a clearance including a sequence of tasks that will be performed to precede a clearance;
5. Prepare and submit the Safety Clearance and or Caution Order form;
6. Apply safety clearance procedures ensuring that all tasks are performed in the order and sequence as approved and listed on the Safety Clearance and or Caution Order form, annotating the time when each task is completed;
7. Conduct a safety briefing for subordinates and coworkers to ensure that they understand clearly the applied clearance requirements including familiarizing subordinates and coworkers with the positioning of all danger tags (main and auxiliary), caution tags, and personnel safety grounds;
8. Determine the requirements for temporary lift of clearances and request temporary lift of clearances including coordination and briefing other persons or crews that may have been working on the equipment or system;
9. Request authorization to release temporary lift and reapply the original clearance order including coordination and briefing other persons or crews that may have been working on the equipment or system;
10. Request authorization to release and perform the release of safety clearances including performing the tasks of unlocking, blocking, tagging, repositioning of switches, and removal of personnel safety grounds as specified in the details of safety clearance procedures;
11. Prepare turn-in and close-out danger tags to the issuing authority.

(c) Workers who receive approved (Clearance Orders must—

1. Apply the safety clearance order by implementing the tasks specified in the "Details of Clearance Procedures";
2. Perform the tasks in the order and sequence as listed;
3. Fill out the "Time Applied" for each task upon completion;
4. Ensure that the related power system or equipment is isolated from all power sources and stored energy sources and that the methods of blocking and locking are properly applied;
5. Apply Danger Tags issued in conjunction with the Safety Clearance Order;
6. Sign the "Placed By" column on both Main and Auxiliary Tags.

Note: Danger Tags must be applied at the time where the switching task is performed for the specific disconnect device identified in "Details of Clearance Procedures." All previous tags attached to the device must be removed (by a temporary lift order), except where other inherent problems preclude the removal of the tag.

7. Conduct a safety briefing, as necessary, to inform subordinates and coworkers on safety issues and concerns related to the applied clearance.

(d) Workers authorized to request Temporary Lift/ Close-Out of Clearances. Worker who receives an approved safety clearance order can request from the issuing authority a temporary lift or close-out of clearance. When this individual is not available, the supervisor can perform the request or designate a person to perform this function. The request must be approved prior to performing any task of unlocking, blocking, tagging, repositioning of switches or removal of personnel protective grounds. When a caution order is in effect as a requirement of the clearance order the following additional procedures must be performed:

1. Request temporary lift or close-out of the caution simultaneously with the request to temporary lift or close-out of the clearance;
2. Request and apply a new caution order for the system or equipment involved. The "Details of Caution Procedures" for the new caution order should be specified in accordance with the original Caution Order.

(e) Workers authorized to approve Temporary Lift/Close-Out of Clearances. Workers issuing safety clearance orders have authorization to receive and approve requests for temporary lift or close-out of clearances. However, they must review the system or equipment status to determine if other workers will be effected by release of the clearance and-determine the appropriate action to be taken in such a case. The worker must make all necessary arrangements for restoration of service such as notifying the customers and utility company. These arrangements must be made prior to performing any switching which may affect the customers' service or utility company's system. They must approve and record the temporary lift/close-out of clearance.

WARNING:

Clearance should not be released when removal of the clearance will leave other workers unprotected. In such cases, a new clearance order must be issued, as necessary, to protect the other workers. The new clearance order must be applied before the old clearance can be released.

(f) Workers who receive approval of Temporary Lift/ Closed-Out Orders must—

1. Perform the tasks of unlocking, blocking, tagging, repositioning of switches, and removal of personnel protective grounds;
2. Perform these tasks in the reverse sequence as listed on the Clearance Order form;
3. Enter the "Time Removed Column" as each task is completed.

Note: The task action to be performed during the release of a clearance is the opposite action as stated for applying the clearance. For instance, if a task of the clearance procedure reads "Open Switch A" the opposite operation is "Close Switch A".

4. Remove all clearance tags;
5. Submit the closed-out clearance order with all associated clearance tags to the issuing authority.

(g) Workers who receive Turned-In Clearance Orders and Tags must complete the termination of clearance by entering the "Released By" and "Accepted By" blocks and the time and date the closed-out clearance order and tags from the "active" file to the "inactive" file.

c. Safety clearance forms. There are four safety clearance forms: Safety Clearance Order, DA Form 5168R (fig. 3–3), Caution Order, DA Form 7408 (fig. 3–5), and Caution Tag, DA Form 5140 (fig. 3–6).

The preparation and application of the forms will depend on each job.

(1) *DA Form 5168-R (Safety Clearance Order (Electrical Facilities).* The Safety Clearance Order form is used for requesting and issuing a clearance for electrical work. It contains all data necessary for applying and releasing a clearance or a temporary lift of clearance. The Safety Clearance Order form

Figure 3–3. Sample of a completed DA Form 5168-R, Safety Clearance Order (Electrical Facilities).

Figure 3–4. Sample of a completed DA Form 7407-R, Caution Order (Electrical Facilities).

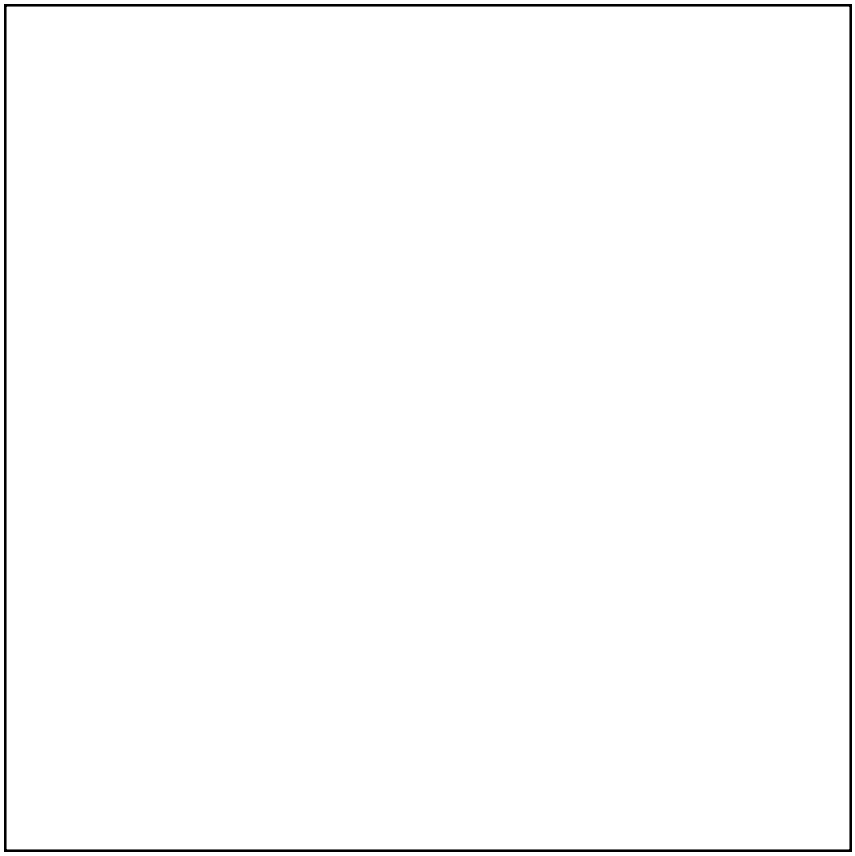

Figure 3–5. Sample of a completed DA Form 7408, Danger Tag.

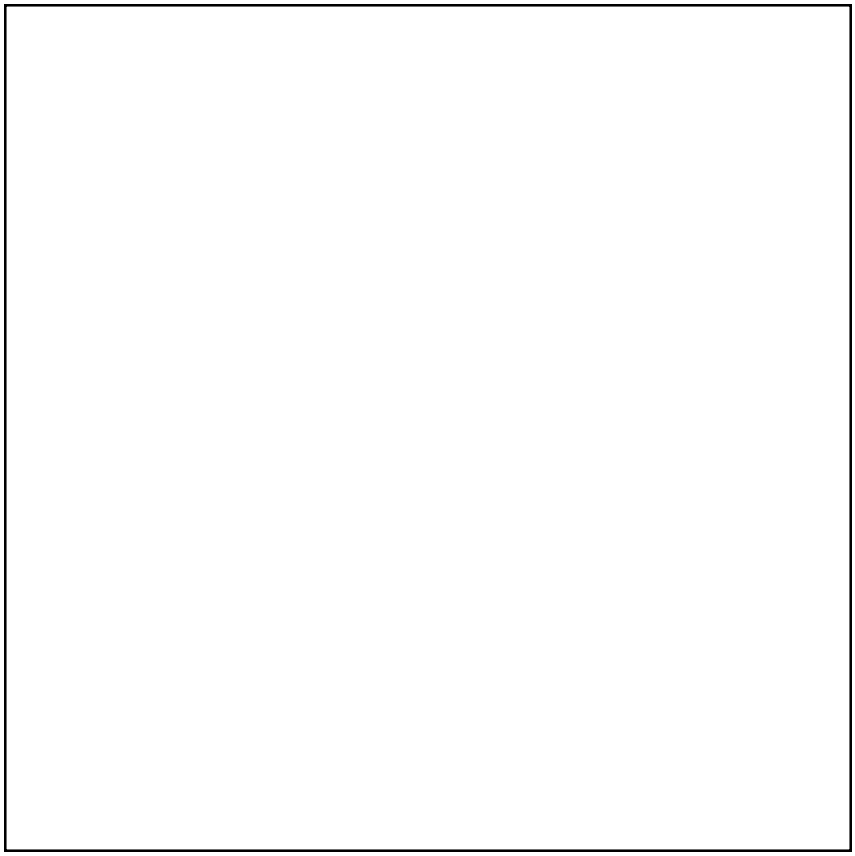

Figure 3–6. Sample of a completed DA Form 5140, Caution Tag.

must be used for all electrical works performed on de-energized lines and equipment operating above 600 volts. DA Form 5168-should be prepared by the worker who is authorized to receive and apply a safety clearance. The safety clearance order form should be typed or hand-written in "black" or “blue” ink pen or ballpoint pen and filled out as shown in figure 3–3. DA Form 5168-R will be reproduced on 8 1/2 - by 11-inch paper. A copy for reproduction purposes is located at the back of this manual. The preparation of the Safety Clearance Order form follows—

(a) Block 1, Order Number. The Order number will consist of two sets of numbers separated by a hyphen. The first set will consist of two digits representing the current year. The second set will consist of four digits beginning with the number "0001". For example: 99-0001.

(b) Block 2, Other Number. If there are other clearances and or cautions which are in effect on the system or equipment for which the clearance is being requested, the individual who issues the safety clearance will enter the order numbers of these clearances/cautions in block 2.

(c) Block 3, Station/Installation. The name of the station/substation or facility where the system or equipment is physically located will be entered in block 3 by the individual who requests the clearance.

(d) Block 4, Line or Equipment Involved. The description of the line or equipment on which the work is to be performed will be entered in block 4 by the individual who request the clearance.

(e) Block 5, Time Applied. The individual who applies the clearance order will enter the time when each task is completed. The 24-hour system will be used. Military (hhmm) or civilian time (hh:mm) may be used on all forms. For example: 1500 or 15:00.

(f) Block 6, Details of Clearance Procedure. The details of the tasks needed to complete the clearance will be described in block 6. The tasks must be numbered in the order that they will be implemented. In the example substation #3 is shut down and repairs made. Clearance is temporarily lifted midway to test for operation. After the test, unit is shut down again and times recorded in the right hand column.

(g) Block 7, Time Removed. The individual who performs a clearance removal will enter the time when each task is completed. The procedures to remove a clearance will be in reverse order to that used for applying a clearance. The task action used for removing an order will be the Opposite action to that used for installing an order. For instance, if the task action used to install a clearance order is “Open switch A", the task action used to remove a clearance order is "Close Switch A".

(h) Block 8a, Issued To. The name of the person who is authorized to receive and implement the safety clearance will be entered in block 8a by the issuing authority.

(i) Block 8b, Issued By. The name of the person who issues the safety clearance must be entered in block 8b. In cases where the individual issuing and receiving the clearance is the same person the person's name will be entered in both the “Issued to" and "Issued by" blocks.

(j) Block 8c, Timed Issued. The time when the safety clearance is issued will be entered in block 8c by the person who issues the clearance.

(k) Block 8d, Date Issued. The date, month, and year when the clearance is issued must be entered in this block. Numerical or alphanumerical forms may be used on all forms. For example: 24-12-1999 or 24 Dec 1999.

(l) Block 9a, Released By. The name of the person who releases the clearance must be entered in block 9a.

(m) Block 9b, Accepted By. The name of the person who accepts the released clearance must be entered in block 9b. In cases where the individual accepting release and releasing the clearance is the Same person the person’s name will be entered in both the “Released By" and "Accepted By" blocks.

(n) Block 9c, Time Released. The time when the clearance is released will be entered in block 9c by the person who accepts the released clearance.

(o) Block 9d, Date Released. The date, month, and year when the clearance is released will be entered in block 9d by the person who accepts the released clearance.

(2) *Safety clearance order logbook.* All information relative to issuing and releasing clearance orders must be recorded in a logbook. This logbook will also document information on accidents that occur during a given clearance.

(3) *Safety clearance order record file.* Separate files are required for active (still in effect) and inactive (released) safety clearance orders. Inactive files should be maintained within the organization's record keeping system according to AR 25-400-2.

(4) *Special cases.* Three special cases exist.

(a) Operation of the system or equipment during a clearance is not authorized while the clearance is in effect. However, when it is necessary for the system or equipment or parts thereof to be operated for purposes of operational or after-maintenance, testing, a temporary lift of the clearance could be applied. There are no restrictions on the total number of temporary lifts that can be issued relative to a given safety clearance order. However, only one temporary lift will be in effect for a given clearance at a time. In addition, if the system or equipment has multiple safety clearances applied, a temporary lift is required for all the clearances in effect. The issuing authority must coordinate all parties involved to ensure safety of all personnel.

(b) Temporary lifts of clearance. When more than one temporary lift of clearance is needed for the job each temporary lift should be annotated alphabetically. The first temporary lift of clearance should be given the letter "A". The next temporary lift of clearance should be given the next letter "B", and so on. The detailed description for each task performed during a temporary lift of clearance should be listed and numbered. The number assigned for each task performed during a lift of clearance will be based on the number given to a related task listed on the original order but is annotated with the alphabetical letter of the temporary lift of clearance as illustrated in figure 3–3. The time when a task is applied and removed during a lift of clearance should be entered by the individual who applied for the lift of clearance.

(c) At an attended substation, the operations of the system or equipment during a lift of clearance should be carried out by the operator on duty.

(5) *DA Form 7407-R, (Caution Order (Electrical Facilities)).* This form is used to direct electrical workers' attention to abnormal, hazardous, and unusual conditions of an electrical system or device. The caution order differs from the safety clearance order in that the system equipment may be operated while the caution is in effect. The Caution Order is normally used in conjunction with a clearance to address the conditions of the system or equipment which are not mentioned in the clearance order. However, the caution cannot be used in lieu of a clearance. DA Form 7407-R will be reproduced on 8 1/2-by 11-inch paper. A copy for reproduction purposes is located at the back of this manual. The preparation of the Caution Order form follows—

(a) *Block 1, Order Number.* The Order number will consist of a letter X followed by two sets of numbers. The first set of numbers will consist of two digits representing the current year. The second set of numbers will consist of four digits beginning with the number "0001". For example: X94-0001.

(b) Block 2, Other Number. If there are other clearances or cautions which are in effect on the system or equipment for which the caution order is being requested, the individual who issued the caution order will enter the order numbers of these clearances or cautions in block 2.

(c) Block 3, Station/Installation. The name of the station, substation, or facility where the system or equipment is physically located will be entered in block 3 by the individual who requests the caution.

(d) Block 4, Line or Equipment involved. The description of the line or equipment to which the caution will be applied, will be entered in block 4 by the individual who requests the caution.

(e) Block 5, Time Applied. The time when a task (listed in the Details of Caution Procedures) is applied and completed will be entered in this block by the individual who performed the task. The 24-hour system will be used.

(f) Block 6, Details of Caution Procedures. The details of caution procedures will depend upon the intent of the caution. For a caution order which involves only switching, tagging, or blocking, the detail of tasks that need to be performed to complete the caution should be described in block 6. For a caution order which stipulates the operation of an electrical device or equipment, the operating instructions must be entered. Where the instructions have an assigned number this number could be entered. The details of the procedures must be numbered in the sequential order that they will be implemented.

(g) Block 7, Time Removed. The procedures to remove a caution order will be performed in the reverse order to that used for applying the caution order. The task action used to remove an order will be the opposite to that used for installing an order. For instance, if the task action used to install a caution order is “Open switch A” the task action used to remove an order is “Close Switch A”. The time when

a task (to remove an order) is completed will be entered in block 7 by the individual who performed the task.

(h) Block 8a, Issued To. The name of the individual who is authorized to receive and apply a caution order will be entered in block 8a by the issuing authority.

(i) Block 8c, time Issued. The name of the individual who issues a caution order must be entered in block 8b. In cases where the individual issuing and receiving the caution order is the same person the person's name will be entered in both the "Issued To" and "Issued By" blocks.

(j) Block 8c, Time Issued. The time at which a caution order is issued will be entered in block 8c by the person who issues the order.

(k) Block 8d, Date Issued. The date, month, and year when a caution order is issued must be entered in this block. Both numerical and alphanumerical forms could be used.

(l) Block 9a, Released By. The name of the person who releases the caution order must be entered in block 9a.

(m) Block 9b, Accepted By. The name of the person who accepts the released caution order must be entered in this block.

(n) Block 9c, Time Released. The time at which a caution order is released will be entered in block 9c by the individual who accepts the released caution order.

(o) Block 9d, Date Released. The date, month, and year where the caution order is released will be entered in block 9d by the person who accepts the released caution order.

(6) *Caution order logbook.* All information relative to issuing and releasing caution orders must be recorded on a logbook. This logbook will also document all operations of the system or equipment while the caution is still in effect.

(7) *Caution order record file.* Separate files are required for active (still in effect) and inactive (released) caution orders. Inactive files should be maintained within the organization's record keeping system according to AR 25-400-2.

(8) *Special applications.* Caution orders remaining in effect for an extended period must be reviewed annually at a minimum to determine if the requirement still exists. Results of the review must be communicated to all elements of the operation. Caution orders issued for abnormal/unusual conditions of an electrical system or equipment which cannot be corrected will become a part of the equipment's permanent record and may remain indefinitely. Caution orders issued for abnormal/unusual condition of mobile equipment must be transferred from the losing issuing authority to the gaining issuing authority when the equipment is transferred between authorities. In this case a duplicate of the order is prepared and forwarded to the gaining, issuing authority and the caution tag is left attached to the applicable device.

(9) *DA Form 7408 (Danger Tag) (fig. 3–5).* Danger Tags must be used in conjunction with the DA Form 5168-R (Safety Clearance Order), and must be applied with each safety clearance issued. The tag must never be used for any purpose other than the protection of personnel working under a safety clearance order. A tag is applied to systems and equipment to ensure that a device's position will not be changed by unauthorized persons as long as the system or equipment has an active safety clearance in effect. The tag can only be removed by the individual who installs the tag or an authorized person designated by his/her supervisor.

(a) Main Hold Tag. The front side of the Danger Tag is designated as the "Main Hold Tag". The Main Hold Tag is used to attach to a primary disconnecting device of a circuit to ensure that the position of the device will not be changed by unauthorized persons as long as the tag is attached. A Main Hold Tag will be applied for each safety clearance issued and remain attached for as long as the safety clearance order is in effect.

(b) Preparation of Main Hold Tag. The Main Hold Tag will be prepared by the individual who issues the tag. It will contain data consistent with that listed on the associated Safety Clearance Order, such as substation name, clearance order number, line or equipment involved, issuing authority, applying authority, date and time applied. Where an Auxiliary Hold Tag is used in conjunction with a Main Hold Tag, the location (or placement) of the Auxiliary Hold Tag will be listed on the Main Hold Tag. The name of the worker who installs the Auxiliary Hold Tag will also be entered. The name of the station/substation or facility where the system or equipment is physically located will be entered in this block by the individual who requests the clearance. The clearance number must be entered in this block by the individual who issues the Danger Main

Hold Tag, as given on the Safety Clearance Order form. The tag number will be one (1) when the tag is used as the Main Hold Tag. The tag number will be entered by the individual who issues the tag. The description of the line or equipment on which the work is to be performed will be entered in the "Clearance On" block by the individual who issues the Danger Main Hold Tag. The name of the individual who receives the Danger Tag will be entered in the "Issued To" block by the issuing authority. The name of the individual who issues the Danger/Main Hold Tag must be entered in the "Issued By" block. In cases where the individual issuing and receiving the Danger/Main Hold Tag is the same person, the person's name will be entered in both the "Issued To" and "Issued By" blocks. The date, month, and year when the Main Hold Tag is installed must be entered in the "Date" block by the individual who installs the tag. Both numerical and alphanumerical forms could be used. For example: 24-12-1999 or 24 Dec 1999. The time when the Main Hold Tag is installed will be entered in the "Time" block by the individual who installs the card. The 24-hour system will be used. Both military form (hhmm) and civilian form (hh:mm) could be used. For example: 1500 or 15:00. The name of the individual who installs the Auxiliary Hold Tag will be entered in the "Placed By" (Auxiliary Tag Placement Section) block by the individual who received the tag. The location where the Auxiliary Hold Tag is to be placed, as specified in the Safety Clearance Order, will be entered in the "Location" (Auxiliary Tag Placement Section) block by the issuing authority. The name of the individual who removes the Auxiliary Hold Tag will be entered in the "Removed By" (Auxiliary Tag Placement Section) block by the individual who receives the tag.

(c) Auxiliary Hold Tag. The back side of the Danger Tag is designated as the "Auxiliary Hold Tag". The Auxiliary Hold Tag is used to attach to subsystem disconnecting devices to disable subsystem circuits which may affect the system or equipment that is being worked on.

(d) Preparation of Auxiliary Hold Tag. The Auxiliary Hold Tag will be prepared by the individual who issues the tag. It will contain data consistent with that listed on the Main Hold Tag such as clearance order number, line/equipment involved, issuing authority and so on. The clearance number must be entered by the individual who issues the tag. This number was given on the Safety Clearance Order form. The tag number entered must match with the assigned number listed on the "Tag Number" column of the Main Hold Tag, where the location of the Auxiliary Hold Tag matches with the location described on the Main Hold Tag. The same number will also be entered on the "Tag No" block on the other side of the tag. No other information is necessary on the other side of the tag when the tag is used as an Auxiliary Hold Tag. The name of the individual who installs the Auxiliary Hold Tag will be entered in the "Placed By" block by the individual who receives the tag. This name should also be entered on the Main Hold Tag. The times when the Auxiliary Hold Tag is installed will be entered by the individual who places the tag. The name of the individual who receives the Auxiliary Hold Tag will be entered in the "Issued To" block by the issuing authority. The location where the Main Hold Tag is installed should be filled in by the issuing authority. The description of the line or equipment held by the Auxiliary Hold Tag must be filled in by the issuing authority. The location where the ground rod is installed for this clearance should be entered by the issuing authority. This ground location must be filled in conjunction with the Main Hold Tag.

(e) Danger Tag Holder. The Danger Tag must be placed inside a tag holder to prevent damage caused by weather or destructive operation of the electrical equipment or devices. Tag holders must be of a nonconductive, see-through (that is clear plastic) material designed for installation with a switch stick.

(f) Special applications are as follows: Gang-operated switches must be locked open and an appropriate number of danger tags (one for each safety clearance) must be applied to the lock. Likewise, a turbine throttle valve must be locked in the closed position and tagged. For overhead lines, a visible line-break must be provided at all points of possible feed. An open oil circuit breaker is not acceptable. When an oil circuit breaker must be used, the line-side leads must be removed from the breaker bushings and the breaker must be mechanically blocked open, locked-out, and tagged. In addition, a voltage test will be used to determine that the lines are de-energized. Protective grounds will be installed on the lines as close as possible to the oil circuit breaker.

WARNING:

Perform the voltage test to verify that the circuit is de-energized before installing protective ground or serious injury may occur. For underground systems, a visible line-brake must be provided when feasible. When an oil circuit breaker or oil-disconnect switch must be used, the same requirements as specified for overhead lines must be met. Oil fuse cutouts must be blocked and locked in the open position. The fuse block must be removed and the clamp must be danger tagged.

(10) *DA Form 5140 (Caution Tag). (Fig. 3–6).* Caution Tags are normally used to attach to an electrical system or equipment to direct attention of electrical workers to the abnormal, hazardous, and unusual operating conditions of the system or equipment or device. The caution differs from the clearance in that the system or equipment may be operated while the caution is in effect. The caution cannot be used in lieu of a clearance.

(a) Preparation of Caution Tag. The front side of the tag should be prepared by the individual who issues the tag. The back side of the tag should be signed by the individual who operates the equipment. On side A the Caution Order number must be entered in this block by the individual who issues the tag. This number is given on the Caution Order form. The name of the station, substation, or facility at which the effected equipment or electrical device is physically located will be entered by the issuing authority. The description of the line or equipment to which the caution tag will be attached will be entered by the issuing authority. The abnormal conditions and unusual operating characteristics of the system or equipment must be entered in this block by the issuing authority. Special instructions needed to operate an electrical system or run equipment or a device should be entered in this block by the individual who issues the tag. The time in minutes needed to wait before closing or reclosing a circuit or operate electrical equipment should be entered by the issuing authority. The name of the individual who requests the caution order will be entered by the issuing authority. The name of the individual who approves the caution order will be entered by the issuing authority. The name of the individual who installs the tag will be entered in the "Placed By" block by the individual who receives the tag. The name of the individual who releases the tag will be entered by the individual who receives the released tag. The name of the individual who authorizes the release of the tag will be entered in the "Ordered Off By" block. Normally, the issuing authority approves the release of the tag. The name of the individual who removes the tag will be entered by the issuing authority. On side B, the name of the individual who operates the system or equipment while the caution tag is still in effect must enter his/her name. The time when the system or equipment is operated while the caution is still in effect will be entered by the operator. The date, month, and year when the system or equipment is operated while the caution is still in effect will be entered by the operator.

(b) Caution Tag Holder. The Caution Tag must be placed inside a tag holder to prevent damage caused by weather or destructive operation of the electrical equipment or device. Tag holders must be of a nonconductive, see through (that is, clear plastic) material designed for installation with a switch stick.

(c) Special applications. Caution Tags which remain in effect for an extended period, must be inspected monthly as a minimum to determine that the tags are physically attached, and protected from inclement weather.

d. Safety Clearance/Caution Order processing. The Safety Clearance/Caution Order processing is as follows:

(1) The individual authorized to receive a Safety Clearance/Caution Order must prepare the Safety Clearance Order, DA Form 5168-R, and or the Caution Order, DA Form 7407, and submit the requested order(s) to the individual who has authority to issue the order(s). The requester must provide a detailed description of all tasks which are required for the system or equipment isolation and personnel protection.

(2) The individual authorized to issue a Safety Clearance/Caution Order will—

(a) Receive the request for Safety Clearance/Caution Order.

(b) Review the system or equipment status to determine if other workers will be affected by the requested/Clearance/Caution Order, and determine the appropriate action to take in such a case.

(c) Make all necessary arrangements for scheduled outages, such as notifying the customers and utility company, if necessary.

(d) Issue the Safety Clearance/Caution Orders and Danger/Caution Tags necessary for the job.

(e) Record and follow up the all clearances in effect.

(3) The individual who received the approved Safety Clearance/Caution Order, has authorization to request a temporary lift of clearance. He/she must prepare and submit to the issuing authority a supplemental Safety Clearance Order, DA Form 5168-R.

(4) The individual who receives the request for temporary lift of clearance will review the system or equipment status to determine if other workers will be affected by the lift of clearance and determine the appropriate action to take in such a case.

(5) The individual who received the approved temporary lift must perform all tasks as outlined in the supplemental Safety Clearance Order form.

(6) The issuing authority will have authorization to approve the release of temporary lift and Safety Clearance or Caution Order. No release of safety clearance/caution can be performed before the release was approved.

(7) The individual authorized to release a Safety Clearance/Caution must complete all tasks listed on the approved order, but in reverse order and opposite sequence from that in which the tasks are applied. For instance, if a task reads "Open Switch A" when a clearance is applied, the opposite operation is "Close Switch A".

3-9. General rules for de-energized line work

The following rules should be applied for all de-energized line work.

a. Low voltage de-energized line work (600 Volts and below). All de-energized lines/equipment/apparatus to be worked on should be securely grounded to a common grounding electrode. An equipotential voltage between the line/equipment/apparatus to be worked on and the platform on which the worker stands must be checked before starting work. An approved voltmeter, scope meter, or voltage detector must be used for this test. All automatic devices such as automatic transfer switches should be physically turned off or disconnected if it is possible. All stored energy sources such as power factor capacitors should be properly drained to ground. The grounding conductor used to drain the stored energy should be retained until the work is completed. In cases where the lines/equipment/apparatus should not be grounded the foreman must explain to his/her crew the reasons for not grounding. All other energized lines, equipment, or apparatus which are not connected to the system to be worked on, but are within the reaches of electrical worker, should be covered with insulated protective equipment. Always treat bare wires such as ground wires of uninterruptible power systems or communication systems, as energized lines.

b. Medium and high voltage de-energized line work (above 600 volts). The following rules must be applied before starting any line work:

(1) Clearly understand the instructions and work requirements.

(2) Prepare all necessary tools and equipment.

(3) Prepare safety procedures.

(4) Apply personal protective equipment.

(5) Perform a safety clearance for lines/equipment/apparatus to be worked on.
Note: When installing a temporary ground for a line, equipment, or apparatus the connection to ground must be made first. Before making a connection to an electric line/equipment/apparatus, test for static discharge with a switch stick as an added precaution. When removing a temporary ground, disconnect the ground connection last.

(6) Cover all other energized lines/equipment within reach with insulated equipment such as rubber line hose, insulator hoods, or rubber blankets.

(7) Discharge all surge arresters and stored energy devices, if existing.

(8) Guard the working area with suitable barriers and warning signs from access by unauthorized persons.

(9) Before starting work, check the equipotential voltage between the line/equipment/apparatus to be worked on and the platform where the worker will stand.

(10) Before cutting a cable, be sure that the cable has been correctly identified by your foreman by checking the duct and cable location against that shown on working print or by cable identification tags. The working print must also be checked against the facility engineer's map records. Cables can also be identified with the aid of an exploring coil by listening for a pulsating beat imposed on the cables by sending an interrupter signal.

(11) After the cable has been identified and grounded, remove a three inch strip of covering around cable and test with a voltage detector at two or more points near the center of the exposed insulation. Repeat the test with another voltage detector if it is available. Alternatively, a spiker can be used, as described in paragraph 7–5.

(12) When cutting cable, place a hacksaw on the exposed cable insulation adjacent to and touching the grounded metallic shield or sheath or the temporary ground on the shield or sheath before cutting.

(13) Do not approach or touch reactors and connected equipment unless it has been proven that they are de-energized and grounded.

(14) When the worker changes position he/she must check all energized lines within his/her reach again and re-cover them with insulated equipment when it is necessary before starting the new work.

3–10. Permanent and temporary ground

A permanent ground is installed for safe operation of electrical power systems and devices. A temporary ground is used for electrical worker's safety when engaged in electrical services.

a. Purpose of grounding. The purpose of a grounding is to limit the potential differences resulting from fault conditions to values that are safe when touched by a human body. This assures that a person in the vicinity of working area is not exposed to the danger of critical electric shocks.

b. Definition of grounding terms.

(1) *Ground:* A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth or to some conducting body that serves in place of the earth.

(2) *Grounded:* Connected to earth or to some conducting body that serves in place of the earth.

(3) *Effectively grounded:* 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 that may result in undue hazards to connected equipment or to persons.

(4) *Grounded conductor:* A system or circuit conductor that is intentionally grounded.

(5) *Grounding conductor:* A conductor used to connect equipment or the grounded circuit of a wiring system to a grounding electrode or electrodes.

(6) *Equipment grounding conductor:* The conductor used to connect the noncurrent-carrying metal parts of equipment, raceways, and other enclosures to the system grounded conductor, the grounding electrode conductor, or both at the service equipment or at the source of a separately derived system.

(7) *Grounding electrode conductor:* The conductor used to connect the grounding electrode to the equipment grounding conductor, to the grounded conductor, or to both of the circuits at the service equipment or at the source of a separately derived system.

(8) *Ground-fault circuit-interrupter:* A device intended for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a current to ground exceeds some predetermined value that is less than that required to operate the overcurrent protective device of the supply circuit.

(9) *Ground-fault protection of equipment:* A system intended to provide protection of equipment from damaging line-to-ground fault currents by operating to cause a disconnecting means to open all ungrounded conductors of the faulted circuit. This protection is provided at current levels less than those required to protect conductors from damage through the operation of a supply circuit overcurrent device.

(10) *Reference ground.* A conducting body such as the earth and the metal frame of a building to which an electric potential is referenced.

c. Types of grounding. Five types of grounding will be described in the section: power system grounding, equipment grounding, electrostatic grounding, lightning protection grounding, and temporary grounding.

(1) *Power system grounding.* Power system grounding has three main functions:

(a) Stabilize the system voltage to ground.

(b) Limit the overvoltages produced by lightning stokes, line surges, or unintentional contact with higher voltage lines.

(c) Facilitate the operation of overcurrent protective devices such as fuses, circuit breakers, reclosers, and relays under ground-fault conditions.

(2) *Equipment grounding.* The main function of equipment grounding is to provide a low impedance path for fault currents to flow back to the source to activate the operation of overcurrent protective devices under ground-fault conditions.

(3) *Electrostatic grounding.* The generation of static electricity is not a hazard in itself. However, the hazard arises when an accumulated static electric charge is subsequently discharged as a spark. Occupancies where flammable or explosive liquids, gases, dusts, or fibers are present need an electrostatic grounding to reduce sparking.

(4) *Lightning protection grounding.* The estimated energy dissipated by a direct lightning stroke is approximately 300,000,000 Joules or equivalent

to l0,000,000,000 kWatts or 66 kG of TNT. The National Electrical Code (NEC) requires a separate grounding system be used for lightning protection. Power system grounding cannot be used as lightning protection grounding.

(5) *Temporary grounding.* Temporary grounding is used for personal safety. A de-energized line located adjacent to an energized line is always subject to both capacitive and magnetic coupling from the live line which can induce voltage in the de-energized lines. In addition, accidental energizing of the lines, accumulation of static charges on the line, improper drain of power capacitors, or surge arresters are other hazards for electrical workers. Temporary grounding shall be applied to all lines, equipment, or apparatus to be worked on and remain until the work is completed.

(a) Installation. Before installing a temporary ground, the line/equipment/device must be tested for differential voltage. Proper clearance distance and hot-line tools must be applied even when the line/equipment/device is de-energized. Temporary grounding shall be installed at both ends of the line/equipment/apparatus to be worked on when it is necessary. All conducting objects such as static lines, transformer tanks, and platforms where the electrical workers stand shall be connected together to ground to prevent dangerous touch and step voltage.

(b) Grounding conductors. Temporary grounding conductors shall be of copper, rubber insulated, and flexible type. Aluminum grounding conductor is not permitted. Since the resistance of a conductor is proportional to its length, temporary grounding conductors shall be kept as short as possible. In general, grounding conductor length should be limited to 30 feet. Sharp bending of grounding conductors should be avoided. The size of grounding conductors will depend on the maximum fault currents available at the service location. Table 3-6 provides recommended sizes for grounding conductors. Where two or more grounding conductors are used the maximum fault currents listed in this table can be derated by a factor of 0.9. Temporary grounding conductors should have the same length if they are connected at both ends of a line, piece of equipment, or apparatus.

(c) Grounding electrodes. The temporary grounding electrode should be driven at least 6 feet into ground. Where a permanent grounding electrode exists, it can be used instead of a temporary grounding electrode. However, the permanent grounding electrode should be checked for good condition before use.

Table 3–6. Recommended Grounding Cable Sizes

Cable Sizes in Copper (AWG)	Fault time (cycles)	Maximum Fault Currents in Amperes
2/0	15 30	27,000 or less 20,000
3/0	15 30	36,000 25,000
4/0	15 30	43,000 30,000

d. What needs to be grounded. All metal electrical component enclosures, maintenance vehicles, equipment, or devices located within or near working areas shall be properly grounded to a common grounding point.

(1) *Electrical component enclosures.* All metal enclosures for electrical components such as transformers, circuit breakers, switches, switchgear, and reclosers located within or near working areas must be properly grounded to a common grounding electrode (either temporary or permanent), through approved grounding conductors.

(2) *De-energized electrical components.* All de-energized electrical components such as overhead lines, power transformers, and capacitors shall be properly grounded to a common grounding electrode (either temporary or permanent), through approved grounding conductors. The grounding conductors shall remain until the electrical work is completed.

(3) *Aerial electrical grounding components.* All aerial electrical grounding components such as lightning arrester grounding wires, metal pole, pole-mounted transformers grounding wires, and static wires located near or within working areas must be properly grounded to a common grounding electrode (either temporary or permanent) through approved grounding conductors.

(4) *Maintenance vehicles.* When maintenance vehicles such as a utility trucks or boom trucks are parked within minimum approach distances listed in table 3-8. The vehicles' chassis must also be properly grounded to the common grounding electrode (either temporary or permanent) for the service area through an approved grounding conductor.

(5) *Platform or boom where the worker stands should be bonded to the lines/equipment/devices to be worked on.* An equipotential between the platform or boom where the worker stands and the line/equipment/device to be worked on must be checked by an approved instrument before starting work. All

electrical conducting material within reach of worker must be covered with approved protective equipment such as rubber blankets. Proper personal protective equipment such as rubber gloves and hard hats must be worn and proper tools should be used.

(6) Other equipment such as diggers and cranes should be bonded, if practicable, to the common grounding electrode (either permanent or temporary).

3–11. General rules on electrical grounding

The following rules should be applied for the grounding of de-energized circuits:

a. All lines/equipment/apparatus regardless of voltage, should be considered as energized unless short-circuited and grounded with approved grounding devices.

b. The temporary grounding conductor should be checked for proper size, good condition, and continuity before each use. When installing a temporary grounding conductor the connection to ground should be made before the connection to a de-energized line, device, or apparatus. A proper hot stick should be used when connecting a temporary grounding conductor to a deenergized line, piece of equipment or apparatus. When removing a temporary grounding conductor, the connection to a de-energized line/equipment/apparatus should be removed first. The temporary grounding conductor should remain until the job is completed and all energized lines or pieces of equipment have been cleared.

c. Where ground switches are installed they must be approved for use as a ground switch. Safety clearance should be applied when the normal operating position of a ground switch is changed.

d. When it is necessary to ground lines above energized circuits the following preliminary precautions must be taken according to the voltages of the energized circuits below the lines to be grounded:

(1) Circuits carrying voltages up to 15,000 volts must be covered with proper protective equipment.

(2) Circuits carrying voltages larger than 15,000 volts must be de-energized.

e. When work is to be done on single-feed lines the temporary ground should be installed between the work and the source of power. In no case should the work be done farther than one mile from the temporary ground.

f. When work is to be done on double-feed lines a temporary ground should be installed on each side of the work. The distance between these two temporary grounds should not exceed 2 miles.

g. When work is to be done on energized lines equipped with pole gaps in the ground wire, bridge such gaps with ground clamps or suitable gap bridging devices before climbing to positions above them.

h. When electrical testing requires that circuits or equipment not be grounded apply the protective grounds first and then temporarily remove them only for the immediate period of the test. All disconnecting devices isolating the circuit or equipment must be locked or blocked open with correct lockout and tagout procedures.

i. When installing grounding equipment on wood pole lines, first sink a ground rod at least six feet into earth. Attach the ground device securely to this rod and then to the conductor keeping as far below the line conductor as possible. Be sure that your body does not come in contact with ground wire or the line conductor. Start at the lowest line conductor and ground each line conductor working upwards and being sure to use the same ground rod for all line conductors.

j. When installing grounding equipment at substations, first securely attach the ground device to the station grounding system and then to each line conductor keeping as far away as possible and below the line conductors if practical. Be sure that your body does not come in contact with the ground wire or line conductor.

k. To remove the protective ground, first remove the ground device from each line conductor keeping as far away as possible and being sure your body does not come in contact with the ground wire or line conductor. Then remove the grounding device from the station grounding system.

3–12. Energized-line work

Energized line work is defined as work performed on a line, equipment, or apparatus which is connected to an energized electrical power source or a stored energy source that is not properly discharged. Synonyms of energized are live, hot, or alive.

a. Permitted work. No energized line work can be performed unless it is permitted by the supervisor in order to maintain continuous power for a critical load within an installation. The permission should be based on the qualification of the workers and the availability of the tools, equipment, and personal

protective equipment.

b. Requirements for energized line work. The following requirements must be observed when performing energized line work:

(1) Workers must be–

(a) Specially trained and qualified for energized line work.

(b) In good health.

(c) Not under influence of alcohol and drugs.

(d) Free of emotional, psychological~ and financial problems.

(e) Familiar with the safety procedures and application.

(f) Familiar with the use of tools and equipment. When a bucket or elevated platform is used, the worker should be familiar with the technique and operation of the equipment or device.

(g) Familiar with the technique and application of the bucket

(h) Familiar with system/equipment/apparatus to be worked on and elevated platform when it is used.

(2) Tools and equipment must–

(a) Be specially made for energized line work.

(b) Meet applicable acceptance test standards.

(c) Have proper voltage class.

(d) Be cared for and maintained to meet in-service standards.

(e) Be visually checked for damage before each use. Damaged tools or equipment must be removed from services immediately.

(f) Be tested in accordance with the American Society for Testing and Material (ASTM) F18 by approved laboratories or manufacturers every six months.

(3) Low, medium, and high voltage services–

(a) Low voltage (600 volts and below). Except for circuit switching or fuse replacement, services on energized lines/equipment/apparatus operating at 600 volts and below between conductors should not be performed unless the following conditions are satisfied. Determining whether it is necessary to main continuous power to the critical loads. Preparing a safety plan for the job. This should also include an emergency escape plan. Having proper tools, equipment, and personal protective equipment available. Preparing a working method for the job. Checking the weather forecast. Never performing energized line work when it rains, snows, sleets, or storms. Never performing work on a wet line or piece of equipment. Checking the working environmental conditions. Never performing energized line work when the surrounding atmosphere is full of dust or hazardous gases. Isolating the working area from entrance of unauthorized persons with suitable barriers. Covering all other energized lines, ground wires and metal objects within reach with approved insulating protective equipment such as rubber line hose, insulator hoods, and rubber blankets. Covering all joints and loose ends of conductors with approved electrical tapes or insulated wire connectors.

(b) Medium voltage (600 to 17,000 volts). Except for circuitswitching or fuse replacement, services on energized lines or equipment operating at 600 to 17,000 volts between conductors should not be performed unless the conditions required for medium voltage systems are satisfied, plus the following. All energized line works must be performed under direct supervision of at least a qualified foreman. No electrical worker is permitted to work on any energized line/equipment/apparatus at a distance shorter than that required by OSHA 29 CFR 1910 .269 and 29 CFR 1926 (See paragraph 3–12b (4) and table 3–7). Non-electrical workers, such as laborers, are not permitted to approach any energized line, equipment, or apparatus which is located within the limits required by OSHA 29 CFR 1910.269 and 29 CFR 1926 without proper personal protective equipment (See paragraph 3–12b (5) and table 3–8). Proper personal protective equipment must be worn by all workers (including non-electrical workers) when approaching an energized line, equipment, or apparatus. At least two qualified electrical workers (including the foreman) must be present at the site for each energized line being worked. No energized line work can be performed when the device to be worked on is not located in a secure position or when the worker is standing on a moving or unstable platform. Do not raise, move, or lower any energized line more than 18 inches.

(c) High voltage, (17,000 volts and above). Except for the circuit switching or fuse replacement,

Table 3–7. Minimum Safe Working Distances

Voltage Range (Phase-to-Phase)	Minimum Safe Working distance	
	Phase to Ground	Phase to Phase
50V to 1kV	Space	Space
1.1 to 15kV	2ft 1in (0.64m)	2ft 2in (0.66m)
15.1 to 36kV	2ft 4in (0.72m)	2ft 7in (0.77m)
36.1 to 46kV	2ft 7in (0.77m)	2ft 10in (0.85m)
46.1 to 72.5 kV	3ft 0in (0.90m)	3ft 6in (1.05m)

Table 3–8. Minimum Safe Approach Distances

Voltage to ground	Distance
-50kV or below	10ft
-for every 10 kV over 50kV	Add 4 inches to the initial 10ft

work on energized lines or equipment operating at 17,000 volts and above between conductors is not recommended for U.S. Army facility electrical workers. Maintenance on high voltage electrical distribution systems (17,000 Volts and above) should be performed by qualified contracting personnel.

(4) *Minimum safe working distances.* When working on energized lines the minimum safe working distance must always be observed. The safe working distance is defined as the distance between the worker's body and the energized part of the system or equipment to be worked on, dependent on the voltages where the work is performed. Table 3–7 provides the minimum safe working distances required by Occupational Safety and Health Administration (OSHA) 2g CFR 1910.269 and 29 CFR 1926.

(5) *Minimum safe approach distances.* The minimum safe approach distance is defined as the shortest possible distance that an unqualified worker such as laborer or groundman can approach without danger. Table 3–8 lists the minimum safe approach distances required by OSHA 29 CFR 1910.269 and 29 CFR 1926.

c. Protective equipment voltage classes. Protective equipment classification is based on the use voltages. The equipment must pass the required proof voltage tests and be cared for to meet in-service standards. Table 3–9 provides the voltage class, color label code, and maximum use voltages for personal protective equipment. Under-rated protective equipment should not be used. In addition, whenever a worker feels a tingle when handling a tool, the service must be stopped and the tools must be replaced. The tingle signals that the protective equipment's insulating capability has been reduced. The equipment must be sent to approved laboratories or manufacturers for testing before being reused.

d. Work methods. Work method is defined as the method that can be applied for energized line work dependent on the nominal voltages of the system. Table 3–10 provides general energized line work methods that most utilities companies use.

e. Categories of energized line work. The categories of energized line work are based on the location where the worker stands to perform the work.

(1) *Workers at ground potential.* Workers are located on the structure or platform supporting the line/equipment/apparatus which is directly connected to ground via a proper grounding conductor. Proper insulating tools and personal protective equipment should be used.

(2) *Workers at intermediate potential.* Workers are isolated from the ground and grounded objects by an insulating means such as an aerial lift or an insulating ladder. Proper insulating tools and personal protective equipment should be used.

(3) *Workers at line potential.* Workers are bonded to the energized line/equipment/apparatus on which work is to be performed and are insulated from the ground, grounded objects, and other energized devices that are at a different potential. This is commonly known as the barehand technique and

Table 3–9. Protective Equipment voltage Classes.

Maximum Use Voltages (Volts)	Class	Color Label	Proof Test Voltages (Volts)	Min. distance Between collector Gauntlet and Glove Cuff (Inch/ mm)
1,000	0	Red	5,000	1/25
7,500	1	White	10,000	1/25
17,000	2	Yellow	20,000	2/50
26,500	3	Green	30,000	3/75
36,000	4	Orange	40,000	4/100

Table 3–10. Energized Line Work Methods

Nominal Voltage Level	Work Method
Up to 750 volts	Gloving by conventional work position or by structure mounting (ground potential)
750 to 7,500 volts	Gloving from structure mounting or in a bucket (ground potential)
7,500 to 17,000 volts	Gloving from electrically insulated bucket or platform (intermediate protection) or use of live-line tools from structure mounting or a bucket (intermediate potential)
17,000 to 36,000 volts	Use of live line tool from an electrically insulated bucket (intermediate potential)

is not recommended for U.S. Army facility electrical workers.

f. Safety preparation. Safety preparation is of utmost importance in electrical work. The worker must be instructed in detail on safety measures and work procedures. Personal protective equipment such as rubber gloves, rubber blankets, and hot sticks should be visually checked for damage and good condition. When an insulated bucket is used the worker should be thoroughly trained and familiar with the operation of the bucket as well as cautions to be observed. Detail on insulated bucket operation is described in paragraph 4–11.

g. Safety check. Before starting work on an energized line or equipment the following safety checks must be performed.

(1) Check the voltage rating of the circuits to be worked on.

(2) Check the clearance to ground of lines and other energized equipment.

(3) Check the voltage limitations of the bucket equipment.

(4) Check that the conductive shoes, clips, and other devices to be used to connect the bucket liner to the worker are in proper operating condition.

(5) Check that the circuit automatic reclosing devices have been made inoperative while work is being performed.

(6) Check the condition of conductors, tie wires, and insulators to see if there are any signs of burns, cracks, damage, or defects.

(7) Check the voltage classes of personal protective equipment. Wear personal protective equipment when required. Personal protective equipment having lower voltage classes are not permitted at the site.

(8) All energized conductors, neutral conductors, ground wires, messengers, and guy wires in the proximity of the work site should be covered with approved protective equipment. The covering should be applied to the nearest and lowest conductor first and removed in reverse order.

(9) Special care should be exercised when working in the proximity of fuses, surge arresters, and like equipment. Procedures may require that they be bypassed for the duration of the work.

(10) Protective equipment should be removed at the end of the working day.

CHAPTER 4
APPAREL, TOOLS, AND MATERIAL HANDLING

4–1. Electrical maintenance support

Apparel, tools, and equipment which support electrical maintenance and the requirements for their inspection and use are important. Always refer to manufacturer's instruction for specifics.

4–2. Inspection of apparel, tools, and materials handling equipment

All tools and equipment used should be in compliance with OSHA requirements as a minimum. Maintenance and testing requirements for personnel protective apparel, tools, and materials will meet the requirement covered in TM 5-684/NAVFAC MO-200/ AFJMAN 32-1082. To prevent the use of defective protective devices, tools, and equipment, inspections will be made as indicated below. After proper inspection the foreman shall, regardless of ownership, prohibit the use of equipment which is considered unsafe.

a. A careful initial inspection of tools brought on the job by a new worker will be made by the supervisor or foreman. Use will be permitted only if the tools are in good condition and conform to requirements of this manual.

b. Weekly inspections of protective devices, tools, and equipment in active use will be made by the foreman or a properly designated worker.

c. A thorough inspection of all protective devices, tools, and equipment will be made by the supervisor at least every 60 days.

d. Inspections of tools and equipment owned by a worker may be made by the supervisor or foreman at any time.

e. Before a job is started a competent person will inspect protective apparel, tools, ladders, scaffolds, ropes, and other materials handling equipment which will be used. All items must be suitable and in good condition.

4–3. Employee protection

Appropriate clothing is a basic requirement. Additional protective apparel and accessories may be necessary depending upon the degree of hazard protection required.

a. Suitable clothing. Clothing appropriate to weather conditions and to the job being done will be worn.

(1) Clothing do's.

(a) Always wear a top shirt or similar garment with sleeves. Long sleeves provide protection from cold and sun. Loose sleeves must not be worn around moving machinery.

(b) Long sleeves must be rolled down and buttoned while working on or near live equipment and electric lines or high-temperature equipment. Garments with exposed metallic fasteners should not be worn.

(c) Wear safety shoes or boots with nonslippery soles and heels in good condition when handling heavy loads such as poles, crossarms, apparatus, reels, and motors. Workers should buy safety-toe shoes since they cost no more and are just as serviceable and comfortable as any other good work shoe.

(d) Wear work gloves when handling rough or heated objects and while performing any other work where gloves will help in preventing hand injuries. Rubber glove protectors will not be used as work gloves.

(e) Wear approved goggles or head shields and gloves while operating welding equipment. Wear goggles that are appropriate for the type of electric or acetylene welding in progress.

(f) Wear nonconducting hard hats and safety shoes or boots when working on overhead and underground systems. Wear insulating gloves where not prohibited for use with live-line tools. Wear helmets when working in congested areas, industrial facilities, missile silos, and other such areas. Also wear helmets when working below other workers, or near exposed energized lines. Helmets prevent head injuries caused by fixed obstructions, falling or flying objects, or from direct contact with over-energized lines. Helmets will meet ANSI Z89.1 Class B requirements (20,000 volts ac tests for three minutes).

(g) Wear appropriate safety equipment when us-

ing a chain saw. Wear work gloves, work shoes with a safety toe, hard hat, and goggles with clear lenses. Industrial ear muffs or plugs shall be worn to protect against the effects of exposure to excessive noise.

(h) Glasses must be fastened with a head or neck band or else restrained under safety goggles so they cannot fall into energized circuits.

(i) Long hair must be secured to prevent entanglement in moving machinery.

(2) Clothing don'ts.

(a) Don't wear rings, metal wrist bands, or watch chains when working on energized electrical equipment.

(b) Where work is exposed to the hazards of flames or electric arcs do not wear clothing that, when exposed to flames or electric arcs, could increase the extent of injury. Clothing made from acetate, nylon, polyester, and rayon, either alone or in blends, is considered unsafe unless the fabric has been treated to withstand the conditions that may be encountered.

(c) Don't wear anything made of celluloid or other flammable plastic when working near electric arcs or open flames. This includes cap visors, collars, cuff protectors, and rims for eyeglasses or goggles.

(d) Don't wear your sleeves rolled up.

(e) Don't wear loose clothing, dangling sleeves, or neckties when working around moving machinery.

(f) Don't wear gloves while working on moving parts in a machine shop as they are more easily caught than your skin.

(g) Don't wear garments equipped with metal slides or zipper fasteners, unless the fastener is effectively covered, when working around energized electrical equipment.

(h) Don't wear shoes with heel or toe plates or hobnails.

b. Protective apparel. Basic requirements are described herein. More specific requirements may be described in other parts of this manual, where deemed necessary by your supervisor or foreman, and as recommended by the manufacturer of a specific tool or item of equipment.

(1) *Eye and face protection.* This protection is required wherever there is any exposure to eye or face hazards. Protection will meet requirements of ANSI Z87.1. Contact lenses are not to be considered eye protection nor worn in environments where toxic or irritant substances could be trapped by the lenses. Eye and face protectors must be thoroughly washed with soap and water before being worn by another person. Eye and face protection must be worn when:

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

(b) Welding or helping in welding of any type including thermite type welders. For electric arc welding, only helmets that meet ANSI Z89.1 may be used. Goggles intended for acetylene welding must not be used for electric arc welding. Approved colored lenses may be needed. Welding curtains may be needed where the public is exposed to welding arcs.

(c) Blowing out machines or equipment with compressed air, blowing soot from boilers, and handling ashes in power plants.

(d) Cleaning or working with rusty materials or handling materials which are subject to flaking or scaling. Compressed air used for cleaning purposes must be less than 30 pounds per square inch (207 kilopascals) and effective chip guarding and protection must be used.

(e) Blowing dirt or dust.

(f) Tinning or soldering lugs or large joints.

(g) Trimming thorny trees or using brush chippers.

(h) Riveting or chipping metal.

(i) Grinding, where no approved permanent guard is attached to equipment.

(j) Burning.

(k) Pouring molten metal, gunniting, or the use of other hot or injurious substances.

(l) Handling chemicals, acid, or caustic, and in any other place where splashing may injure the eyes, except where complete head coverings are provided. Chemical goggles are necessary.

(m) Anytime there is a possibility of an electrical flash.

(2) *Foot protection.* Foot protection will meet ANSI Z41 requirements where work activities are such as to be inherently dangerous to toes, such as jack hammers, tampers, post-hole diggers, and chain saws. Special electrical requirements are as follows:

(a) Use conductive footwear where static charges can cause discomfort but in no case will they be worn where workers are exposed to other shock hazards.

(b) Electrically insulated footwear should be used when a dangerous step or touch potential is expected to occur.

(3) *Respiratory protection.* Before entering into an area where toxic/flammable gas/vapor may be expected, respiratory protection must be worn. Federal regulations governing respirator protection are contained in 30 CFR Part 11 and OSHA Safety and Health Standards, 29 CFR 1910.134. The National Institute of Occupational Safety (NIOSH) is part of the U.S. Department of Health and Human Services and does not promulgate regulations. However, NIOSH routinely makes recommendations regarding the use of respirators, and specific respirators must be approved by Mine Safety and Health Administration (MSHA) and NIOSH. Respirator will also comply with ANSI Z88.2. When work requiring a long stay inside a toxic/flammable gas/vapor area is expected, air ventilation must be provided. (See paragraph 7-4 for details.) Respirator use is subject to the following requirements.

(a) The worker must have satisfactorily completed a pulmonary function test, been trained and fitted for the type of respirator to be used, and be clean shaven where the respirator contacts the face. A worker's physical qualifications should meet the requirements of ANSI Z88-6.

(b) The space in question must be covered by a confined space entry plan including emergency rescue, air monitoring equipment to be used, frequency of air testing, ventilation equipment, procedure to minimize atmospheric hazards, and type of respirator to be used.

(c) Air purifying respirators of the canister gas mask type are generally used for emergency air purifying. Chemical cartridge respirators are used more often for nonemergency situations or for long or repeated exposures. Particulate filter respirators are used for most types of particles. Air-supplied respirators are used in oxygen-deficient atmospheres.

(d) Misuse of respirators may cause problems. Sometimes filter respirators for particulates are incorrectly used. Sometimes chemical filtering respirators are used when atmosphere-supporting or self-contained breathing apparatus is required. Some substances require protection both from damage to the respiratory system and systemic injury through the skin.

(4) Respirator use rules. Check with the facility environmental coordinator for the approved respirator to be used based on the following rules.

(a) Canister type respirator (gas masks) must be worn when entering tanks, rooms, or confined spaces where there is a suspicion or possibility that poisonous gases may be present. Whenever a gas mask is used, even for a short length of time, the canister must be replaced immediately after use with a new canister.

(b) Chemical cartridge respirators must be worn when obnoxious odors are encountered or when painting in confined places where the exposure does not justify the use of a canister type gas mask.

(c) Filter type respirators must be worn when doing spray painting in the open, or when blasting or metallizing, or when working in any dust laden places where no harmful gases are encountered.

(d) Air purifying type respirators must not be depended upon in places where there is insufficient oxygen in the atmosphere to support life. Ventilate the area or use supplied air respirators.

(e) Dust type respirators must be used when using compressed air for cleaning machinery or bus structures, where there is wood dust in the air, and other such dusty areas.

(f) Gas masks and chemical cartridge respirators must be inspected and sterilized after use and before being worn by another person. Filter type respirators will be issued for individual use only.

(5) *Hearing protection.* Hearing protection is required when noise levels exceed those given in table 3–1. Hearing protectors must have been tested in accordance with ANSI S3.19 as a basis for the manufacturer's noise attenuation data. The types of ear protectors are plug, cap, and muff.

(a) The plug type is inserted into the ear canal. The cap type fits over the ear canal opening. The muff type covers the entire ear. Each type has advantages and disadvantages and because of comfort their acceptance will vary from worker to worker. It

is recommended all types be available and that each of these types must be custom fitted by experienced people to assure their effectiveness.

(b) Plugs or caps, when properly fitted, reduce noise to the ear by 25 to 30 decibels in the higher more harmful frequencies. The better type of ear muff can reduce noise by 35 to 45 decibels. Combinations of the types may give slightly more protection but total attenuation never exceeds 50 decibels.

(6) *Protective clothing.* Conform to clothing do' B and don'ts given previously and to the following specifics:

(a) Wear flash resistant nonsynthetic clothing when working on or near energized equipment.

(b) Wear appropriate gloves, welders gloves for welding, leatherpalm gloves for handling sharp-edged materials, and electrical rubber gloves for work on energized circuits. Additional protective clothing may be mandated for these tasks such as welders' aprons and chaps, depending on the work.

(c) When working near traffic areas wear safety color fluorescent clothing.

(d) Wear U.S. Forest Service-approved protective chaps when using chain saws.

(7) *Skin protection.* Skin must be protected from toxic or irritant substances where these occur or where there is a possibility they can occur in the workplace. Prevent injury by wearing suitable protective clothing. Protective ointments, prompt application of proper cleaners, and appropriate first aid remedies should be on hand. Be sure emergency-type water sources are on hand for irritant substances which could come into contact with the body, such as an acid spill in a battery room.

(8) *Responsibility.* Personal protective apparel is worn when it is impossible or impracticable to eliminate a workplace hazard. Supervisors should ensure that workers are fully trained not only in their proper use and selection, but why they are needed. Foremen are responsible for ensuring that personal protective apparel is worn, but workers should be provided with the most comfortable apparel available. Inspection and maintenance of equipment is a joint supervisor, foreman, worker responsibility. The worker should be familiar with the requirements of acceptable equipment. The foreman should train the worker in the maintenance/inspection requirements and equipment should be inspected by both before being put into use. The supervisor is responsible for seeing to the repair or replacement of unacceptable equipment.

4–4. Office safety

The fundamentals of safety and elimination of hazards (chap 3, paras 3–2 and 3–3) will eliminate most safety problems. Common sense should be used. The following rules are given because they are so often violated.

a. Drawers of desks and file cabinets will be kept closed when not in use. Only one drawer of a file cabinet will be pulled out at a time in order to avoid overbalancing, unless the cabinet is securely fastened to the wall or to other cabinets.

b. The floor will be kept free of tripping hazards such as telephone cords, electric extension cords, and paper cartons.

c. Broken glass and other sharp objects will not be placed in waste paper containers. Sharp-pointed pins will not be used for fastening paper together. Staples, paper clips, or other approved fasteners will be used.

d. Volatile substances will be used only in well ventilated areas. Toxic substances will not be permitted in office areas during working hours of any office personnel.

e. Workers will not attempt to clean, oil, or adjust any machine that is running. If the machine is not equipped with a starting switch that can be locked in the “off'” position, it will be disconnected from its power source. Unsafe electrical cords or faulty electrical equipment should be disconnected from the power source and tagged.

f. Boxes and chairs will not be used in place of ladders. Do not sit on the edge of a chair. Do not tilt back when sitting in a straight chair.

4–5. Field and shop safety

Maintain all rules given for office safety and use only equipment approved and authorized by the supervisor for use in the workplace. Workers are responsible for the safe condition of the equipment they use. Unsafe equipment must be taken out of service and reported to the foreman or supervisor. People, tools, and equipment may need to be temporarily supported before work can be accomplished. All tools must be handled with respect and knowledge of the damage their uncontrolled or incorrect use can cause, either by direct action in some cases or indirectly by degradation of their protective abilities in other instances.

Materials must be lifted when moved in an approved manner. Special precautions are required for substances which are hazardous if incorrectly handled.

4–6. Support safety

No worker or any material or equipment can be supported without a determination as to the adequacy of the support and to its proper fastening in place. The use of ladders, scaffolds, and boatswain's chairs as temporary work structures can result in injuries if safe practices are not followed.

a. Ladders. Ladders will conform to OSHA Standards (29 CFR 1910.25). Workers will never use a ladder for any purpose other than as a work platform, and only when using small hand tools or handling light material. Never use a ladder as a platform for lifting heavy materials or when substantial exertion is required.

(1) Always inspect the ladder carefully before using it. Ensure that side rails, spurs, shoes, rungs, extension hardware, and rope are all in good condition, with no splinters, cracks, looseness, or other defects. Never use a defective or improvised ladder. Defective ladders will be destroyed or cut to a smaller size.

(2) Before placing new wooden ladders in service give each ladder two coats of boiled linseed oil to which Japan dryer has been added, applied hot, and then varnish. To refinish ladders, follow the same procedure after they have been cleaned and sanded. Wooden ladders will never be painted so as to obscure a defect in the wood; only a clear, nonconductive finish will be used.

(3) Portable metal ladders or wooden ladders with metal side reinforcement or metal rungs will not be used in the vicinity of energized electrical circuits. (Exception: Such ladders may be used in specialized work, at high-voltage substations, where nonconductive ladders might present a greater hazard and proper precautions are taken when used in such specialized work.) Any such ladders used for other authorized purposes will be legibly marked "Caution-Conductive Ladder-Do Not Use Around Electrical Equipment." Wire truss portable ladders will never be used.

(4) Always use ladders that are long enough for 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 of a stepladder which is over 5 feet (1.5 meters) in length. Place a ladder so that the horizontal distance from the base of the ladder to the vertical plane of the support is approximately onefourth the ladder length between points of support. Where the ladder extends above the top support, ladder length to the top support only is considered.

(5) All portable ladders will be equipped with nonslip bases and care will be exercised in placing them. Blocking or lashing or having the ladder held by someone will be required, as indicated below when:

(a) Work is done from a stepladder where the worker must stand 10 feet (3 meters) or higher.

(b) It is necessary to work with both hands from a straight ladder where the worker's feet are more than 10 feet (3 meters) from the ground.

(c) The ladder is used on slippery or hard surfaces.

(d) The worker is in such a position on the ladder that force is exerted sideways or outwardly.

(e) The top of the ladder cannot be placed squarely against a flat riding surface.

(f) The distance from the base of the ladder to the surface against which it is leaning is not at least approximately one-fourth the length of the ladder.

(6) Ladders placed near doors in passageways must be protected against being struck by the door or by traffic.

(7) Remove climbers before working on ladders.

(8) Face a ladder when ascending or descending, and take each step in order.

(9) When climbing a ladder never carry anything which will interfere with the free use of both hands for holding onto the ladder.

(10) When standing on a ladder, do not lean to one side while working unless the ladder is adequately secured.

(11) Do not place ladders over machines with exposed moving parts.

(12) Lower all ladders before the users leave the job, unless the ladder is located in an enclosed space not accessible to the public, in which case lash the ladder securely.

(13) Workers will belt off to a ladder whenever

both hands must be used for the job or there exists a possibility of the worker falling from an elevated position.

(14) When dismounting from a ladder at an elevated position (as at a roof) the worker will ensure that the ladder side rails extend at least 3 feet (0.9 meters) above the dismount position, or that grab bars are present.

(15) Comply with the following straight ladder requirements.

(a) Straight ladders will not be climbed beyond the third step from the top.

(b) Straight ladders will not be spliced together to form a longer ladder.

(c) A straight ladder will not be placed against an unsafe support.

(d) Only one person should be on a straight or extension ladder at a time.

(16) Step ladders will not be used as straight ladders and workers will observe the following instructions.

(a) Do not stand on the top platform of stepladders unless it is designed to be stood on.

(b) Fully spread stepladder legs and lock the spreading bars in place.

b. Scaffolds. Scaffolding will be of sufficient strength and rigidity to support four times the weight of the workers and material to which it will be subjected; that is, it will have a safety factor of at least four. Construction details of all scaffolding will comply with OSHA Standards (29 CFR 1910.28).

(1) Temporary construction platforms 6 feet (1.8 meters) or more above ground must have a standard railing and toe boards on all open sides as per OSHA 29 CFR 1910.23. All wood used for scaffolding or trestles must be sound, straight grained, and free from large knots and other imperfections. Warped or twisted planking must not be used. Scaffolds must be well braced and fully capable of supporting both the human and tool loads to be imposed upon them. All decking must be securely fastened. No part of the scaffold must be removed or weakened while the decking is in place. All scaffolds except swing scaffolds will rest on a suitable footings and will stand level. Movable scaffolds will have their casters or wheels locked to prevent movement. Swinging scaffolds must be constructed to prevent excessive tilting.

(2) Platforms or scaffolds on which personnel are to work must be inspected by a competent person before they are used and as often thereafter as circumstances require.

(3) Scaffolds will not be moved without first removing all workers, loose tools, materials, and equipment resting on the scaffold deck.

(4) Always observe the following rules when required to work on a scaffold.

(a) Never work on a scaffold that is coated with hazardous materials (such as ice, snow, mud, grease, or other slippery materials).

(b) Never work on a scaffold that is less than 18 inches (450 millimeters) wide.

(c) Never work on a scaffold that is not level and stable.

c. Boatswain's chair. A boatswains chair will be constructed to meet the following minimum safety requirements:

(1) The chair seat will be not less than 12 by 24 inches (300 by 600 millimeters) and of 1-inch (25 millimeters) thickness. The seat will be reinforced on the underside to prevent the board from splitting.

(2) Two seat slings of a fiber rope approved for use near electric lines will be of at least 5/8 inch (18.9 millimeters) diameter and reeved through the four seat holes so as to cross each other on the underside of the seat.

(3) Seat slings will be of at least 3/8-inch (9.5 millimeters) diameter wire rope when a worker is conducting a heat producing process such as gas or arc welding.

(4) The worker must be protected by a safety life belt attached to a lifeline. The lifeline will be securely attached to substantial members of the structure (not to a scaffold), or to securely rigged lines, which must safely suspend the worker in case of a fall.

(5) The tackle will consist of correct size ball bearing or bushed blocks and properly spliced 5/8-inch (18.9 millimeters) diameter first-grade approved rope.

(6) The roof irons, hooks, or the object to which the tackle is anchored will be securely installed. Tiebacks when used will be installed at right angles to the face of the structure and securely fastened.

4–7. General tool safety

Use proper tools suitable for the job in progress. Tools must be approved and authorized by the supervisor of the electrical section and meet OSHA requirements. Inspect them for use every day. Follow the safe practices and calibration intervals outlined by the manufacturer. Keep unguarded sharp-edged or pointed tools out of your pocket. Cutting tools will be properly sharpened and provided with cutting edges suitably guarded when not in use. Never lay tools down when working in an elevated position unless the tools are protected from falling. Use containers for tools being transported or carry them in a tool belt. Tools will be fitted with proper handles where required. Broken wooden handles will be replaced. Do not tape or wire lash defective wooden handles. Metal tools will not be used near energized equipment. An eye wash/shower should be readily available whenever there is exposure to tools which use welding materials, acids, solvents, and other chemical substances.

a. Measuring tools. Never use metal tapes or cloth tapes having metal reinforcing or metal strands woven in the fabric, brass-bound rules, metal scales and gages, or wire-bound hose and rope, when working on or near energized electrical equipment or lines. Always use wooden rulers or nonmetallic tapes when taking measurements near electrical equipment or conductors.

b. Nonpowered hand tools. Never use improvised tools and always store tools not in use on tool boards or in appropriate containers. Never use hand tools on moving machinery unless directed to do so by your foreman.

(1) Always assume a safe working position when using wrenches to avoid injury due to the wrench slipping. Do not use shims to make a wrench fit. Do not use wrenches with sprung or damaged jaws. Do not use pipe to extend a wrench handle for added leverage unless the wrench was designed for such use.

(2) Always use adjustable wrenches with their jaw openings turned toward the direction of pull.

(3) Never use tools, such as cold chisels, that have mushroomed heads.

(4) Never use tools with multiple cutting edges, such as files and rasps, unless they are equipped with suitable handles.

(5) Never use a hammer on highly tempered tools, such as files or drills, because flying metal chips may cause injury.

(6) Never use screwdrivers with metal shanks extending through the handle when working on or near energized equipment.

(7) Chisels, drills, punches, ground rods, and pipes will be free of burrs. Items which are held by one person and stuck by another will be held with suitable holders. A holder will be held by a worker in a position which avoids the danger of being struck by a tool being used by another worker.

(8) The insulation on hand tools will not be depended upon to protect users from shock unless designed for energized work.

(9) Axes, picks, and sledge hammers will be only used where there is sufficient room to swing the tools and will conform to the following.

(a) Never use axes as mauls or sledges.

(b) Where double-bit axes are provided, workers must be given special instructions in their safe use.

(c) Always carry an axe with the head forward, by holding the handle next to the head. Never carry any type of axe or brush hook on your shoulder.

(d) Keep cutting edges of axes and picks sharp.

(e) Handles must be smooth without splits, and securely fastened to the head.

(f) Always place axes and picks transported in trucks so as to prevent injuries to workers.

c. Pneumatic and hydraulic tools. Use these tools with caution. Eye protection, foot protection, and other protective devices will be worn when their use could reduce the possibility of injury. Tools will be operated only by competent persons who have been trained in their use.

(1) Never exceed the manufacturers recommended operating pressures for pneumatic and hydraulic equipment, hoses, valves, and fittings.

(2) Always verify that pneumatic or hydraulic tools used on or around energized lines or equipment are equipped with nonconducting hoses. The hoses should have adequate strength for the operating pressure in use. Always use hoses, valves, and fittings that are pressure-rated by the manufacturer. Never use hose that has any kind of defect.

(3) Never lay pneumatic or hydraulic hose over ladders, steps, scaffolds, or walkways where the hose could become a tripping hazard. Never use hoses for hoisting or lowering tools.

(4) Pneumatic tools will never be pointed at another person.

(a) Always install safety clips or retainers on pneumatic-impact tools to prevent dies and tools from being accidentally expelled from the barrel.

(b) All hoses exceeding 1/2-inch (12.7 millimeters) inside diameter will have a safety device at the source of supply or branch line to reduce pressure in case of hose failure or disengagement of a connection.

(c) Before making adjustments or changing/disconnecting air-tools (unless equipped with quick-change connectors), the air will be shut off at the air supply valve ahead of the hose. The hose will be bled at the tool before breaking the connection.

(d) Compressed air will not be used for cleaning purposes unless the pressure has been reduced to less than 30 pounds per square inch (207 kilopascals) and then only with effective chip guarding and personal protective equipment.

(e) Compressed air will not be used to blow dust or dirt from clothing or exposed skin.

(5) Always use hydraulic fluid that meets the requirements of U.S. Bureau of Mines, Schedule 30.

d. Electrically powered portable tools. Electrically powered tools can be classified as portable cord-connected type or self-contained battery type.

(1) Portable cord-connected power tools. Safety rules for portable cord-connected tools must be followed for both the tool and the cord connection. All electrically-powered tools, except those powered by selfcontained batteries or which are labeled as double insulated, must have a line cord with a grounded conductor and a polarized grounding plug. The receptacle to be used for the tool must be grounded also to make the conductor and grounding plug effective. All tools used outdoors or in damp or wet locations will be protected by a ground fault circuit interrupter. The rules for grounding portable equipment, systems, and methods of accomplishment are outlined in the NEC. The object of grounding is to ensure a metallic connection of low resistance directly from metal surfaces of electric tools to ground. When insulation fails, metal surfaces are energized by coming into contact with bare portions of the electric conductor. The current will flow directly through the grounding system to ground and the potential difference between the electric tool surfaces and ground will be very low (usually less than 5 volts). The low resistance path to ground facilitates the operation of the overcurrent devices in the circuit. Figure 4–1 indicates that if the grounding path is broken (or if a grounding cable is not used) current from a defective tool will pass directly through the person to ground.

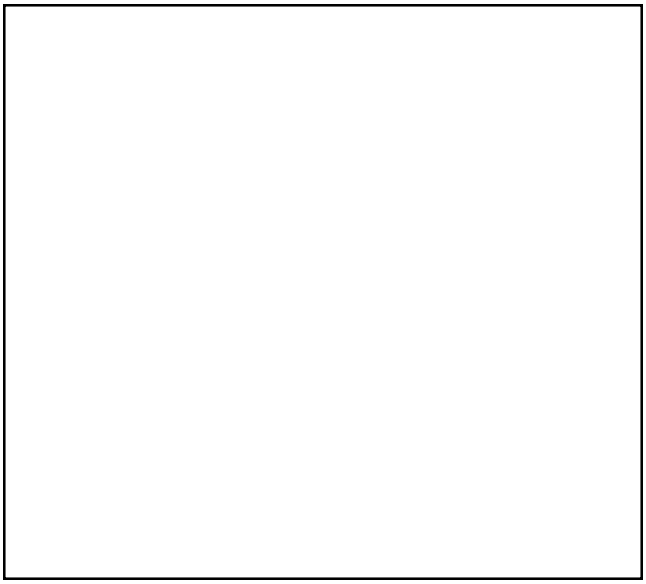

Figure 4–1. Grounding path.

(a) Electrically-powered hand tools which are cord connected to any source of power must not be used when any worker or nearby worker can even minimally be in contact with water.

(b) Electrical tools will not be used where there is a hazard from flammable vapors, gases, or dusts.

(c) Extension lamps are portable power tools and should be connected to only porcelain, composition, or rubber-covered sockets that incorporate a bulb guard. The shock hazard of extension lamps can be eliminated through the use of small portable transformers which reduce the input power to 6 volts.

(2) *Cord connections.* Cord connections should

preferably be provided as a part of the portable power tool. Where additional cords are necessary for extension to a receptacle they will match or exceed the rating of the portable device cord and carry an Underwriters Laboratories' label.

(a) Cords should be inspected frequently for defects that may become a shock or short circuit hazard. Implement an assured equipment grounding program to verify cord and plug equipment is installed as per 29 CFR 1926.404.

(b) Rubber-sheathed cord should be used with portable electric tools and with extension lamps used inside boilers, tanks, or other grounded enclosures.

(c) Special types of cords should be considered for use in areas where oils and solvents are present.

(d) Cords with a green-covered grounding conductor and polarized plug and receptacle should be used with portable electric equipment for the purpose of positively grounding the frames of tools which are not double insulated.

(e) Handle cords with care so as not to damage the insulation by dragging them over sharp edges or by rolling heavy trucks or materials over them.

(f) Always maintain plugs and cords in a serviceable condition.

e. Machine tools. Rules for machine tools apply whether tools are permanently connected or portable.

(1) *Work space.* Always provide bins or containers for all scrap material, and racks or bins for stock materials. Always keep work benches in good condition and free from scrap material.

(2) *Belts.* Always keep exposed belts and gears covered with safety guards to prevent injury. Never use your hands to shift moving belts.

(3) *Machinery.* Never work on any machinery belt or the machinery until a danger tagout (see paragraph 3–8) is attached to primary operating controls (such as start switch, governor, throttle, clutch lever or other such device) used to set the machine in motion. The foreman must verify that all operating levers, valves, and switches are blocked open and provided with tagouts to avoid inadvertent startup of equipment under repair. Safe Clearance and danger signs must be displayed as required.

(a) Always make arrangements with the cognizant supervisor to lock equipment out of service before starting repairs on steam, air, hydraulic, or motor-driven equipment such as conveyors, crushers, or cranes.

(b) Always take a safe and secure position near machinery to avoid falling, leaning, or contacting moving or live parts.

(c) Never take a position on, in, or near any equipment at rest; this will avoid injury in the event the equipment is started up.

(d) Never remove machine guards except for inspection or repair to the guards or machinery. Never remove guards while machine is operating. Always replace guards immediately after work is completed.

(e) Never clean shafts and other parts of rotating machinery, except commutators and collector rings, while the machinery is operating.

(f) Always remove crank handles from hand-operated winches when force is not being applied to the handle.

(4) *Cutting tools.* Always remove the chuck wrench from the chuck as soon as a drill is installed or removed. Always remove the cutting tool drill from a machine as soon as work is finished.

(5) *Lathe or shaper work.* Always wear approved safety glasses or goggles when doing lathe or shaper work to avoid eye injuries.

(6) *Grinding wheels.* Always wear close-fitting goggles when grinding if a glass safety screen is not installed. The tool work rest should have a maximum opening of one-eighth inch (3.17 millimeters) and the tongue should not exceed 0.25 inch (6.35 millimeters). Grinding wheels and rings should be inspected and tested before using to make sure they are not damaged.

(a) Never stand directly in front of a grinding wheel because there is always the danger of a wheel breaking.

(b) Always set the grinding rests close to the wheel for small work to prevent the work from being carried down between wheel and rest.

(c) Do not use the side of an ordinary wheel for grinding. The face of the wheel must be properly dressed at all times.

(d) Never drive a wheel faster than the speed recommended by the manufacturer.

(e) Always hold articles you are grinding or buffing so that your hands will not be injured if anything slips.

(7) *Drill presses.* Insure that the drill press is securely fastened to the floor or bench top. Always fasten or clamp the work securely when using a drill press, unless the work is large enough to provide holding leverage. A secure hold is especially important when reaming or when working on brass.

(a) Never force the drill or feed it too fast.

(b) Always remove metal chips with a stiff brush or piece of wood. Never use your hand or fingers.

(c) Always use drills that are properly sharpened.

f. Powder-actuated tools. Only those workers who are qualified by training in their operation may use these tools. Operators and assistants using these tools will wear eye protection (safety eye goggles and/or face shields) and a safety hat. Tools may never be pointed at any person. Powder actuated tools can not be used in an explosive or flammable atmosphere.

(1) Explosive charges must be carried and transported in approved containers. Tools will not be loaded until just prior to the intended firing. Only cartridges with an explosive charge adequate for the job and with proper penetration can be used. Tools and cartridges will never be left unattended.

(2) Prior to use, the operator will inspect the tool to determine that it is clean, that moving parts operate freely and the barrel is free from obstructions, and ensure that the protective shield is properly attached to the tool.

(3) In case of a misfire, the operator will hold the tool in place for 30 seconds, before trying to operate the tool a second time, and then wait another 30 seconds before trying if there is a second misfire. Misfired cartridges will be disposed of properly. (Place in a metal container and return them to your supervisor.)

g. Welding and cutting tools. Welding and cutting will be performed only by experienced and properly trained persons. Before welding or cutting is started, the area will be inspected for potential fire hazards. Suitable fire extinguishing equipment shall be made available in the work area. Rules and instructions supplied by the manufacturer or affixed to the machine will be followed. Additional personnel shall be assigned to guard against fire during and after the performance of hot work.

(1) Use adequate local exhaust ventilation and or respiratory protection plus other personal protective equipment as needed.

(2) Protect combustibles and flammables in the work area from sparks, slag, and heat produced by the operation. Also take precautions to protect other persons from the sparks and slag. Make a fire check of the area about 30 minutes after work is stopped.

(3) Where combustible materials such as paper clippings or wood shavings are present, the floor will be swept clean for a radius of 35 feet (10.5 meters) before welding. Combustible floors will be kept wet or protected by fire-resistant shields. Where floors have been wet down, personnel operating arc-welding or cutting equipment will be protected from possible shock.

(4) When welding or cutting in elevated positions, precautions will be taken to prevent sparks or hot metal from falling onto people or flammable material below.

(5) Protect electrical cables and gas hoses from physical damage, and from being a tripping hazard. Welding hose will not be repaired with tape.

(6) An electric welding machine will be properly grounded.

(a) When electrode holders are to be left unattended, the electrodes will be removed and the holders will be so placed or protected that they cannot make electrical contact with workers or conducting objects.

(b) When the welder must leave his/her work or stop work for any appreciable length of time, or when the welding machine is to be moved, the power supply switch to the equipment will be opened.

(7) Gas welding machines will be provided with approved backflow check valves in both gas and oxygen lines.

(a) Use friction lighters or stationary pilot flames, not matches or cigarette lighters, to light a torch. Remove matches and butane cigarette lighters from your pockets and keep them away from welding and cutting operations.

(b) Use gas cylinders whose contents are clearly labeled and protect them from excessive heat and accumulations of snow and ice.

(c) Keep valve protection caps on cylinders except when the cylinders are secured in place on a welding cart or connected to a manifold.

(d) Store oxygen cylinders at least 20 feet (6 meters) away from fuel gas cylinders and flammable materials. Store cylinders in an upright position and secure them to prevent them from falling over.

(e) Keep grease and oil away from oxygen system valves, fittings, regulators, and gauges.

h. Painting. Painting may be done with a brush or using spray guns as applicable to the work. The requirements given in this paragraph apply to touch-up or outdoor painting for electrical maintenance, not for industrial painting operations. Review the material safety data sheet (MSDS) for the material being used and follow the precautions given therein. Paint only in areas approved as suitable for hand painting or for hand and spray painting as applicable to the equipment to be used. Observe the following rules when painting:

(1) A brush used near live parts energized at above 600 volts must be attached to an approved insulated stick.

(2) Mix and apply paint in adequately ventilated areas or use appropriate respiratory protection.

(3) Keep flammable paint away from heat, open flames, smoking, and another ignition sources. Do not smoke within 25 feet (7.5 meters) of any painting operation.

(4) Use a good grade of linseed oil or alcohol to clean paint from hands, face, or body; then wash thoroughly with soap and water. Never use gasoline, turpentine, or thinners.

(5) Always clean paint from your hands before eating or placing your hands on unprotected parts of your body.

(6) Never allow paint to collect and remain around or under fingernails after the work shift.

(7) Never go near open flames while wearing painting clothes or carrying paint rags or waste.

(8) Never store rags, waste, burlap, and clothing used in connection with painting in the same room or cabinet with paint materials.

(9) Never chew tobacco or gum while mixing, brushing, or spraying.

(10) When using paint-spraying equipment:

(a) Follow the manufacturer's instructions.

(b) Keep the spray gun pointed away from yourself and others.

(c) A metal object being sprayed should be supported in a manner to avoid insulating it from conductive surfaces, because paint spraying produces static electricity.

(d) Make sure that excessive air pressure is not delivered to the spray gun. The pressure should only be sufficient for the job at hand.

(e) Do no spray painting near live wires unless barriers are placed between the spray gun and live parts.

i. Solvents. The following requirements apply to touch-up or outdoor use of solvent for electrical maintenance and not for industrial solvent treatment. Solvents used inside must be approved for use in the area where applied. Use only approved solvents for which MSDS are available and follow all MSDS precautions. When a solvent is required to remove oil or grease, a petroleum distillate of the safety type such as Stoddard solvent should be used.

(1) In special cases where a strong chlorinated solvent is required, the room must have positive ventilation.

(2) The use of carbon tetrachloride, alone or in mixtures, for cleaning purposes is prohibited.

(3) Ventilation must be provided in areas where solvents are used in order to avoid fires, explosions, or endangering workers.

(4) Protective equipment, such as gloves, goggles, and aprons, should be worn when working with solvents, to prevent irritation to the skin and eyes.

(5) Avoid wetting clothing with solvents; clothing that has become wet with solvent should be removed.

4–8. Materials handling safety

The following requirements apply to manual lifting,

use of hand trucks, and handling and storage of materials requiring special precautions.

a. Manual lifting. Manual lifting of material accounts for such occupational injuries as strains, sprains, fractures, and bruises. These injuries are caused, primarily, by 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. There are five steps to safe lifting (see figure 4–2). If there is any doubt as to your ability to lift or lower the load without strain, confer with the foreman directions the lifting.

(1) Inspect objects for slivers, jagged edges, burrs, or slippery surfaces, and wear gloves when needed to protect your hands. Keep hands and gloves free of oil and grease which might interfere with getting a firm grip on the object being lifted.

(2) Workers will not attempt to lift beyond their capacity. Caution will be taken when lifting or pulling in an awkward position. Never carry a load that obstructs the vision. Obtain assistance in lifting heavy objects or use hoists or cranes.

(a) When two or more persons carry a heavy object that is to be lowered or dropped, one person only will give signals for the group.

(b) When two or more persons are carrying an object, each worker, if possible, should face the direction in which the object is being carried.

(3) Accessories, such as chains, falls, blocks and tackles, and jacks and hoists, should be used wherever practical instead of lifting by hand. Inspect all lifting devices in accordance with TB-43-0142.

(a) Never load a jack in excess of its rating. Make sure the footing for a jack is substantial.

(b) Always center the jack properly under the load, and if there is danger of the head slipping, put a wooden block on top of the jack to help keep it in position. Place the jack so there will be an unobstructed swing of the handle to prevent injury to the knuckles.

(c) Never leave the handle in the socket of a jack standing under load.

(d) Never load hoists and load binders in excess of their rating. If the strain requires the use of handle extensions on come-alongs (Coffing) or chain fall (Blackburn) hoists, they are overloaded.

Figure 4–2. Correct lifting instructions.

(4) When lifting transformers and other equipment, slings of suitable strength must be used. Place slings so as to avoid cutting them on sharp edges of equipment. Rope slings of suitable strength may be permitted for lighter work if the rope cannot be cut by sharp edges or projections. Only rope slings must be used around energized equipment where the use of metal slings would create a hazard.

(5) Heavy timbers, steel members, and other heavy objects should, if practical, be lowered into place and not dropped.

(6) Do not throw tools and materials up or down to workers on a different level. Raise or lower them by handlines or in canvas tool bags or buckets.

(7) When tools or material are raised or lowered, stand clear at all times and avoid coming directly under any load until it is properly placed and secured.

(8) When tools and materials are raised or lowered, prevent their coming in contact with energized wires or equipment.

b. Hand and forklift trucks. Manually-operated

hand trucks and machine operated forklift trucks will be used as appropriate for lifting heavier or larger objects.

(1) The operator will always face in the direction of travel.

(2) Equipment will always be operated at a safe speed for existing conditions.

(3) Before moving the equipment, the operator will make sure that no person or objects are in the path of the truck. Clearances in all directions will always be checked, particularly overhead clearances.

(4) Sudden stops which might spill the load will be avoided.

(5) All loads will be securely fastened or safely positioned to prevent tipping or falling.

(6) When using hand trucks, you should observe the following:

(a) Keep the center of gravity of the load as low as possible.

(b) Place the load so the weight is over the axle and not the handles, so it will not slip, shift, or fall off.

(c) Keep the truck downhill from you when going up or down an incline.

(7) Fork lift trucks will be operated only by authorized personnel who are qualified and trained in their use. Operators will comply with the following.

(a) Brakes and controls will be tested prior to use. Equipment with faulty brakes or mechanical or electrical defects will not be operated. Needed repairs will be reported immediately.

(b) Do not add fuel with the engine running. Equipment with internal combustion engines will not be operated in enclosed areas for prolonged periods of time as the safe levels of carbon monoxide in the enclosure may be exceeded.

(c) Lift bars on fork lift trucks which are movable or replaceable will be held firmly in place by a proper securing pin. Jury-rigged devices, such as using a threaded bolt, will not be permitted. Only attachments provided by or approved by the manufacturer may be used. Such attachments will be properly secured. Improvised methods will not be used.

(d) When picking up a load, forks will be set squarely and as far as possible under the load. Loads should not be raised or lowered while traveling. Loads will not be suspended or swung over other persons. No one should be allowed to stand or walk under elevated forks. Loaded or empty, forks should be carried as low as possible, but high enough to clear uneven surfaces.

(e) On inclines and declines, all types of loaded lift trucks will be driven with the load on the upgrade side of the driver.

(f) No one will be allowed to ride the fork lift truck other than the operator, except when seats are provided for this purpose.

(g) A fork lift truck is considered unattended if the operator is 25 feet (7.5 meters) away or the truck is not in his/her view. When unattended, the load engaging means will be fully lowered, controls will be neutralized, power will be shut off, and brakes set. Wheels will be chocked when the truck is parked on an incline.

c. Storage and handling of materials subject to special precautions. Hazardous materials subject to EPA requirements such as asbestos, PCB, and SF_6 gas are covered in chapter 3, paragraph 3–4. Materials that require more than normal handling and storage precautions because of possible adverse effects from mishandling or improper storage are required to conform to the following:

(1) *Flammable liquids.* Conform to applicable directives and regulatory agency requirements regarding the handling and storage of flammable liquids:

(a) Flammable liquids will be stored, handled, and transported only in approved containers, and extreme care must be used at all times to prevent ignition.

(b) When pouring or pumping flammable liquids from one metallic container to another, electrical contact will be maintained between the pouring and receiving containers.

(c) Leaky flammable liquid furnaces or torches will not be used.

(2) Poisons and pesticides. Before handling poisonous substances, workers will thoroughly familiarize themselves with the hazards involved and utilize all necessary precautions, protective devices, and/or equipment. Particular care will be exercised by

persons with open sores. Workers will not handle food, drink, and tobacco with such poisonous substances on their hands. Handling of pesticides will be done only by personnel certified by the applicable agency.

(3) *Explosives.* Explosives will not be handled by facility workers. Any requirement must be provided by contract personnel licensed in accordance with regulatory agency requirements. This requirement does not apply to cartridges used in powder-activated tools, which are exempt from regulatory agency provisions but do required qualified training.

(4) *Acid and caustics.* Acids and caustics should not normally be handled by electrical workers except for use in battery maintenance which is covered in paragraph 5–13.

(5) *Compressed gases - general.* Portable gas cylinders or containers, whether full or empty, will be handled with extreme care and will be stored in a suitable, well-ventilated location, properly secured in a vertical position with each container's valve cap in place, except when in actual use and connected to a device. Do not drop, jar, or expose to temperature extremes and keep away from sparks and flames.

(a) Cylinders will have their contents properly identified.

(b) Cylinders will not be rolled and will not be lifted by the valve or valve cap; a suitable cradle or other device will be used.

(c) Cylinders will not be placed where they might become part of an electric circuit or within 5 feet (1.5 meters) of an electrical outlet.

(d) A flame will never be used to detect gas leaks. A leaking cylinder will not be used but will be taken outdoors away from sources of ignition. Notify your foreman of the need for disposal.

(e) A sign "Danger-no smoking, matches, or open lights" or equivalent wording will be conspicuously posted in rooms or at entrances to areas where compressed gas is used or stored.

(f) Workers will never force connections which do not fit nor will they tamper with the safety relief devices of cylinder valves.

(g) No attempt will be made to mix gases in a cylinder or to transfer gas from one cylinder to another.

(h) The recessed top of cylinders will not be used as a place for tools.

(i) Compressed gases will not be used from a cylinder or cylinder manifold or other container unless an acceptable pressure regulating device is installed on the cylinder, valve, or manifold. Regulators will not be required with gases used from cylinders through torches or other devices which are not equipped with shutoff valves. All connections to piping, regulators, and other appliances will be kept tight to prevent leakage. When cylinders or containers are not in use, always keep valves tightly closed.

(j) Compressed gas cylinders will be transported so as to prevent them from falling, rolling, or creating a tripping hazard. They will be stored and/or-transported upright. Unless they are secured on a suitable truck, rack, or container provided for portable service; regulators will be removed and valve protection devices installed before cylinders are moved.

(k) Before the regulator is removed from a cylinder, the valve will be closed and all pressure released from the regulator.

(l) Gas cylinders will not be stored inside any occupied building. Separate storage buildings or sheltered storage areas will be used.

(m) Oxygen cylinders in storage will be separated from other gas cylinders or combustible materials (especially oil or grease) by a minimum distance of 20 feet (6 meters) or by a 5 foot (1.5 meters) high noncombustible barrier. Oil, grease, or similar materials will not be allowed to come in contact with any valve, fitting, regulator, or gage of oxygen cylinders.

d. Cleaning operations. Use only approved solvents and compressed air reduced to a pressure of no more than 30 pounds per square inch (207 kilopascals).

4–9. Rigging

Various types of fiber rope, wire rope, chains, rigging hardware, or combinations are used to lift material and equipment. The safe use of rigging devices requires that the combination of rope and rigging hardware must have adequate lifting capacity ratings and, when applicable must be approved for such use near any energized work. Refer also to CIE-4. Only qualified workers can install, maintain, and/or repair ropes and chains.

a. Fiber rope. Fiber ropes may be made of syn-

Table 4–1. Approximate safe working loads of new three-strand fiber ropes used in a straight pull.

Nominal diameter in	(mm)	Polypropylene lbs	(kg)	Polyester lbs	(kg)	Nylon lbs	(kg)	Polyethylene lbs	(kg)
1/4	(6.4)	250	(113)	300	(136)	300	(136)	250	(113)
3/8	(9.5)	500	(227)	700	(318)	700	(318)	500	(227)
1/2	(12.7)	830	(376)	1,200	(544)	1,250	(567)	800	(363)
5/8	(15.9)	1,300	(590)	1,900	(862)	2,000	(907)	1,050	(476)
3/4	(19.1)	1,700	(771)	2,400	(1,089)	2,800	(1,270)	1,500	(680)
7/8	(22.2)	2,200	(998)	3,400	(1,542)	3,800	(1,724)	2,100	(953)
1	(25.4)	2,900	(1,315)	4,200	(1,905)	4,800	(2,177)	2,500	(1,134)

Table 4–2. Moisture regain of fiber ropes

Type	Moisture regain percent
Polypropylene	0
Polyethylene	0
Polyester	0.4
Nylon	4.5

thetic materials or natural vegetable fibers.

(1) *Materials.* Synthetic fibers used for rope are nylon, polypropylene, polyester, and polyethylene. Natural fibers used are manila and sisal. Natural fiber ropes should not be used because they have high moisture absorbing factors and low loading strengths. Synthetic ropes' size to strength characteristics are given in table 4–1. Values are given in inches (in) and pounds (lbs) first and in parentheses second in millimeters (mm) and kilograms (kg). These values are based on new ropes under static testing without consideration of operating conditions. A safety factor should always be used in determining actual safe lifting capacity.

(2) *Construction.* Twisted rope is usually made of three or four strands. There are also braided ropes and parallel ropes. Each require different methods of splicing which are beyond the scope of this manual. Refer to TM 5-684 and the "Lineman's and Cableman's Handbook" for knot and splice data.

(3) *Conductivity.* No rope should be considered an insulator because all ropes contain moisture as part of the fiber makeup. The moisture regain of fibers is given in table 4–2. When rope becomes wet, dirty, or contaminated, its electrical conductivity is increased. Even insulators conduct electricity if not kept clean or dry. Only polypropylene and polyethylene ropes which are specially treated to resist wetting are recommended for use near energized conductors.

(4) *Safety (design) factor.* Different ropes have better characteristics for shock and sustained loadings. The minimum safety factor recommended is 6 for polypropylene and polyethylene and 9 for polyester or nylon rope.

(5) *Care of rope.* Rope should be cared for as follows.

(a) Never overload a rope or drag it over rough or sharp objects. The given safety factor is based on the minimum breaking strength of the rope. In figuring safety factor, make allowance for the age and condition of the rope.

(b) Be careful in making a rope fast. Avoid short acute bends over unyielding or sharp-edged surfaces. Never drag rope over the ground, over sharp objects, or over another rope. If rope is installed on an object with sharp corners, pad the rope.

(c) A rope with a kink or hockle (reverse kink) in it should be removed from service. Wet ropes are especially likely to kink.

(d) When rope is not in use, store it properly in a cool dry area away from direct sunlight to prevent shrinkage. Be sure it is free from mechanical injury, heat, or excessive dryness. Keep loose coils off the floor and hung on a wooden peg.

(e) Never use rope around storage batteries.

(f) A wet rope may absorb moisture, and therefore, it may not be as strong as a dry rope. Exceptions are polypropylene and polyethylene ropes

which do not absorb moisture. Polyester and nylon ropes, when they are properly finished with a marine overlay, could provide an increase in strength when wet. Never use a wet or frozen rope next to an energized line. Never permit a wet rope to freeze.

(g) Always finish (serve) the ends of fiber rope to prevent unraveling.

(h) Keep ropes clean. Dirt on the surface of and/or embedded in the rope acts as an abrasive on strands and fibers.

(i) The ends of all ropes should be prevented from fraying by first whipping and serving and then melting. Avoid excessive stretching of nylon rope by surging loads to prevent surface abrasion.

(6) *Inspection of ropes.* Rope should be inspected each time it is used.

(a) Examine carefully for cuts, worn spots, acid stains, and burns. The outward appearance of a rope is often deceiving.

(b) Rope must be free from metal strands and cores, solder, oil, and grime. An approved safety hook is the only metal permitted on a handline.

(c) A splice in a rope must be free of all metal objects, tapes, or knots. Splicing must be done in accordance with the "Splicing Handbook" from the Cordage Institute and must be tested and approved by the supervisor or foreman before usage. Splicing may reduce the safe working load down to 80 or 90 percent of a new rope. A hitch in the rope may reduce the rope strength to 45 percent and should not be used. Only a bowline knot which may reduce the rope strength to 60 percent can be used.

(d) A tackle must always be used with a block or load connected. If a tackle is to be used intermittently, it should be pretested before each use, as a safety precaution, with three times the load which it will carry.

(e) Before using fiber ropes as slings to lift loads, the capacity of the ropes should be determined first. When different types of ropes, chains, and rigging hardware are used in combination, the overall capacity is the capacity of the weakest item.

(7) *Use of rope.* Be aware of the following requirements when using rope.

(a) The elasticity and stretch of synthetic rope can cause a delay in response when lifting or dropping loads. Different fiber compositions will have different elongation curves.

(b) Use caution when the load is under excessive tension and then suddenly released. The whipping action is very dangerous to personnel and equipment in the area.

(c) Never use wet rope on or near energized conductors.

(d) Carry handlines up poles or structures uncoiled and attached to the back of your body belt. Be sure handlines do not catch on pole or structure attachments.

(e) The safe loads for rope indicated in table 4-1 must not be exceeded.

(f) Avoid sudden jerks or strains.

(g) Reverse rope ends periodically, BO all sections of it will receive equal wear.

(h) For hoisting work, where protection of a worker's life is paramount, use a safety factor three times as great as the safety factor previously given.

(i) When bent around a rounded surface the radius around which the rope is bent should be not less than six times the rope diameter, preferably eight times.

(j) Use pulleys, when necessary to prevent chaffing ropes, while lifting or lowering loads.

b. Wire rope. Increased fatigue life and resistance to abrasion and abuse are the main reason for the use of wire rope in slings and other hoisting devices. Such rope is usually made of wire strands laid together and twisted over a fiber-saturated and lubricated core. The core cushions and preserves the shape of the rope and lubricates the wires. Use wire rope in accordance with the recommendations of the manufacturer and do not exceed the safe working load required by ANSI B30.9, based on the breaking strengths of ASTM A 603. The safety factor for wire rope can be from 3 to 7 depending upon consideration of loads; acceleration; rope speed; the number, size, and arrangements of sheaves and drums; and the length of the rope.

(1) *Care of wire rope.* Never overload wire rope beyond its safe load.

(a) Never store wire rope or put any strain on it because it may cause a kink.

(b) Never store wire rope by winding it too tightly.

(c) Never store wire rope in a wet or damp storage area.

(d) When wire rope is cut, finish (serve) the cut ends with soft iron wire to keep the wires from unraveling.

(e) Lubricate wire rope as needed and never remove the rope's internal lubricant. Use a jet of air or steam, or wire brush the ropels exterior prior to applying the manufacturer's approved lubricant.

(2) *Inspection of wire rope.* Never use a wire rope without wearing gloves for safety. Check wire rope for broken strands by running a cloth over the rope to find the broken strands. Immediately remove wire rope from service and discard if it has one or more of the following defects:

(a) Corrosion of the wire rope or attachments caused by acids or alkalies. (Rust film, which has caused pitting or loss of less than one-third of the original diameter of outside individual wires can be removed and the wire can be cleaned, relubricated, and reused.)

(b) One or more broken wires in the valley between two adjacent strands, six randomly distributed broken wires in one rope lay, or three broken wires in one strand in one rope lay.

(c) Wear or scraping of one-third the original diameter of outside individual wires.

(d) Kinking, crushing, bird caging, or any other damage resulting in distortion of the wire rope structure.

(e) Evidence of heat damage.

(f) End attachments that are cracked, deformed, or worn.

c. Use of wire rope. Handle wire rope in accordance with the following requirements.

(1) Never apply sudden or abrupt loads on wire rope. When handling extra heavy loads never fasten rope over sharp edges or corners without padding.

(2) Wire rope should never be coiled or uncoiled like fiber rope. Always wind around sheaves or drums and avoid rope twist and spreading of coils and crossings or overlapping on sheaves or drums.

(3) Use sheaves and drums with grooves slightly larger than the wire rope to avoid pinching and binding the strands and to permit the rope to adjust itself to the curvature. However, the grooves should not be so much larger that the rope will flatten.

d. Chains. Chains have an advantage over wire ropes in that they are not as easily damaged. Always check that chains are an approved type for lifting. Only alloy steel chains for rigging that have been marked and maintained in conformance with the manufacturer's guidelines may be used. Do not use these chains for tying down equipment.

(1) *Care of chains.* Never overload chains beyond the safe loads indicated by the manufacturer's recommendations and do not exceed the safe working loads of ANSI B30.9 based on the breaking strengths of ASTM A 906.

(a) Never store chains in a wet or damp storage area.

(b) Normalize or anneal chains periodically as recommended by the manufacturer.

(c) Hooks, rings, links, couplings, or other attachments, when used with steel chains, must have a rated capacity at least equal to that of the chain.

(2) *Inspection.* Inspect chains used in load-carrying service before each initial use and weekly thereafter.

(a) Remove chains from service when any of the following defects are evident: nicked or cracked links, lifted linkwelds, more than 10 percent elongation of any link or section, or when wear of 20 percent of the diameter of any link has occurred.

(b) Chains are to be repaired by the manufacturer or in strict accordance with the manufacturer's recommendations.

(3) *Use of chains.* Never use chain slings that do not have permanently affixed durable identification stating size, grade, rated capacity, and sling manufacturer.

(a) Avoid sudden or abrupt application of loads to chains. When handling extra heavy loads do not fasten chains over sharp corners or edges without padding.

(b) Chains are conductors; they must never be used near live conductors or energized equipment.

(c) Never shorten or lengthen a chain by use of kinks or bolts.

e. Slings. Determine the capacity rating of fiber rope, wire rope, chains, rigging hardware, or combinations thereof before using them to lift loads. Refer to the requirements of ANSI B30.9. For individual items used in combination, the safety factors are not cumulative, and the overall capacity rating of the combination is the capacity of the weakest item. The particular application or service factors may further reduce the capacity rating. The sling angles affects the capacity of each leg by the sine of the angle to the horizontal. Never provide a sling angle of less than 30 degrees. This reduces the capacity by 50 percent (sine 30 degrees = 0.5).

(1) Store slings so they will not be damaged.

(2) Protect in-use slings from being damaged by sharp, rough, or square corners. Use chafing protection between rope and edges. Sharp bends (which should be avoided to protect the sling from being damaged) also need chafing protection.

(3) Remove damaged slings from use and destroy them.

(4) To prevent sling-related accidents, do the following:

(a) Do not use knots or other devices to shorten slings.

(b) Keep sling legs free of kinks.

(c) Keep the load within the sling's capacity.

(d) Balance loads supported by basket hitches to prevent slippage.

(e) Securely attach the slings to the load.

(f) Keep suspended loads clear of obstructions.

(g) Keep people clear of suspended loads and loads about to be lifted.

(h) Keep your hands and fingers from between the sling and the load while the sling is being tightened around the load.

(i) Place blocks under the load so slings may be removed without damaging them.

f. Rigging hardware. Do not use job-fabricated hardware unless it has a been tested and certified by a rigging engineer.

(1) Use forged-alloy or stainless steel hoisting hooks (excluding sling and choker hooks) that are stamped with their safe working load and are equipped with safety keepers, swivels, and headache balls (minimum tension devices).

(2) Use forged-alloy or stainless steel shackles of the locking or secured-pin type for hoisting. Inspect them before use and discard any that are worn in the crown or pin by more than 10 percent of the original diameter. Do not replace shackle pins with bolts.

4–10. Heavy lifting equipment

Cranes, winches, and derricks are used on vehicles for hoisting heavy equipment, as opposed to aerial lifts or buckets used to elevate personnel to job-sites above ground.

a. Operation of equipment near energized electrical facilities. Equipment and workers must take into account the safe operating requirements for such an operation.

(1) When mobile hoists, cranes, or similar lifting devices are used near energized lines or equipment, the lifting device will be properly grounded, or insulated, isolated, or considered as energized.

(2) Unqualified workers will not set up nor operate any piece of equipment where it is possible to bring such equipment or any part thereof within the minimum safe approach distances specified in table 3–2. This applies to any medium- or high-voltage (600 volts and above) line or installation unless the line is de-energized, a clearance is secured, and the line or equipment is grounded. To maintain the distances specified in table 3–2, the worker may:

(a) Install adequate guards or barriers, or

(b) Use a full-time signalman to warn the operator when approaching minimum distances.

(3) Qualified electrical workers will comply with the requirements for aerial lifts.

b. Equipment operation. Only authorized persons will be permitted in the cab or on the equipment. Only those designated persons who are trained and qualified will operate the hoisting equipment.

(1) Always include the weight of auxiliary load-handling devices (such as buckets, magnets, load

falls, slings, and hooks) as part of the load. Follow the manufacturers operating and maintenance procedure and never overload the lifting device. Alterations and modifications are to be made only by authorized persons.

(2) Only one person is permitted to give orders to the lift operator during the entire movement of the object. The operator, however, will obey a "Stop" signal given by anyone.

(3) Inspect the vehicle before use each day and have defects corrected. Also have the equipment tested and certified annually. For the first lift of each day, the load will be test-lifted and the brakes checked (load lifted several inches and then tested) and the following minimum checks will be made.

(a) Check all control mechanisms for any possible maladjustment which could interfere with proper operation.

(b) Check all safety devices for any malfunctions.

(c) Check for any deterioration or leakage in the air or hydraulic system.

(d) Check for the adequacy of hooks, slings, and load attachment devices.

(e) Check for the presence of a fire extinguisher which is at least a U/L-rated 5BC (2.5-pound or 1.1-kilogram capacity approved for Class B and C fires) in accordance with ANSI/UL 711.

(4) Operators will not leave their position at the controls of lifting devices while the load is suspended.

(5) No person will be permitted to ride on the hook, sling, or load of any hoisting equipment. No worker will be under a suspended load or inside the angle of a winch line. No worker will stand or work near a chain or rope under tension unless the nature of his/her work requires it.

(6) With every load change, the slings and bindings will be checked and will be readjusted as necessary to ensure safety and stability. All slings and other fittings will be of sufficient strength and of the proper type so as to be safe for their intended use.

(7) Observe the following precautions when using a winch and hoisting cable.

(a) Because of the heavy nature of work done with winches, it is essential that all moving parts be kept thoroughly lubricated. The rated capacity of both winch and cable must never be exceeded.

(b) Use chain or wire rope when pulling poles, stumps, trees, or when lifting objects with a winch and derrick.

(c) When using a winch and cable for any purpose, always pass the cable over a sheave. Never run the cable over the end of a truck without using a sheave.

(d) Never use winch cable over sheaves or bars to raise or lower a load which should be handled with a derrick.

(e) All personnel should be instructed to stand clear of a cable when it is under strain.

(f) Kinks in winch lines should be avoided to prevent weakening at kink points.

(g) Do not use your hands to guide or straighten winch cables on a drum while the drum is in motion.

(h) Wear leather work gloves when handling winch cable.

(i) Discard defective cable.

(j) Do not use winches with mechanical defects.

(k) Do not use bent or broken A-frames or booms, or those which have cracks in the steel.

(8) Observe the following precautions for erecting derricks.

(a) To safely assemble a derrick, the truck should be as nearly level as possible. For safety, two or more workers are required to remove any leg of the derrick from the truck. For larger derricks additional workers may be required. Support the boom when extending it so that the telescopic ends cannot be pulled out too far causing a section to drop. Do not permit anyone to stand under the derrick while it is being raised or lowered, nor at other times, unless a stiff leg or safety cable is connected. To reduce excessive strain on tires, springs, and chassis, support the truck by placing the derrick supporting jacks in position whenever possible. It may be necessary to block the rear wheels if the truck is not standing on level ground.

(b) To protect the public and workers, do not operate trucks on streets, roads, or highways with the derrick assembled, unless the truck is towing a trailer, and then only for short distances and under the immediate direction of a designated worker, who will give undivided attention to the movement.

4–11. Aerial lifts

Aerial lifts are electrically isolated buckets, which are often referred to as insulated buckets. Aerial lifts must be constructed to meet ANSI/SIA A92.2. Follow aerial lift rules as given to meet facility and OSHA safety practices.

a. Operation of aerial lift equipment near energized electrical facilities. Electrical workers may operate aerial lift equipment between the distances specified in table 3–2 and the distances specified in table 3–3 if all of the following conditions are met:

(1) A job hazard analysis has been done.

(2) A hot line order has been obtained.

(3) The activity is being performed under the direct supervision of a designated person who is trained and competent in this type of work.

(4) The distances between energized parts and the aerial lift equipment is monitored while the aerial lift equipment is being moved and/or repositioned.

(5) The aerial lift equipment is grounded.

(6) No one, other than necessary workers, are within 10 feet (3 meters) of the equipment during its operation. Workers are to perform their work while on the equipment; not from a position on the ground.

b. Types of aerial lifts. Aerial lifts include the following types of vehicle-mounted aerial devices used to elevate personnel to job-sites aboveground.

(1) Extensible boom platforms.

(2) Aerial ladders.

(3) Articulating boom platforms.

(4) Vertical towers.

(5) A combination of any of the above.

c. Manufacture. Aerial equipment may be made of metal, wood, fiberglass reinforced plastic (FRP), or other material; may be powered or manually operated; and are deemed to be aerial lifts whether or not they are capable of rotating about a substantially vertical axis. Aerial lifts may not be “field modified" unless such modification is certified by the manufacturer.

d. OSHA aerial lift rules. OSHA mandates the following rules.

(1) Aerial ladders will be secured in the lower traveling positions by the locking device on top of the truck cab and the manually operated device at the base of the ladder, before the truck is moved for highway travel.

(2) Lift controls will be tested each day prior to use to determine that such controls are in safe working condition.

(3) Only authorized persons will operate an aerial lift.

(4) Belting off to an adjacent pole, structure, or equipment while working from an aerial lift will not be permitted.

(5) Workers will always stand firmly on the floor of the bucket and will not sit or climb on the edge of the bucket or use planks, ladders, or other devices for a work position.

(6) A body harness will be worn and a lanyard attached to the boom or bucket while working from an aerial lift.

(7) Boom and bucket load limits specified by the manufacturer will not be exceeded.

(8) The brakes will be set and outriggers, when used, will be positioned on pads or a solid surface. Wheel chocks will be installed before using an aerial lift on an incline, provided they can be safely installed.

(9) Generally, an aerial lift truck will not be moved when the boom is elevated in a working position with workers in the bucket.

(10) Articulating boom and extensible boom platforms, primarily designed as personnel carriers, will have both platform (upper) and lower controls. Upper controls will be in or beside the platform within easy reach of the operator. Lower controls will provide for overriding the upper controls. Controls will be plainly marked as to their function. Lower level controls will not be operated unless permission has been obtained from the worker in the lift, except in case of emergency.

(11) Climbers will not be worn while performing work from an aerial lift.

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

(13) Before moving an aerial lift for travel, the boom(s) will be inspected to see that equipment is properly cradled and outriggers are in the stowed position.

e. Other general rules. Observe the following safety rules.

(1) The operating and maintenance instruction manuals issued by the manufacturer will be followed.

(2) Shock loading (sudden stops or starts) of the equipment will be avoided.

(3) When a boom must be maneuvered over a street or highway, necessary precautions will be taken to avoid accidents with traffic and pedestrians.

(4) The operator will always face in the direction in which the bucket is moving and will see that the path of the boom or bucket is clear when it is being moved.

(5) Workers will not ride in the bucket while the truck is traveling. (Exceptions: Workers may ride in the bucket for short distances at the work location if the bucket is returned to the cradled position for each move and the workers face the direction of travel.)

(6) When workers are in the bucket of an aerial lift, the emergency brake of the vehicle will be set. Wheel chocks or outriggers will be used to provide added protection. When the vehicle is on an incline, wheel chocks will be used regardless of whether or not outriggers are used. The truck should sit approximately level when viewed from the rear.

(7) Workers will not stand or sit on the top or edge of the bucket or on ladders placed in the bucket. Workers' feet will be on the floor of the bucket the entire time they are in it.

(8) When two workers are in the bucket or buckets, one of them will be designated to operate the controls. One worker will give all signals, which will be thoroughly understood by all persons concerned.

(9) When two workers are working from the bucket, extreme care will be taken to avoid one worker contacting poles, crossarms, or other grounded or live equipment while the second worker is working on equipment at a different potential.

(10) In no case will more than one energized conductor or phase be worked on at a time.

(11) The aerial lift with workers and equipment will maintain proper clearances from unprotected energized conductors. Safety rules governing the use of hot-line tools, rubber goods, personal protective equipment, and general safe practices apply to work done from aerial buckets.

(12) When using pneumatic or hydraulic tools in a bucket, the operator will be sure that hoses or lines do not become entangled in the operational control B .

(13) Bucket care will be provided the following requirements.

(a) Remove water accumulation from the bucket. The bucket interior must be dry during use.

(b) Wipe exposed insulation of bucket and boom clean with a dry cloth at the start of each day.

(14) Always inspect a bucket daily before any work is done.

(a) Inspect visible hydraulic hoses for chafing and then inspect hoses and fittings for leaks with the system under pressure.

(b) Inspect wire cables for frayed strands and secure attachment.

(c) Inspect the bucket safety belt assembly for good condition.

(d) Verify that the most recent dielectric test for the bucket and arm occurred within the last 6 months.

(e) Examine the exposed insulation of an insulating boom for cuts, unusual discoloration, or other signs of damage prior to use or at any time damage is suspected.

(f) Inspect the remaining portions of booms, sheaves, cables, fittings, bucket, and bucket liner for defects.

f. Insulated buckets. Insulated buckets are re-

quired for work in accordance with table 3–5. An insulated bucket of an aerial lift is provided with a conductive bucket liner.

(1) The liner, usually a metallic screen, must completely surround the bucket walls and floor to provide electrostatic shielding for the occupant. Tools and other equipment carried in the bucket must be stowed carefully to avoid damaging the liner.

(2) Insulated buckets will be subjected to an arm current (dielectric) test. This test will consist of placing the insulated bucket in contact with an energized source equal to the voltage to be worked upon for a minimum 3 minute period. The leakage current will not exceed one microampere per kilovolt of nominal line-to-line voltage. Arm current tests should be made at the start of each day, each time a higher voltage is to be worked, and when changed conditions indicate a need for additional tests. Keep a record of all tests. Work operations will be suspended immediately upon any indication of a malfunction in the equipment.

g. Maintenance. Perform periodic maintenance in accordance with the manufacturer's operations and maintenance manual. Perform electrical tests on insulation no less than every 6 months.

4–12. Live-line tools, electrical safety tools, and specialty electrical tools

These are tools manufactured for use by electrical workers to provide protection (and thus safety) when working on energized (live-line) equipment such as lines and bus bars, on de-energized and grounded lines, or for other maintenance activities.

a. Live-line tools. Live-line or hot-line tools insulate the worker from the energized line. They are also known as hot sticks since they are in the form of an insulated stick or pole. If there is a loss of insulation the worker's safety is compromised. Live-line tools are not only used to work on energized lines; they are also used to safely de-energize and ground lines for de-energized line working. The following paragraphs discusses their terminology and use.

(1) *Terminology.* ANSI/IEEE 935 is the guide to be used for tool terminology. It does not give detailed definitions but does provide pictorial descriptions of the various components used. Another useful tool reference is “Hot Sticks - a Manual on High-Voltage Line Maintenance.”

(a) Tool material. Tools are constructed of insulating material and/or conductive material. Metal conductive material is used primarily for mechanical strength. The conductive material may be coated or covered with insulating material to protect the worker from electrical contact and to avoid flashovers.

(b) Difference between insulated and insulating tools. An insulated tool is made of conductive material and then fully or partly covered by insulating material, while an insulating tool is essentially made entirely of insulating material.

(2) *General hot-line tool types.* ANSI/IEEE 935 covers 10 different types of equipment used in live-line working.

(a) Insulating sticks. Insulating sticks consist of hand sticks used only to operate on a line or equipment by a worker. They may be fitted with splines at their ends to permit other tool attachments. Support sticks are used to hold or move conductors.

(b) Universal tool fittings. These tool fittings are spliced-end tools such as pliers, wrenches, hammers, and some 35 others, and some 6 clevis and tongue tools to fit on the end of insulating sticks.

(c) Insulating covers and similar assemblies. These are of various types to provide insulation from conductors, conductive hardware, insulators, and as barriers to limit work zones. See rubber protective equipment covered in paragraph 4–14.

(d) Bypassing equipment. This equipment is used to provide an electrical shunting device around equipment, to connect or disconnect a circuit under load, to bypass a fuse or other device, to fuse and protect a bypass, or to pickup an electrical load.

(e) Small individual hand tools. These are insulating or insulated hand tools for use with rubber gloves.

(f) Personal equipment. Personal equipment includes mechanical protection such as gloves, boots, helmets, shoes, and electrical protection such as conductive or insulating apparel and eye protection.

(g) Positioning equipment. Positioning equipment includes body belts, bucket trucks, ladders, suspension attachments, platforms, and seats.

(h) Handling and anchoring equipment. Includes ropes, slings, rope block yokes, gin poles, saddles, and various accessory devices.

(i) Measuring and testing equipment. In-

cludes dynamometers, gap and wire gages, measuring sticks, phasing testers, and voltage detectors.

(j) Hydraulic and miscellaneous equipment. Includes hydraulic compression heads, cutter hoses, pumps, and various miscellaneous hot-line devices.

b. Safety tools. Safety tools may be used in conjunction with hot-line tools or to de-energize the line, or after de-energization to maintain ground continuity. Grounding jumpers, elbow connectors, fuse pullers, grounding clusters, and underground cable grounding spike clamps are devices available and should meet ASTM F 855 and IEEE 1048 requirements for protective grounding of power lines.

c. Specialty tools. Specialty tools are used in electrical maintenance activities, such as setting poles by the pike pole method where jennies, cant hooks, pike poles, and bumpboards are used. Specialty tools not covered in this chapter, such as fall protection climbing devices, and hand lines are covered in paragraphs 6–5 and 6–12 respectively. Aerial line tool use is covered in paragraph 6–13.

4–13. Care and inspection of live-line (hot-line) tools

These tools are only as safe as their continued care and inspection make them. ANSI/IEEE 516 and IEEE 978 provide additional information on maintenance and testing.

a. Manufacture. Tools should be manufactured to meet ASTM F 18 series specifications as appropriate to the device and material. The insulating tool portion can be made of fiberglass or wood. Fiberglass should be used, if possible, as it does not absorb moisture, is impervious to oil-borne materials and solvents, stronger, and is a better insulator than wood. Like any insulator, fiberglass must be keep clean and dry to maintain its insulating ability. Only use live-line tools that have a manufacturer's certification as having been tested to meet the following minimum requirements.

(1) *Fiberglass.* A fiberglass tool must have withstood 100,000 volts ac per foot (328,100 volts ac per meter) of length for 5 minutes.

(2) *Wood.* A wood tool must have withstood 75,000 volts ac per foot (246,100 volts ac per meter) of length for 3 minutes.

b. Records. Records will be maintained for all live-line tools to indicate their shop or laboratory inspection and test dates. It is recommended that electrical shop and laboratory testing be provided at intervals of not more than 6 months for tools in frequent use and not more than one year for tools stored for long periods of time. OSHA requires that electrical testing of hot line tools be provided every 2 years.

c. Tool inspection. OSHA rules require that live-line tools will be visually inspected before use each day. Tools to be used will be wiped clean and if any hazardous defects are indicated such tools will be removed from service. The following field observations warrant their removal from service.

(1) Failure to pass electronic test or a moisture meter test using portable live-line tool testers.

(2) An electrically overstressed tool showing evidence of electrical tracking, burn marks, or blisters caused from heat.

(3) A mechanically overstressed tool showing such evidence as damaged, bent, worn, or cracked components; or a tool with deep cuts, scratches, nicks, gouges, dents, or delamination in the stick surface; or a tool with a deterioration of its glossy surface.

(4) A tingling or fuzzy sensation when the tool is in contact with energized conductor or hardware.

d. Tool cleaning. Clean live-line tools before each use with a clean absorbent paper towel or cloth and then wipe with a silicone-treated cloth. Waxing is not necessary after every use but only as needed. Use cleaning and waxing kits manufactured for live-line tools and follow directions for their use. Never use cloths that have been washed in harsh solvents, soap, or detergents. Residues left on the tools may be conductive and abrasives can destroy the surface gloss of the tool and cause water or moisture beads to form on the surface of the tool.

e. Handling and storage. Workers share responsibility with their foreman and supervisor for the continued safe condition of live-line tools.

(1) *Storage.* All live-line tools not being regularly transported will be stored in a dry location and will not be tampered with or handled by unauthorized personnel. A warm location may result in condensation forming. Wood tools must not be subject to temperature changes which can cause warping. Store tools in padded bins and racks away from dirt, moisture, and ultraviolet rays.

(2) *Transportation.* Live-line tools will be transported with care and protected from mechanical damage. Exposure to the weather should be avoided. The same elements of care should be used

for storage. Never lay tools on the ground. Containers should be padded to prevent damage to insulating surfaces from abrasive or bumping actions or contamination from the environment.

f. Repairs. Repairs should be made only by competent personnel. Generally if there is no roughness on the surface and the live-line tool meets electronic and moisture tests there is no need for repair. Small surface ruptures and small voids beneath the surface may need repair. Electrical tests such as high-potential or dielectric-loss tests should follow any such repairs. Tests should be performed by qualified personnel under contract or by facility workers who are familiar with the test requirements of IEEE 978.

g. Use of live-line tools. When using live-line tools, employees will not place their hands closer than is absolutely necessary to energized conductors, equipment, or metal parts of the tool being used, and in no case closer than the minimum approach distance specified in table 3–3.

(1) Quick change tool heads will not be used without a "Quick change safety clip."

(2) Approved blocks, ropes, slings, and other tackle used in live-line tool work will not be used for any other purpose and will be kept clean, dry, and free from any foreign substances.

(3) Live-line tools being used to spread or raise conductors will be securely fastened and will not be held by workers except as necessary to secure or release them.

(4) Live-line tools should be hung on a hand line or approved tool hanger if possible. Do not hang a tool on a conductor or bond wire.

(5) Live-line tools will not be used in rain or heavy fog except when considered necessary by the foreman. In no case will they be used when conditions permit formation of rivulets of water along tools.

4–14. Rubber protective equipment

Rubber protective equipment consists of gloves, sleeves, blankets, insulator hoods, and line hose. Assure that all items meet or exceed requirements of the applicable ASTM F 18 series specifications.

a. Provision. The foreman should determine the necessary type and amount of protective equipment required on every job and visually inspect the equipment before use. Rubber goods must be inspected immediately before use or at least once a week. If an item is found to be defective, it must be destroyed.

(1) Each line truck and service or trouble vehicle should carry enough rubber protective equipment for all of the crew's needs when handling work on voltages of 15,000 phase-to-phase and under. The equipment will be carried in waterproof, lightproof, and dustproof compartments or containers.

(2) Do not carry rubber protective equipment in compartments with other tools or with tools in tool bags.

b. Use of rubber protective equipment. Rubber protective equipment must be used on all conductors or live parts which might possibly be contacted by a worker climbing through or reaching from a working position. See paragraph 3–15 for the recommendation against combined live-line tool use and rubber gloves.

(1) Protective equipment should be positioned to protect workers against unforeseen hazards such as slipping, cutting out, leaning back, or falling.

(2) Protective equipment should be placed by working from a level below the wires or insulators on the pole or structure, beginning with those nearest the climbing space, and covering the live parts in the order of their distance from the climbing space. Be sure to wear rubber gloves and sleeves if required.

(a) Other points of contact, such as grounded guys, equipment, and secondary wires, should be covered to provide complete protection.

(b) In cases where the voltage is too high for safe use of rubber protection, the lines and taps near the work area should be covered as necessary for the voltage level, de-energized, discharged to ground, and grounded on all sides and preferably within sight of the work area.

(3) The removal of protective equipment must be done with equal care, wearing rubber gloves and sleeves if needed, and working below the level of wires and insulators. The order of removal should be the reverse of the order of placement.

(4) Rubber sleeves must be used under any conditions where there is a possibility of the arms coming within the minimum distance (table 3–3) of the energized conductors or equipment.

c. Use of rubber gloves. Rubber gloves and sleeves if required, with leather gloves suitable for the purpose, and gauntlets, should be worn when climbing or working on installations or structures in the vicinity of live circuits or any wire or equipment

that may become energized by remote or accidental means. Rubber gloves should not be used without protector gloves over them. Liners are also available for wearing inside rubber gloves to absorb perspiration.

(1) Use only the gloves assigned, except in case of emergency.

(2) Keep sleeves of wearing apparel tucked inside the cuffs of the rubber gloves.

(3) Rubber gloves must be put on before the employees are within reaching distance of live wires or parts. Reaching distance is within 3 feet (90 centimeters) in any direction of wires or parts in excess of 600 volts.

(4) Do not remove gloves until out of the reaching distance of live wires or parts.

(5) Use rubber gloves and protector gloves (leather gauntlets) only for the specific purposes for which they are intended.

(6) Take care to keep hands away from contact points where an arc may form.

(7) Wear rubber gloves at all times when:

(a) Working on circuits, wiring, or equipment in accordance with table 3–5.

(b) Removing or replacing fuses.

(c) Changing surge arresters.

(d) Changing capacitors.

(e) Applying or removing grounding devices unless insulating sticks are used of the proper length.

(f) Working on equipment or lines which parallel power circuits and which may be subjected to induced voltage or accidental contact with live conductors.

(g) Working street lighting (series) circuits.

(h) Working on signals and signal wires.

(i) Working alone in wet weather, or when working on equipment with hazardous exposed parts. Only in extreme emergencies is a worker permitted to work in wet weather or allowed to work alone on or near energized conductors or equipment, regardless of weather conditions.

(j) Assigned as a pulling, tensioning, or reel attendant.

(k) Assigned as ground worker who may contact conductors being installed on poles and equipment.

(l) Handling poles or structures that are being erected in or between existing energized lines.

d. Use of rubber sleeves. Rubber sleeves should be worn whenever there is a possibility of arms coming within the approach distance of table 3–3. They will be worn for rubber glove work. They must be worn when using live-line tools, even though the wearing of rubber gloves is not recommended.

e. Care and inspection. Rubber protective equipment should be inspected daily and stored in its proper compartment or container. Protective equipment will not be stored in a sharply bent position or exposed to the sun's rays, light, or heat.

(1) *General care.* Wipe protective equipment dry before storing. Protect from contact with oil, paint, creosote, kerosene, gasoline, acids, and other harmful materials. Rubber protective equipment must be turned in at least once every 6 months for gloves, every 12 months for sleeves and blankets, and upon indication that the insulating value is suspect for line hose and covers. Turn in will be made to a testing laboratory for cleaning, inspection, and electrical tests. Shorter inspection periods may be required where frequent use of equipment is made.

(2) *Care of rubber gloves.* When not in use, rubber gloves should be carried in glove bags and when in use as follows:

(a) Rubber gloves must be washed when tested at an approved laboratory and kept free from embedded foreign matter.

(b) Talcum and similar powders may be used after washing rubber gloves to avoid skin irritation and to prevent the rubber from sticking together.

(3) *Inspection of rubber gloves.* Before putting on rubber gloves, give each glove an air test to detect cuts and weak spots. Roll the glove up tightly beginning at the gauntlet end. Notice if any air escapes through the palm, thumb, or fingers. Gloves which show weak spots or air leakage must be destroyed.

(4) *Care of rubber blankets and sleeves.* Roll; never fold. When being rolled, their surfaces must be brushed clean to prevent dirt from becoming em-

bedded in the surfaces of the rubber. Do not wear climbers when standing on rubber blankets.

(5) Inspection of rubber blankets and sleeves. Inspect immediately before use. Items with cracks, holes, snags, blisters, or other defects must be discarded.

(6) Care of line hose and insulator hoods. Spread open line hose and insulator hoods to dry so as to permit free circulation of air on the inner side. Store hose and hoods in compartments so that no part is strained or distorted.

(7) Inspection of line hose and insulator hoods. Inspect hose and hoods immediately before use. Examine hose or hoods before use to ensure that there are no defects and to determine whether or not they are suitable for further use.

4–15. Electrical testing devices

Electrical testing devices are necessary to assure that maintenance of electric lines can be accomplished safely. For a more complete discussion of test devices, "Electrical Equipment Testing and Maintenance" is recommended as a reference. This section covers testers which are considered necessary for normal safety considerations. Always use testing devices according to the manufacturer's recommendations and with the appropriate personal protection and/or live-line tool.

a. Voltage detectors. Voltage detectors are used to determine whether the line or device is energized. Low-voltage detectors often use neon glow lamps or solenoid plunger testers. Medium- and high-voltage detectors are proximity and direct-contact types. It is very important that the user understand where and how the detectors should be used. Some detectors cannot be used to detect or measure voltages on cables with metallic sheaths or semiconductor coatings. Some detectors can not be used on ungrounded-circuits or to detect lower voltages.

b. Phasing testers. Phasing testers are used to determine the phase relationships and approximate voltages on energized lines.

c. Line fault locators. These locators are used on underground lines up to 34.5 kilovolts to determine the location of line faults.

d. Insulator testers. These testers are used to measure the potential across each insulator in a suspect string of cap and pin insulators. They can be used without interrupting service.

e. Leakage-current monitors. The leakage current that can occur from overcurrent conditions on insulated ladder and truck booms need to be monitored for worker safety. Use of a monitor which sounds an alarm at a preset leakage current level alerts the worker to danger and eliminates the need to watch the current which is also continuously displayed on the monitor's screen.

f. Combustible gas/oxygen detectors. Portable monitors provide visual and audible warnings of explosive atmospheres and/or low oxygen levels. A reading of any gas concentration ranging from 0 to 100 percent of the lower explosive level (LEL) and O to 25 percent of the oxygen level is given.

4–16. Insulating oil handling operations

De-energize oil-insulated equipment, if possible. Observe the following additional precautions during oil-filtering, oil-reclaiming, and other oilhandling operations:

a. Always de-energize potential and current transformers before taking oil samples from them.

b. Have appropriate fire extinguisher(s) readily available.

c. If necessary to process oil in an energized power transformer, conduct a job hazard analysis, prepare a written work procedure, and take appropriate precautions.

PART TWO
EXTERIOR SYSTEMS

CHAPTER 5
OUTDOOR SUBSTATIONS

5–1. Substation work

Safety precautions to be used in maintaining electrical apparatus and lines found in those outdoor areas must be observed.

5–2. System familiarity

A substation provides a protected area where equipment and lines permit switching power circuits and may allow transforming power from one voltage to another. A substation presents a potential safety hazard because usually only portions of the apparatus concerned can normally be de-energized. For safe operation, a thorough knowledge of the system, including aerial and underground line connections, is necessary. Systems are designed to be safe to operate if maintained properly. Operating safely requires maintenance to be done in a manner that eliminates risks and requires knowledge of the work area, its hazards, and its design operating rationale.

a. Diagrams and schematics. Electrical diagrams and schematics of the substations should be available at the facility's engineering office and should be updated. Diagrams and schematics should be studied to understand the operation of the systems and the location and connections of all circuits. Protective devices, alarms, and interlocking circuits all operate to protect the system. The worker must understand where, why, how, and when blocking protective devices will maintain safe working conditions. However, only a supervisor can authorize blocking.

b. Engineering guidance. Diagrams and schematics should be kept up to date under the supervision of the facility's engineering staff. Staff guidance should be sought when performing maintenance on complex systems. Staff input is mandatory if the maintenance work involves additions or changes to the power and control systems involved.

c. System operation. System single line diagrams should be permanently mounted at each substation. When Safe Clearance switching operations are performed, mimic buses on switchgear are helpful as a visual indication of the lines or equipment served.

(1) *Protective devices.* Protective devices within the system, such as relays and fuses which are to be worked on or replaced, must retain respectively their correct coordination settings or be of the proper size and type. Always record previous data so that changes in system coordination are not made.

(2) Alarms. System alarms, if blocked during maintenance, must be returned to their correct operating conditions.

(3) *Interlocking.* Interlocking is provided to maintain proper electrical operation in the case of a circuit loss or switching change. Interlocking provisions should be known so as to eliminate any dangers of electrical feedback from another source. Possible paralleling of two unsyschronized sources. Or other unsafe operation.

d. Abnormal conditions. Any maintenance done after fault conditions have interrupted normal service, imposes more than normal maintenance risks. Faulty energized equipment and lines should always be de-energized before any work is done. All abnormal operating equipment and electrical components should be de-energized and tagged.

e. Defective equipment. If an apparatus which is to be worked on is found to be in a dangerous condition or not working properly, it should be removed from service immediately and tagged. Then, a complete report of the condition of the equipment should be provided by the worker to his/her foreman or supervisor the same day.

(1) Defective equipment removed from service, such as distribution, potential, and current transformers; capacitors; and surge (lightning) arresters must positively be identified by the foreman before they are put in storage. Any existing defective equipment in storage or at any other location must also be identified.

(2) Identify defective equipment by painting a large red X on the body, not on the top of the equipment. The red X must remain on such equipment until it has been repaired or until it has been prop-

erly disposed of.

(3) It should be considered gross neglect of duty and willful disobedience of instructions for a worker to deface in any way the red X on defective equipment or to place such equipment in service while so identified. The worker in charge of repairing any piece of defective equipment should be the only person authorized to remove such identification and then only after all repairs have been made and the equipment has met all necessary tests.

(4) In cases where defective or reclaimed equipment is repaired and tested by electrical facility workers, they may then remove the defective identification marking.

5–3. Work area control

Control of the work area is mandatory to accident prevention. Procedures for specific maintenance may vary but certain rules are basic to all work.

a. Previsit briefing. A previsit briefing will be carried out to familiarize workers with the work area. The briefing will include the status of the equipment, what part if any is energized, location of ground, what the limits of the working space are, what open switches disconnect the equipment from any source of supply, and system operating aspects. If for any reason there is an interruption in the work, or conditions change, another conference briefing will be conducted to familiarize all of the workers with the new conditions.

b. Clearance access. When entering an attended station, workers not regularly employed in the station must report immediately tot he operator in charge, stating their names, offices, purpose of the visit, and their planned activities. For unattended stations, workers must be escorted by installation personnel. Unattended station doors must always be kept closed and locked.

c. De-energizing work areas. When it is necessary to work on or near any electrical circuits or apparatus, the Safe Clearance procedures prescribed in paragraph 3–8, as well as pertinent rules given in this chapter, must be carefully followed. If work must be performed on energized lines, it is mandatory that the requirements given in paragraph 3–12, be followed.

(1) *Switching.* Station operators must notify maintenance workers before doing any switching that affects their work.

(2) *Lockout and tagout.* Lockout and tagout all power sources and circuits to and from the equipment and circuits in the work area. All controls will be made nonoperative and all feedback circuits, such as from potential transformers or other sources, will be cleared.

(3) *Barriers and barricade tape.* Temporary barriers will be placed between the space occupied by workers and the energized equipment, both as a protection and a reminder of the limits of the working space. The person holding the Safe Clearance is responsible for barricade locations and they are to be moved only under that person's direction. After the work is finished, that person will remove the barriers prior to releasing the Safe clearance.

(a) Use of barricade tape. It is recommended that solid red barricade tape be used to enclose work areas and a white-with-a-red-stripe barricade tape be used to isolate temporary hazard areas. Only active workers may enter the solid red taped area until the hazard has been corrected. A temporary hazard could be a faulty but energized line.

(b) Placement of barricade tape. Tape should completely enclose the work area, be visible from all approach areas, and be at an effective barrier level. The area enclosed should be large enough to provide worker safety and arranged so any test equipment can be operated outside the taped area.

(c) Nonpermittted use. Temporary barriers and barricade tape will not be used as a substitute for guard railings, for work platforms, or for protection for holes in the floor. Information tags or other warning devices will be provided to identify a hazard that is not obvious.

(4) De-energizing proof testing. All lines and equipment on which de-energized work is to be performed will be tested to be sure they are de-energized before protective grounds are applied.

(5) *Grounding.* After indication that all circuitry in the work area is de-energized, provide protective grounds as covered in paragraph 3–11. Place ground so that each ground is readily visible to at least one member of the crew. Stay clear of cables and connecting devices while ground are being applied.

(6) *Adjacent energized equipment protection.* When work is to be done on or near energized lines, all energized and grounded conductors or guy wires within reach of any part of a worker's body will be covered with rubber protective equip-

ment. Bare communications conductors will be treated as energized lines and will be protected accordingly.

(a) Flexible blankets will not be used at grade level without protecting them from physical damage and moisture by means of a tarpaulin, canvas, or protective mat.

(b) To avoid corona and ozone damage, rubber protective equipment will not be allowed to remain in place on energized lines or apparatus overnight or for more than one 8-hour period, unless approved by the supervisor in charge.

(7) *Worker protection*. Personal protective apparel will be worn as deemed necessary be the supervisor or foreman in charge, as recommended by the manufacturer for the tool being used, or as otherwise directed in this manual. Protective tools will be used as appropriate to the work being done.

d. Working area housekeeping checks. Check the working area to ensure safe conditions and eliminate or protect against such hazards which can include the following—

(1) Equipment hazards such as lack of guards or safety devices.

(2) Material hazards such as sharp, worn, slippery, corroded, or rough items or areas.

(3) Work station weather hazards such as wind, rain, ice, or dust.

(4) Arrangement hazards such as congestion, unsafe storage in place, or improper worker's tool provisions and storage.

(5) Lack of fire prevention and first aid equipment and inadequate working equipment and tools.

(6) Insufficient testing equipment, protective apparel and equipment, and safety forms and tags.

e. Installation precaution. All apparatus and lines should be legibly marked for identification and to match diagrams and schematics before any work is done. Markings should not be placed on removable parts. Where permanent markings are not provided, temporary markings may be utilized on the understanding that follow-up permanent markings will be provided for all devices and circuits operation at voltage levels above those used for control circuitry.

5–4. Safety rules checklist

The following minimum requirements are mandatory to ensure worker or equipment safety:

a. Communication channel availability. Some method of communication to summon emergency personnel or medical assistance will be provided and will be functional through the period which work is performed.

b. Lighting level. The lighting level will be sufficient for safe work. Temporary self-contained lighting systems will be provided where normal natural or installed lighting is not sufficient, available, or safe.

c. Working period. Normally no worker will work more than a standard 8-hour period with suitable breaks. Under emergency conditions a maximum of 12 hours may be necessary but the work period will be preceded and followed by a minimum of 8 hours off.

d. Technical direction. On all cases of specialized work a qualified person will provide technical direction.

e. Co-worker requirement. No one will work alone.

f. Worker qualification. Workers must be qualified to do the work in question; must be fully cognizant of all safety procedures and equipment conditions; and must be alert and in good health.

g. Equipment preparation. In addition to previous requirements of this chapter check the following:

(1) All control power must be de-energized and all stored-energy mechanisms must have been discharged.

(2) All stationary (bolted or plug-in) nondrawout type circuit breakers must be de-energized on both the line and load side.

(3) All drawout circuit breakers must be checked to be sure that interlocks (which prevent the circuit breaker from being withdrawn in the closed position) have not been defeated or bypassed.

5–5. Testing safety rules

When performing electrical tests at any voltage the person in charge of the testing must, in addition to other applicable instructions in this manual, take the following precautions:

a. Use only devices which have been checked and found to be properly calibrated both immediately before and immediately after the test.

(1) When testing live circuits or equipment, all temporary leads used in testing must be securely supported to prevent interference with other workers or injury to the tester.

(2) Protect testing personnel and others, particularly their eyes, from flashovers.

b. When performing mechanical tests, keep the operating personnel and others at a safe distance, or in a safe location by means of barricades, to prevent injury resulting from the failure of the equipment being tested.

c. Use an approved voltage detector when testing for blown fuses on low-voltage circuits. Do not use fingers as the test for blown fuses.

d. A test indicating absence of voltage on the secondary side of a transformer or regulator must not be considered as a positive indication of the absence of voltage on the primary side.

e. When it is necessary to test transformers and other equipment for short circuits, open circuits, and grounds, and a step-up test transformer is used, the following procedure must be followed:

(1) In the low-voltage circuit of the step-up transformer, use fuses rated not larger than 10 amperes unless large equipment is being tested. Control the circuit with a double-pole switch, so that all wires feeding the step-up transformer will be de-energized when the switch is open. The medium-voltage leads from the test transformer to the apparatus being tested must be kept insulated from the surface on which test personnel are standing. The medium-voltage wire to be handled during the test must be attached to the end of a 6-foot (1.8-meter) live-line safety tool, and personnel handling the tool must hold it near the opposite end.

(2) in testing large transformers, use a testing transformer and fuses large enough to handle the charging current of the transformer being tested.

(3) Workers are positively prohibited from handling live medium-voltage wires with their hands. The step-up transformer circuit must be de-energized each time it is necessary to handle the wires for making connections incidental to the test, unless the wire is attached to the insulating stick.

5–6. Switching safety rules

Opening/closing a power switch may expose the operator to some degrees of hazard. An accident may occur if a switch is closed when a fault is still present on the line. The supervisor, before writing the switching orders, must prepare the switching sequence and all load isolation requirements. All switches operated in the switching sequence must be correctly identified and the instruction manuals of the switches must be provided. The worker must read the instruction manual to be familiar with the switch operation. All safety steps listed in he instruction manual must be scrupulously followed before opening/closing a switch.

a. Air switches. Most switches today are air switches. Many switches cannot be opened if there is a load on the line, if there is a large transformer magnetizing current from transformer, or if there is a heavy charging current from an unloaded transmission line. Always know the interrupting capabilities of the switch you are opening or closing.

(1) *Disconnect switches.* Disconnect switches of the nonload break type will not be used to interrupt loads and magnetizing currents, unless specific approval has been given that the disconnect will interrupt the current safely or unless the switch is of the loadbreak type. Switch sticks providing the minimum working and clear hot stick distance are used to manually operate switches and they should be used for no other purpose. Always assume that disconnect switches are not of the load break type, unless you have positive proof otherwise and then operate on the following basis:

(a) Disconnect switches may be used with care to open a live line, but not under load.

(b) Disconnect switches may be used with caution to open sections of de-energized lines, where these lines parallel other medium- or high-voltage lines. Under certain conditions induced voltages can build up in the de-energized line and can be dangerous to switching operations.

(c) Be aware of dangers when using disconnect switches to open a tie line or to break two parallel medium- or high-voltage lines.

(2) *Airbreak switches.* Gang-operated airbreak switches equipped with arcing horns may be suitable for loadbreak operation, or they may be only capable of interrupting the magnetizing current of transformers, the charging current of lines, or to make and break line parallels. Airbreak switch use

should be specifically stated. The handle of the switch should be of the permanently insulated type and be effectively grounded when operated. Ground mats should be provided for the operator to stand on with both feet. Either fixed or portable small iron-mesh mats should be used. The mats must be electrically connected to the operating rod and the substation ground grid to equalize the ground gradient and prevent any potential differences in case of insulation failure or flashover. Rubber gloves should be worn by the operator.

(a) The hinges of airbreak switches should be sufficiently stiff (and kept in this condition) so that when the blades have been turned into the open position they will not accidentally fall back on their line-side energized clips.

(b) The switch should be inspected after it has been opened to see that all blades have opened the proper distance. Single-throw airbreak switches should be opened to the maximum amount. Double-throw airbreak switches should be opened so that the blades clear both sides of the switch by the same amount.

(c) Locks will be provided for all airbreak switch operating mechanisms and they will always be kept locked, except when opening or closing the switch.

(3) *Interrupter switches.* Interrupter switches are designed to be opened under load. Metal-enclosed loadbreak switches are used in place of circuit breakers as a more economical switching method.

(4) *Inching.* Inching is a method of opening manually-operated nonloadbreak disconnects in a gradual manner, when the operator believes there is no load current. If a small arc occurs from the charging current, it may be considered that a cautions opening would allow the arc to be broken. Inching is dangerous and this practice is prohibited.

b. Oil switches. The consequences of operating a faulty oil switch or closing into a faulted circuit with a oil switch are likely to be devastating and possibly fatal. Switching procedures must be developed at each facility to make sure that no energized oil switch is operated while workers are in the vicinity. Unless the switch has been equipped to operate from a remote location at least 20 feet (6 meters) away, the switch must be completely de-energized before switching. Switch position and ground conditions must be verified before operation. In addition, no medium-voltage oil switch is to be operated unless routine maintenance, including oil testing, has been performed within the past year. Oil switches must incorporate a mechanical stop to prevent inadvertent operation ground. Any abnormalities or defects discovered in any oil switch should be reported to the supervisor.

c. Similar switching section. When switch bays, cells, or compartments are similar to adjacent sections, the separation barrier between sections must be painted an appropriate color to prevent the possibility of pulling the wrong blade.

5–7. Fusing safety rules

Always remember that a fuse is a single-phase device. Fuses can be subject to partial melting or damage by currents which may not be of sufficient magnitude to blow the fuse.

a. Fuse handling. Fuses should normally not be handled, except when they need to be replaced. Remove them completely and as speedily as possible. When replacing fuses in primary fuse cut-outs, do not use your free arm to shield your eyes from possible flashes. Always use safety glasses. The person changing the fuses must stand firmly on a level surface and, where operating in an elevated position be secured with a safety belt to prevent a slip and fall if there is a flash. Fuse sticks must be used in all instances.

b. Operation of energized fuses. Open all lines protected with energized fuses in the same manner as for air switches. De-energize nonloadbreak installations. For loadbreak installations provide a time delay after fuse replacement, in order to allow the fuse to interrupt any fault condition that was not corrected at the time of the fuse replacement.

c. Open fuse holder. Do not leave outdoor fuse holders open for an extended period of time, as water damage or warpage from the elements may make closing them dangerous or degrade their protective ability.

d. Closed-position fuse locking. Follow the fuse and or switch manufacturer's instructions, as appropriate, to be sure that the fuse is securely locked, latched, and held fast in a closed position.

e. Bypassing. Do not bridge fuses or fuse cut-outs internally. Where it is necessary to bypass fused conductors, use plainly visible external jumpers and remove them as soon as possible.

5–8. Energy-storing protective device safety rules

Protective devices such as surge arresters, choke coils, and capacitors store electrical charges as a by-product of their protective mechanism. This stored charge must be discharged to ground before such devices can be considered de-energized. Always wear eye protection when de-energizing or energizing these devices.

a. Surge arresters. A surge arrester limits over voltages and bypasses the related current surge to a ground system which absorbs most of the energy. The overvoltage condition can be caused by a fault in the electrical system, a lightning strike, or a surge voltage caused by switching loads. All surge arrester equipment must be considered as loaded to full circuit potential, unless it is positively disconnected from the circuit. Be sure the permanent ground conductor is intact before any work is done.

(1) High-voltage substation or at grade surge arresters should always be provided with screens or fences to prevent possible contact while parts of the surge arresters may be alive. The screen or fence should have a gate large enough to permit the removal of individual units. The gate should be provided with a lock and the key should be kept by an authorized person.

(2) Surge arresters must never be touched or approached, unless they are completely disconnected from all line lines and live equipment and until all parts have been discharged to ground and effectively grounded.

(3) Horn gap switches must be opened and separated from all live lines and equipment, whenever it is necessary to work near a surge arrester.

(4) If the first attempt to disconnect a surge arrester is unsuccessful, wait 2 or 3 minutes before making a further attempt so as not to cause an internal fault.

b. Choke coils. Choke coils are inductors which operate in a manner similar to surge arresters, except that they operate on overfrequency rather than overvoltage.

c. Capacitors. Capacitors consist of an electrical condenser housed in a suitable container. Power capacitors provide for power factor correction. Coupling capacitors are used for coupling communication circuits to metering circuits. Because capacitors can hold their charge, they are not electrically dead immediately after being disconnected from an energized line. Capacitors on electric lines should be provided with discharge devices for draining the electrical charge to 50 volts or less in 5 minutes, after the capacitors on electric lines should be provided with discharge devices for draining the electrical charge to 50 volts or less in 5 minutes, after the capacitors have been completely disconnected from the circuit.

(1) *Discharge circuits.* The operation of these units must not be depended upon for safety, since they may be burned out or not functioning as designed. Line capacitors removed from service from any purpose must be considered at full voltage or higher until the terminals have been short circuited and discharged to ground by approved method. Do not short circuit terminals until capacitors have been de-energized for at least 5 minutes. Capacitors made before 1979 usually contain PCBs. Precautions listed in paragraph 3–4 on the handling of hazardous materials must be followed if the case is ruptured or liquid is visible on the outside of the case.

(a) It is not safe to use fuses or disconnect switches to disconnect large capacitor banks or 60 kilovolt-reactive single-phase, 180 kilovolt-reactive three-phase, and larger. Circuit breaker must be used.

(b) After disconnecting all capacitor banks, wait 5 minutes. Short-circuit and ground all terminals. All operations must be performed using rubber gloves or a hot stick. On eye-connected banks, the neutral may or not be floating. In either case, it must be grounded.

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

(2) *Coupling Capacitors:* A little known characteristic of coupling capacitors makes them especially hazardous to personnel if not properly grounded. This characteristic is their extremely high resistance, which results in a long discharge period.

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

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

5–9. Instrument transformer safety rules

Instrument transformers reproduce a primary cir-

cuit voltage or current in a low-voltage secondary circuit for use in metering or relaying the primary circuit.

a. Voltage (potential) transformers. These units provide a means of obtaining low voltage from a higher voltage circuit. To serve their intended purpose 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 voltage transformer has a constant voltage maintained on both the primary and secondary, although there is a fixed difference between the two voltages. If by accident the secondary is short circuited, a very high current will flow in both windings, causing the windings to overheat very quickly. The case and one of the windings of the low-voltage side of voltage transformers will be grounded before energizing the transformer.

(1) Replacing a blown primary-winging 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 voltage 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-winding 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 voltage transformer is disconnected. A dark lamp, connected on the low-voltage side of a voltage transformer, is not a positive indication of the condition of the high voltage side. Voltmeters, in addition to lamps, must be connected to the low-voltage side. Lamps must first be connected while the voltmeter is used as an extra check. On most modern switchgear a drawout arrangement usually automatically disconnects and ground the transformers, when access to the fuses is necessary.

(2) A supervisor should give instructions for replacing a blown primary winding fuse on a distribution voltage transformer located within switchgear, or where it is impossible to use a standard 6-foot (1.8-meter) puller.

(3) Whenever a circuit breaker or a sectionalizing switch is not provided to isolate the voltage transformer, the worker must report the situation to his/her supervisor immediately. The supervisor must arrange for a feeder breaker opening. Replacing primary fuses when the transformer is energized is not authorized.

b. Current transformers. These units provide a method of obtaining a lower amperage at a low-voltage from a higher-voltage circuit. Current transformer cases and secondaries will be grounded before energizing any current transformer. 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 an 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.

5–10. Power transformer and regulator safety rules

Power transformers change voltage levels. Voltage regulators apply needed control for variation s in loads whose effect on line-voltage drop exceeds that which is acceptable. Both require regular servicing but their protective and circuit disconnecting means are not necessarily similar. See paragraph 6–11 for additional power transformer safety requirements.

a. Transformers. Consider all transformers energized and at full voltage, unless they are disconnected from primary and secondary wires, or unless they are disconnected from the primary wires and then short circuited and grounded. The secondary neutral will be considered a sufficient ground, provided there is a grounding conductor which is interconnected with the common central, the transformer case, and a ground electrode. Always check continuity of this ground connection. When removing transformers, the case and neutral grounds must be disconnected last. Under no conditions will transformer covers or handhole plates be removed, nor will any work be done on the inside of transformers until these instructions have been complied with.

(1) When transformers are installed or replaced, the secondaries will be checked for correct voltage and, where applicable, for phase rotation.

(2) When transformers are installed, and before they are energized, the ground connection will first be made to the case and to the neutral when applicable.

(3) When working on or in the vicinity of any three-phase wye-connected transformer bank, check whether the transformer neutral is grounded. If not grounded then the neutral is floated and it is possible to have full phase-to-ground voltage on the neutral.

(4) Unless transformers are load-tap-changing (LTC) type, tap changers will be operated only when the transformer is de-energized. When re-energizing, maintain a safe distance of at least 20 feet (6 meters) to assure that internal switching was successful.

(5) When relieving pressure on transformers, the pipe plug, pressure relief device, or inspection cover place will be loosened slowly, so that the internal pressure of the transformer will dissipate gradually. Pressure relief valves will not be opened when there is precipitation or high humidity, except on failed transformers and when re-fusing.

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

(7) Energized padmounted transformers and equipment will be locked or otherwise secured when unattended.

(8) Properly control connected leads or jumpers before transformers are raised, lowered, or repositioned.

b. Voltage regulators. Voltage regulators are installed with bypass and disconnect switches. Never open or close a regulator bypass switch, unless the regulator is set on its neutral position and the control switch is open, or automatic control is otherwise inactivated according to the manufacture's recommendations. When regulators are maintained as spares in substations, their bushings must be short-circuited and grounded.

5–11. Metalclad switchgear safety rules

Metalclad switchgear is inherently safe to maintain so long as manufacturer's instructions and the following rules are adhered to.

a. Prior to the drawout of a circuit breaker operating mechanism—

(1) De-energize switchgear (including control power) and ground as much of the switchgear as permitted by operating conditions.

(2) Trip the circuit breaker open and discharge the stored-energy mechanism if provided.

(3) Check that protective interlocks are functioning to protect against closed-position circuit breaker drawout.

(4) Assure that all crew members know you are racking out.

b. Maintenance can now be performed. Access to switchgear terminals through portholes in circuit breaker cells will be limited to the following—

(1) When both sets of portholes in a cell are de-energized, that is line and load or bus to bus.

(2) After both are de-energized, the access to switchgear terminals through the portholes will be permitted for cleaning, inspecting, and maintenance of terminals and bushings.

(3) Use an approved ground and test device for access to terminals. Such access may be for application of protective ground, phase identification on de-energized circuits, and phasing tests on live circuits. The use of a ground and test device positively and easily grounds the incoming cables and the switchgear bus. It also permits easy external connection points to the bus or cable for testing.

c. After providing required maintenance of the racked-out mechanism, the following precautions will be taken as a minimum:

(1) Check that the cubicle is free of foreign objects.

(2) Check that control circuits are de-energized by pulling fuses on control circuits.

(3) Ensure that the drawout mechanism is in the open position.

(4) Assure that all crew members are aware of that you are racking in.

(5) Close the cubicle door before closing the circuit breaker.

5–12. Network protector safety rules

A secondary network system provides a high degree of continuity of service in heavy-load density areas. A grid of interconnecting low-voltage cables is supplied by two or more medium-voltage feeders through transformers having secondary network protectors. Network protectors are used in large buildings with

heavy loads since the loss of one point of supply does not cause loss of service.

a. Closing. Do not close a network protector manually, unless specifically instructed to do so, and then only when it is certain that the medium-voltage feeder is in service and that the transformer is energized and in the proper phase relation. When closed by relay, the operation should be performed only by a worker properly qualified in maintenance of network protectors.

b. Maintenance safety.

(1) Always perform appropriate electrical tests using a three-phase network protector test kit, before performing any installation or operation of the network protector.

(2) Network protectors are designed to operate within the current and voltage limitations given on their nameplates. Do not apply these units to systems with currents and/or voltages exceeding these limits.

(3) To perform work on network protectors requires personnel with training an experience on energized equipment. Only qualified electrical workers, familiar with the construction and operation of such equipment and the hazards involved should be permitted to work on network protectors.

(4) There are several interlocks on a network protector for personnel and or equipment protection. Under no circumstances should they be made inoperative.

(5) Roll out the network protector's removable element before making any adjustments or doing maintenance of any nature.

(6) Never energize the network protector without its arc chutes and barriers in place.

(7) Always be sure that all network protector hardware is in place and bolted tightly before placing a network protector into its housing for operation.

(8) Since network protectors are used where a large amount of power is distributed to heavy-load density areas, a short circuit in the system involves very high fault currents. Extreme care should be exercised.

(9) The extensive use of barriers and interlocks as a part of the network protectors, provides greater safety to maintenance personnel. Keep barriers in place and immediately replace any that have been broken. Although barriers and interlocks are provided, insulated tools or insulated gloves are required to remove the rollout unit from the enclosure, and to remove fuses, or at the initial installation of the network protector on the system.

(10) Before performing maintenance or removing a network protector from service, de-energize the network protector.

c. After maintenance. On the first trial operation, or on the first operation of a network protector after repairs have been made on its mechanism or circuit breaker, the door of the network protector should be closed, when practicable. Always have a network protector blocked open, when installing or removing secondary fuses, to prevent the possibility of the network protector closing automatically.

5–13. Storage battery safety rules

Electric storage batteries emit hydrogen and oxygen, particularly while being charged. This forms a highly explosive mixture.

a. Smoking or the use of any open flame, such as torches, will not be permitted around batteries. When soldering or lead burning is done, the battery room must be well ventilated, the battery cell vent plugs must be removed, and the excess gas above the electrolyte must be blown out of those cells near the work area.

b. Cleaning batteries or terminals with brushes or other devices which may short out the cell will not be permitted. The ignition of the hydrogen-oxygen mixture in cells by a spark from a short on terminals has caused cells to explode.

c. When doing work on batteries where contact with the electrolyte can be made, a container with baking soda and water must be provided for workers to neutralize the electrolyte on hands and tools.

d. When making up electrolyte for storage batteries, a worker must always pour acid into the water. The reverse may cause an explosion.

e. Acidproof gloves, sleeves, aprons, and goggles should be worn by personnel while repairing batteries.

f. Do not store sulfuric acid in places where freezing temperatures can occur.

g. For further information on servicing and main-

taining storage batteries, see the manufacturer's instructions.

5–14. Safety requirements for phasing or connecting of circuits

Use phasing testers when it is desired to tie two or more circuits together. Never tie two circuits together without first checking their phase relations on all phases.

CHAPTER 6
OVERHEAD LINES AND ASSOCIATED ELECTRICAL COMPONENTS

6–1. Aerial line work

This chapter includes specific rules for poles and structures and the aerial lines they support along with their necessary pole-mounted equipment. The rules cover pole handling and erection, climbing and working on poles, stringing of lines, working requirements around pole-mounted lighting, equipment and tool handling, and tree and brush trimming required for foliage which impinges upon aerial line right-of-ways.

a. Working in elevated positions. Additional safety requirements are imposed on aerial line work. Workers must not only recognize electrical hazards but be trained not to fall. Not all work can be accomplished from aerial lifts. Workers must be trained in safe climbing procedures for situations when limited structure access prevents use of an aerial lift and the structure design cannot accommodate positive fall protection load requirements. Only workers who meet "Qualified Climber" requirements should be permitted to do work which requires climbing poles or trees.

b. "Qualified Climber" requirements. Each facility should establish these requirements both for facility and contract personnel. They should apply to all persons whose work involves climbing.

(1) Physical fitness required for climbing should be documented one only by an annual physical, but also be validated by supervisory observation.

(2) Climbing duties should be a part of routine job activities, not an occasional occurrence.

(3) A minimum of 2 years of documented climbing training should be completed. Experience should include hazard recognition and hands-on-training incorporating appropriate safe climbing practices and rescue training.

(4) Demonstrated proficiency is required on structure types similar to those which are to be climbed and should show that these structures have been climbed on a routine basis within the last 5 years.

(5) A worker in training may function as qualified only when working under the direct supervision and observation of a "Qualified Climber."

6–2. Pole handling operations

Precautions are necessary in handling poles safely. Poles are long, heavy, and preservative-treated, thus they pose hazards to the workers involved in installation and dismantling operations. Any mistreatment of poles during installation will degrade their ability to meet service requirements and endanger those workers who climb them.

a. Direction. The foreman must direct the handling of poles and give all signals when poles are being lifted or handled Poles should, whenever possible, be handled starting from the top and the end of the stack. Workers must roll poles away from them using cant hooks or bars. Poles must not be caught with cant hooks while in motion. Whenever possible, carrying hooks should be used when carrying poles.

b. Pole contact precautions. Creosote, which is usually applied to poles as a preservative, can cause skin burns on contact. The following precautions should be taken to avoid burns.

(1) Never roll up sleeves when handling poles.

(2) Always wear gloves, and keep your neck well covered with a collar or a handkerchief.

(3) Always keep trousers well down over your ankles as much as practical.

(4) Never rub your eyes or wipe perspiration from your face with your hands or shirt sleeves when they have been exposed to creosote.

(5) Where direct contact with creosote is apt to occur, the hands, arms, and face may be rubbed with a preparation made up of one part gum acacia or gum tragacanth and three parts lanolin. If this preparation cannot be obtained, satisfactory protection can be provided by petroleum jelly (Vaseline). First aid treatment must be obtained immediately if you come in body contact with creosote.

c. Facility receival. Poles are usually shipped to the facility's pole storage yard on flatbeds to which they are secured by skids, stakes, slings, and binding. Removal is safe if done properly. The objective is to unload poles so that none is broken and the poles do not roll onto any worker.

(1) Skids, rope lines, and slings should preferably be 1/2-inch or 5/8inch (12.5 to 16 millimeters) wire rope. These should be inspected to ensure they are sufficiently strong enough for the operation.

(2) All binding wire, stakes, and other fastenings will be inspected for weakness or breakage before unloading.

(3) Always place necessary lines to restrain loads when stakes and binding wires are cut.

(4) The supervisor will determine that all possible persons are safely in the clear before binders or stakes are cut.

(5) Binding wires will be cut with long-handled wire cutters. Never cut binders from the top of the load.

(6) Only one person should be permitted on top of a loaded car at a time. No one should be allowed on top of a carload of poles to cut wires or after any wires or braces have been cut or removed.

d. Ground handling. Once on the ground the poles can be positioned by the use of cant hooks. Special precautions should be taken while using these hooks.

(1) Hooks must be sharp and should be protected when not in use.

(2) 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.

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

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

(5) Before moving the pole, make sure that there are no tripping hazards behind any workers.

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

e. Temporary pole storage. Storage of poles must ensure that they will not deteriorate because of mishandling.

(1) Poles that are stored for considerable periods should be stacked above the ground on racks which provide sufficient ventilation and can be properly blocked to keep them from shifting or rolling.

(2) Poles should never be stored with crossarms, braces, steps, and hardware attached.

(3) Poles should be stored according to size to make them as accessible as possible.

(4) An area of at least 10 feet (3 meters) around stored poles must be kept free of grass and weeds. There should be sufficient space under the poles to permit removal of leaves and debris. The foreman is responsible for these activities.

(5) Poles stored temporarily on or near roadways, before erection or removal, should be placed as close as possible to the curb or edge of roadway as is safe. Never store poles at points in the road where there are sharp turns. Place each pole so that its top faces the direction of traffic. Poles stored on highways should not have crossarms attached.

f. Hauling poles. Pole hauling must be done so as not to endanger workers and or the public.

(1) Poles, after being loaded on a vehicle, must be secured in at least two places and in a manner that ensures poles will not be released in traveling over rough terrain. Never use a chain smaller than 3/8 inch (9.5 millimeters) diameter.

(2) A minimum of at least two people (a driver and a helper) should be assigned to haul a load of poles. The helper should assist the driver by watching traffic both from the sides and the rear. The helper should also see that there is ample clearance when turning corners, entering highways, or crossing intersections. If necessary, the helper should act as flagman to warn and guide traffic.

(3) Poles must not be hauled at night except in emergencies.

(4) Poles extending more than 4 feet (1.2 meters) beyond the back of a truck or trailer will have warning devices attached. Provide a red flag by day and a red light by night to the rear end of the poles being hauled. The red flag or light must be visible in any direction. State highway regulations must be observed when poles are transported on state highways.

(5) Poles temporarily dispersed along streets and highways must be laid near the curb or in parkways between the curb and sidewalk, where they will not interfere with traffic, driveways, or walkways. When laid on an incline, poles must not be placed where they will interfere with drainage. The foreman must decide whether or not danger signs by day and red lights at night are required.

(6) When moving a pole by hand, with a pole cart or with the truck derrick, warn those nearby who might be struck accidentally. Station a worker with a red flag to warn or stop traffic as necessary.

6–3. Pole installation requirements

Poles will normally be installed for new aerial line construction by contract workers. However, facility-installed poles may be needed for short line replacements of storm-damaged lines or because of pole decay. Remember that poles and guys must be located relative to local facility property line requirements.

a. Pole holes. If new poles are to be set adjacent to existing poles to be dismantled, new holes must be dug. Power tools are available for digging, such as power borers or augers and should be used by qualified personnel. Rock cutting drills are available, as a safer alternative to the use of explosives, where rock is encountered. Most facility-provided pole holes will probably be dug by hand when power diggers are unavailable or cannot be used.

b. Digging holes. Digging pole 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 rocks; blisters on hands from the use of hand tools (blisters can be partially eliminated by using gloves); and foot and leg injuries resulting from falling over tools left too close to the pole hole, particularly shovels that have been left turned up.

c. Hole covers. Cover all open pole holes as soon as they are dug, except when the pole is to be set into the hole immediately after digging. Hole covers must be at least 30 inches (750 millimeters) in diameter. Covers may be made of 1-inch (25 millimeters) lumber with two cross braces not smaller than 1 inch by 4 inches (25 by 100 millimeters). Four or five shovels of soil should be put on the cover after it is placed over the hole.

d. Hole casings. Casings may be required in sand or swampy soil to prevent the sides of a hole from caving in. Casing covers are required if pole setting is not done immediately.

e. Setting poles. Pole setting is a hazardous job even with the best equipment and experienced personnel. The methods authorized for setting poles are by piking, using the winch line method, or using a gin pole.

Figure 6–1. Pike pole method

(1) *Pike pole method.* Figure 6–1 illustrates the pike pole method. This is the earliest method of raising poles and should be employed when a truck cannot be brought in. A jenny initially supports the pole and a cant hook keeps the pole from rolling. The bumpboard protects the wall of the hole from being caved in by the pole butt. Pikers, lift the line pole, by punching into the pole the steel spikes of the pike poles. The number of pikers required increases with the pole length as shown in table 6–1.

(a) Before setting a pole the foreman must ensure a clear working space and verify that all movable obstacles are removed from the area. Personnel must not wear safety belts and climbers when setting poles. Tools or other items must not be substituted for bumpboards. Always use a jenny to support the pole until it is high enough to use pikes. Only experienced workers should use the jenny. The angle of contact between the pole and jenny should be maintained as close to 90 degrees as possible.

Table 6–1. Average size of crew required to raise poles of different lengths by piking.

Pole length in feet	(meters)	Size of crew	No. of pikers	No. of journeyman	No. of people at butt
25	(7.5)	5	3	1	1
30	(9.0)	6	4	1	1
35	(10.5)	7	5	1	1
40	(12.0)	8	6	1	1
45	(13.5)	9	8	1	1
50	(15.0)	10	8	1	1

(b) At least three experienced workers must be used in addition to the supervisor. One person should handle the butt of the pole and a minimum of two side pikers are needed. Unexperienced workers used in this work must be thoroughly instructed on the hazards involved. A two-legged jenny must be used. It is the responsibility of the supervisor to assure that all polelifting tools are always in good condition.

(2) *Winch line method.* Figure 6–2 shows the winch line method.

(a) When erecting poles by truck winch and winch line, rig as shown with all workers in the clear. At least three experienced workers must be used in addition to the supervisor. For safe erection, the gins or maneuverable rigging assembly must have enough teeth to handle the pole. Pikes will not be used in combination with a winch.

(b) Side guys used in setting poles or structures will be attached to pencil bars driven into the ground. Tie lines or other guy lines will never be wrapped around any worker's body. The supervisor must concentrate on supervising the work to assure that it is being safely performed.

(3) *Gin pole method.* In setting extra-heavy poles or those of 45 feet (12.5 meters) or longer, use a tackle block attached to another pole (either existing or specially set for the purpose of raising the new pole) rather than the pike pole method. The pole used as a gin (maneuverable rigging point) to raise the new pole, must be guyed sufficiently with not less than 5/8-inch (16-millimeter) diameter rope to hold it erect under the strain of the load. When the new pole is raised by car or truck, the temporary guy must be run from a snatch block at the bottom of the gin pole to a substantial anchor. This prevents the gin pole from slipping at the ground line. Otherwise the gin pole must be set in a hole 1 or 2 feet (0.3 to 0.6 meters) deep.

(4) Pole setting truck precautions. Pole setting trucks should be parked, when practicable, so that the steel boom will not be closer than 10 feet (3 meters) to energized overhead conductors. When the work is to be done around energized conductors and it is impossible to lower the boom sufficiently to be in the clear, the conductors must be de-energized before work is begun. When work is being done with the boom close to energized conductors, all personnel must not touch the pole and must keep away from the frame of the truck. Never touch (with bare hands or with any part of the body) a pole which is being set in an energized line. A cant hook or dry rope around the butt of the pole may be used to guide it into the hole.

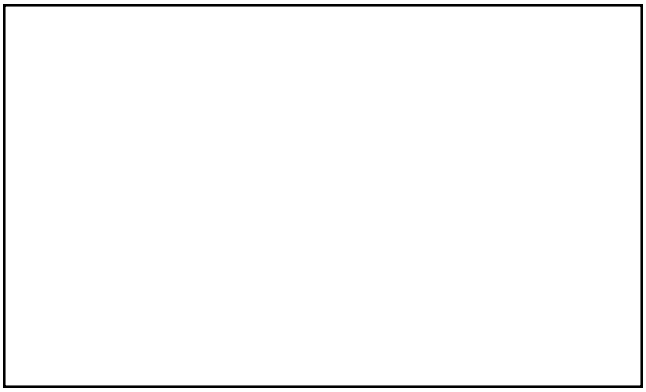

Figure 6–2. Winch line method

(5) *Energized lines.* A lineman-A must be used to guide poles through energized conductors.

(a) When a pole of any type is being set or removed between or near conductors energized at more than 600 volts, the pole, winch cable, and truck frame must be effectively grounded with protective grounds. Lines must be covered with rubber protective equipment to prevent poles from touching energized parts and, workers must use rubber gloves. Attach a protective ground to the frame of all winches. If the pole is to be erected by hand (pikes), the protective ground must be attached to the pole (using an approved grounding band) approximately 15 feet (4.5 meters) from the butt end. In all cases, exercise extreme care to keep the pole from contacting conductors.

(b) Wood poles must not be considered as providing insulation from energized lines.

(6) *Backfilling.* Backfill the hole after the pole has been placed. Use the pikes to align the pole while backfilling. Pikes must not be removed until sufficient tamping has been done to prevent the pole from falling.

f. Dismantling poles. Many people have been fatally injured or permanently crippled from accidents during improperly performed pole dismantling.

(1) The following methods must be strictly adhered to. Each pole must be guyed in at least three different directions by guy ropes before any work proceeds on the pole. This can be done by the following procedure:

(a) Make two turns around the pole with a sling and tie securely.

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

(c) Insert pike poles under two sides of the sling well up the pole.

(d) Snub off securely by pencil bars driven into solid ground or by any other substantial snub.

(2) Always check the pole to see if additional support may be necessary because of pole conditions or strains.

(a) Determine the condition of the pole butt before removing guys or wires and support with additional pike poles or temporary guys if necessary.

(b) When an old or reinforced pole is to be dismantled, guy it sufficiently to withstand any altered strain on it and to support the weight of personnel who are to work on it.

(c) When changing the strain on a pole, the foreman should see that it is sufficiently guyed to stand the altered strain. The foreman should not permit workers to climb a pole which is under an abnormal strain. The foreman will be responsible for the placing of guys to prevent any pole from falling.

(3) A truck equipped with an "A" frame and backed up to the pole can be used to restrain the pole. The top of the "A" frame can be tied by the winch line to the pole. The pole at the groundline level can be securely tied off to the truck.

(4) In locations where poles cannot be lowered with a rope or derrick, a guideline must be attached so that the pole falls in the desired direction.

(5) All members of a crew, who are not actually engaged in removal of a pole, must stand clear to avoid possible injury if the pole should fall. Where necessary, stop all pedestrians and traffic during pole removal.

(6) When a pole is being removed, dismantle the pole before beginning excavation around the butt.

6–4. Climbing and working on poles

Workers should be familiar with general rules for climbing poles and approaching the overhead work area; the impacts of climbing wood poles as opposed to steel towers; and the dangers of crossing structures from one side to another.

a. Climbing and working general rules. Except in emergencies or when unavoidable, do not work at the base of a structure or a pole while people are at work above. Before climbing a pole the worker must first determine and ensure—

(1) What circuits are energized and at what voltage, and any unusual conditions which might pose a hazard.

(2) Types and positions of circuits and the direction of feeds.

(3) The best climbing space to avoid all live wires, grounded wires, and signal circuits.

(4) That there is an ample supply of rubber protective equipment on hand to completely protect the worker on the pole from all live wires, grounded wires, and signal circuits.

(5) That not more than one worker will descend a pole at the same time. The first worker will be in place on the pole or down on the ground before the next worker ascends or descends the pole. When it becomes necessary for one worker to work above the other, they will exercise extreme care.

(6) Before climbing poles, ladders, scaffolds, or other elevated structures; riding span wires, messengers or cables; or entering cable cars, boatswain chairs or similar equipment; the worker will first verify that said structure or device is strong enough to safely sustain his/her weight.

b. Type of pole. The type of pole to be climbed will affect the precautions that the worker must take in regard to climbing equipment and procedures. However all types of poles must be safe to climb, in terms of being strong enough to bear the weight of the particular climbers and their tools and in providing adequate climbing space. Before allowing anyone to climb on a pole, the foreman will make sure that the pole is inspected and that it can be safely climbed based on the following determinations:

(1) Age, treatment, and physical condition of each pole must be tested according to the applicable provisions of TM 5-684. Poles unsafe for climbing must be reported to the foreman so that they may be braced or guyed before climbing.

(2) Configuration of conductors or equipment on the pole must provide adequate climbing space.

(3) Changes in stress resulting from removal of supporting conductors or guys do not affect the safety of workers.

(4) Poles to be climbed are in such condition and are supported in such a way as to safely support workers on such poles. Pikes will not be used as a support method while personnel are working on poles.

6–5. Pole climbing equipment

Usually pole climbing will be done on wood poles rather than on concrete or steel poles. The two major differences between these types of poles are that wood poles are not grounded poles (although they should not be counted as providing protective insulation) and climbing wood poles (along with trees) requires climbers (gaffs) rather than step bolts or ladders. All workers need to be provided with body belts and safety straps when climbing and while working more than 6 feet (1.8 meters) above ground level. Positive fall protection may also be appropriate.

a. Responsibility. A full set of climbing equipment must be supplied to each worker who is authorized to climb. Never loan or borrow a set of climbing equipment.

(1) Climbing equipment should be carefully inspected daily. Leather should be checked for cuts, cracks, and enlarged buckle tongue holes. Metal parts should be checked for cracks, wear, or loose attachments. Climbers (gaffs) should be regularly checked for proper cutting edges, length, and shape.

(2) It must be understood by all personnel that the foreman, or a properly delegated worker, will inspect all tools, safety devices, and other equipment weekly. Any item that is not considered safe will be condemned, regardless of ownership, and must not be used.

(3) Body belts, meeting the requirements of OSHA Standard 1926.959, with straps or lanyards, should be worn to protect personnel working at elevated locations on poles, towers, or other structures. If such use creates a greater hazard to the safety of the workers, other safeguards must be employed. Body belts and straps should be inspected before use each day to determine they are in safe working condition.

(4) Positive fall protection. Provide positive fall protection where the strength of the pole (steel/concrete) permits meeting OSHA requirements. Exceptions are ascending or descending by a qualified climber or situations where a job hazard analysis so warrants. On wood structures consider adding position fall protection when transitioning obstructions, if a job hazard analysis indicates a fall arresting point will provide adequate strength.

b. Wood-pole climbing equipment. Equipment sets each consist of a body belt, a pole strap, and climbers (an assembly of gaffs, leg straps, and pads). The Edison Electric Institute provides an excellent document entitled “Use and Care of Pole Climbing Equipment” which should be used as part of the training for pole climbing certification.

(1) Climbers should meet the following requirements:

(a) Leg iron (shank) to be made of spring steel.

(b) Gaff (spur) to be forged from tool steel.

(c) Leg iron length, sizes range from 15 to 18 inches (380 to 460 millimeters) from instep to end of shank.

(d) Leather straps, two each of 1-1/4 inches (26 millimeters) wide, at least 22-inches (560 millimeters) long.

(e) Pads, for protection of calves.

(2) Climbers and pole straps or other leather items which have any of the following defects must not be used until repaired:

(a) Cracked, dry, or rotten leather.

(b) Leather which is worn thin.

(c) Cuts or worn places which are of sufficient depth to weaken the leather.

(d) Broken stitches or loose rivets at buckles, D-rings, or snaps.

(e) Snaps which have weak springs behind the tongue, or loose rivets which hold the tongue.

(f) Loose tongues in buckles.

(g) Buckles, D-rings, or snaps which show considerable wear or which have been cracked or bent.

(3) Leather equipment should be cleaned and dressed every 3 months. This period should be shortened when equipment is frequently wet from rain, perspiration, or covered with dirt or mud.

(a) Wipe off all surface dirt and mud with a

sponge dampened (not wet) with water. Never use gasoline or other cleaning fluids as they tend to dry out and harden the leather.

(b) Wash leather with a clean sponge in clear lukewarm water, and a neutral soap (free from alkali), preferably Castile soap. Thoroughly wash the entire length of the leather and work the lather well into all parts. Place in a cool area to dry.

(c) Leather should be oiled about every 6 months. Use a small quantity, about 4 teaspoonsful (20 milliliters) of pure neatsfoot oil per set of equipment, and apply it gradually with the hands, using long light strokes while the leather is still damp from washing. Leave in a cool place to dry for 24 hours, and then rub the leather vigorously with a soft cloth to remove all excess oil.

(4) When safety belts and straps are not in use, they must be stored in proper compartments on the electric truck or in other suitable places to protect them from being damaged. When stored, climbers should be wrapped in pairs and fastened with their straps.

(5) Climbers, straps, and pads must be kept in good conditions at all times. Gaffs must be at least 1-1/4 inches (26 millimeters) long, measured from the point of the gaff to the point of contact with the stirrup on the under side. Sharpen climbers using a gaff shaping bit as follows—

(a) Place the climber between wood in a vise with the leg iron horizontal and the gaff on the top side.

(b) Use a smooth cut file and finish with a sharpening stone. Never grind with an emery wheel, as this takes the temper out of the metal.

(c) File only at and toward the point of the gaff and only on the outside. Never file the front or flat side except for a slight touching up.

(d) Do not file a long sharp point. The sharp part of the point should be about 1/8 inch 13 millimeters) long.

(e) Never use a climber with a gaff shorter than 1-1/4 inches (26. millimeters), as measured on the flat side.

(6) Climbers should not be worn when—

(a) Working on the ground,

(b) Traveling to and from a job.

(c) Piking poles,

(d) Walking through underbrush or rough terrain.

(e) Riding in motor vehicles.

c. Concrete/steel pole climbing. Positive fall protection should always be considered. OSHA standards (29CFR1926) requires fall protection for certain working heights above grade. Generally fall protection has been accepted as the use of a body belt. However with the development of positive fall protection devices, a positive fall protection system should be provided whenever the anchor point strength requirement can be met.

(1) *Requirement.* A fall arresting device should always be considered whenever the worker will be working more than 6 feet (1.8 meters) above ground level on line or substation structures/equipment where a feasible anchor point is available. Workers should be secured for fall arrest, while climbing or changing work positions, and for position security while working in place. Where both hands are required for working from a ladder, the requirements for either fall arrest, position security, or both, will be applied dependent upon the working height.

(2) A proper anchor point must be identified and evaluated by qualified personnel before an appropriate system can be selected. OSHA regulations indicate that pad eyes, bolt holes, and other sturdy structures, capable of supporting 5,000 pounds (2,200 kilogramg) per attached worker, are acceptable.

(3) Positive systems all have in common an anchor point independent of the support method, a belt or harness to hold the worker, and a connecting device between the anchor point and the belt or harness.

(a) Belts and harnesses should only be used for the personal protective purpose for which they are designed. Their misuse could result in serious injury or death. In addition to fall-arrest harnesses, there are fall-arrest/positioning, fall-arrest/suspension, fall-arrest/retrieval, and retrieval/positioning harnesses.

(b) The choice of a belt or a harness is determined by the impact limits for a fall-arrest system. A belt may be used for impact forces up to 900 lbs (400 kilograms) while a harness has a higher force level of up to 1,800 pounds (800 kilograms). All items

of the complete fall arrest system must be taken into account, not just the belt or the harness.

(c) Manufacturers instructions in regard to height and weight should be followed for sizing of the belts or harnesses and their connecting devices and for inspection and maintenance of the complete systems. All equipment must be taken out of service and inspected for damage after being subjected to a fall impact.

(4) Workers authorized to climb must have a complete set of approved tools. The number of tools carried in tool belts must be kept to a minimum.

6–6. Pole climbing and work precautions

Only after determination of the pole's safety, collection of necessary climbing equipment and work tools, and assurance that the line is de-energized and grounded, or that hot-line work is authorized to be carried out, can the worker start climbing. Protect hands and arms by wearing gloves and long sleeve shirts.

a. More than one climber. If more than one worker needs to work on the pole at the same time, the first worker must reach working position before the next worker leaves the ground. 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.

b. Necessary wood-pole climbing precaution. Always proceed as follows—

(1) Seat the gaffs securely. Be especially vigilant when the pole is ice or sleet covered.

(2) Use pole steps whenever they are available, but only after checking that they can be used safely.

(3) Use the climbers carefully on the pole to avoid injury to another worker on the pole.

(4) Every precaution must be taken to avoid weather cracks, checks, knots, shakes, rots, and hard places, which might cause gaffs to cut out. Remove any tacks or nails which may impede safe climbing.

c. Concrete/steel pole or tower climbing precautions. Workers may be required to climb concrete/steel poles with the same equipment as wood poles. Climbing towers to work on obstruction lights, marker lights, and similar devices may be required. Before climbing 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 great majority of falls are due to slick work gloves or slick shoe soles. Ice or wet weather conditions increase the hazards. Always make sure that gloves and shoe soles are in good condition and free from grease or other inhibitors. Rough cord sole shoe or boots are recommended. Careful inspection and attention must be given to the safety belt's condition and positioning, as steel or concrete surfaces can cause a belt to wear out or break due to cutting action. Climbing safety devices must be used where installed.

d. General pole climbing precautions. The pole climber will observe the following rules:

(1) Both hands must be free for climbing.

(2) The worker must not stand on mail boxes, signs, fire alarm boxes, or similar equipment which may be attached to the pole or located near it.

(3) Racing up and coasting down poles is positively prohibited.

(4) Safety straps must be used from the ground up.

(5) When climbing over slippery or ice-coated crossarms or timbers, where the hands are apt to slip off, two safety straps should be used. The use of rope safeties is prohibited.

(6) All signs must be removed from a pole before any worker climbs or does any work above them on a pole. It is not desirable to have signs on poles, but street signs may be necessary at times. Where street signs are removed they must be replaced after all work is completed.

(7) Climb on the high side of a raked or leaning pole if possible, but do not climb on the side where the ground wire is attached. Avoid grasping pins, brackets, crossarms, braces, or other attachments that might pull lose and cause a fall.

(8) Never slide down any type of pole or any guy wire. If it is impossible to use climbers for ascending and descending such places, ladders or other means must be used.

(9) Do not ride overhead guys or cables. (This does not apply to cables installed for river crossings or otherwise intended to support workers in suitable conveyances.)

e. Working on poles. Never change the amount

of strain on a pole by adding or removing wires until you are sure that the pole will stand the altered strain. If in doubt, consult your foreman. Observe the following safety precautions..

(1) Safety belts must be used by workers at all times while handling wires or apparatus on a pole or structure. The following precautions must be taken:

(a) Be careful in attaching snaps to D-rings. Visually ensure that the snap keeper is fully closed in the correct ring before any weight is applied to the safety strap.

(b) Always be sure that safety straps are not twisted while in use.

(c) Never depend on a crossarm or crossarm pins and braces for support.

(d) Never attach safety straps above the crossarm in the top gain or around insulator pins, crossarm braces, transformer hangers, pole steps, or guy wires. If there is no crossarm in the top gain, the strap must not be placed closer than 2 feet (0.6 meters) to the top of the pole. In this case take precautions to assure that the belt does not slip off. Ideally the strap should be below the top pole attachment, except where that attachment is above eye level.

(e) Do not permit any worker to fasten both safety belt snaps in the same D-ring in order to reach out farther on the pole. An extension safety strap must be used or the safety belt let out so that work can be performed with the safety belt snaps fastened one in each D-ring.

(f) Workers 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 from coming in contact with anything that may open a snap. The tongue of the snap on the safety belt must face away from the body.

(2) Take the following precautions when hoisting or lowering materials:

(a) Junked material which cannot be lowered safely may be dropped only if there is no danger to workers or the public.

(b) Workers engaged in hoisting tools and materials should be positioned so that they will not be injured by an accidental dropping of the tool load.

(c) Materials and tools must not be left in an insecure overhead position. Large objects must be securely lashed.

(d) Minimize the number of tools carried in tool belts. Secure tools returned to a tool belt. Keep all other tools on the ground until they are required. Then tools should be raised and lowered by means of a canvas bucket attached to a handline. If a tool is too large to be safely raised in this manner, it should be raised by means of just a handline.

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

6–7. Crossing structures

When it is necessary to climb half-way across a crossarm to inspect middle phase insulators, the worker may climb the rest of the way across, provided that, a safety belt can be kept strapped around a timber as a safeguard. To get from one side of a double-pole supported structure to the other, the worker must descend to the ground and go up the other pole unless there are adequate handholds and adequate clearances from live parts to allow safe crossing along the structure.

a. Crossing open air switches. Never 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, another worker should be stationed to warn anyone approaching about the danger zone.

b. Balancing support. Never hold onto air switch arcing horns for support in walking timbers, as these horns break easily and a fall might result.

c. Climbing H-frames. Never walk along an H-frame crossarm with the line energized.

6–8. Stringing or removing de-energized conductors

Before stringing or removing de-energized conductors a briefing must be held to discuss the plan of operation, the type of equipment to be used, any adjacent energized lines, needed grounding devices and procedures, use of crossover methods, and the Safe Clearance authorization required. Overhead ground wires require the same safety precautions.

a. Work precautions. Observe the following work precautions for stringing or removing lines and for all aerial line work:

(1) *Adjacent to energized lines.* When pulling wire over or near energized conductors, the worker attending the payout reel must wear rubber gloves and be positioned on an insulated stand of a size equivalent to or larger than a standard rubber blanket. The payout reel must be grounded. Any deviation on grounding payout reels requires special permission from the supervisor. A bull line, which must be of dry polypropylene rope not smaller than 1/2 inch (13 millimeters) diameter should be placed in position to pull the wire before attempting to string it. The bull line must be of sufficient length to reach the distance the wire is to be pulled. Fasten the wire to the end of the bull line and pull it into position. A car or truck should be used to pull the wire so that the driver can see the signals of the reel operator. Both in pulling in the wire and in sagging it, the pulling must be slow and steady to prevent swinging the wires into the energized conductors. The wire must be watched carefully to prevent its hanging up on tree limbs, weeds, and other obstructions. No workers should be permitted to touch any conductors or wires on the ground without rubber gloves.

(2) *Over, under, or across energized lines.* When wires are strung and sagged over, under, or across conductors carrying a voltage of 5,000 volts or less, personnel handling the wire will wear rubber gloves and use other necessary protective devices. Conductors carrying more than 5,000 volts must be positively and constantly grounded during the stringing operation. As soon as the wire is ready to be deadended, it must be grounded with standard grounding devices.

(3) *Weather.* Electrical charges may appear on the line from a lightning strike or from induced static charges from a very dry atmosphere. Discontinue operations when there is any indication of lightning in the surrounding area.

(a) Fallen wires. All personnel must look for fallen wires. A worker finding a fallen wire will stand by it to protect all street and highway traffic and pedestrians from the hazards. As soon as possible, another worker must be directed to telephone the facilities engineer or the appropriate superintendent to have the wire de-energized. The worker finding the fallen wire must not leave until instructed by the supervisor in direct charge.

(b) Fire. Electric lines close to a fire should be de-energized to protect the firemen. The lines must not be re-energized until all danger has been removed. Where lines were located close to the fire, the lines, ground wires, and guying must be inspected. Inspect insulators for cracks and crossarms and poles for charring before the lines are restored to service.

(c) Vehicular protection. Wires being strung along or across streets or highways must be kept sufficiently elevated to eliminate vehicular collisions. The foreman should delegate a competent person to act as flagman. Traffic should be blocked when this line elevation is not possible.

b. Grounding. Requirements for grounding of de-energized lines are covered in chapter 3, paragraph 3–11. Other grounding requirements should be as follows—

(1) Permanent ground wires. Permanent ground wires are installed to protect workers. Remember that the metallic case, covering, or mounting support of any energized piece of electrical equipment must be considered energized at full voltage if it is not properly grounded. All permanent grounds must be installed according to the requirements of the NEC or the NESC as applicable.

(a) Ground wires must be installed clear of all metallic line equipment (except that which is normally grounded), hardware, or street lighting fixtures.

(b) Ground wires on distribution wood poles must be protected with wood molding for the entire working length of the pole and protected to prevent guy wires from cutting the ground wires. The entire working length of the pole is from the point where ground wire terminates near the top of the pole to 5 feet (1.5 meters) below the lowest crossarm or bracket, and from the ground line to 8 feet (2.5 meters) above the ground line.

(c) Never cut an overhead ground wire or neutral wires of any kind because of the need for line or equipment replacement, unless specifically instructed by your supervisor to do so. Also, avoid opening a joint in such a wire without first bridging the joint with wire of a suitable size.

(2) *Common neutral systems.* Fuses of all transformers will have been opened before-work can be done on a transformer bank where the grounded neutral wire is used for both primary and secondary neutrals. The connections from the transformer to the grounded neutral will be made before the connection from the transformer to the phase wire is made. The connection from the transformer to the grounded neutral wire must never be disconnected while the transformer is energized.

(3) Protective grounding equipment. Protective grounding equipment must be maintained in good condition and must be inspected immediately before being used. Use only approved screw-type ground clamps. Grounding equipment must be connected to ground point first, then to the item to be grounded.

c. Handling and stringing. ANSI/IEEE 524 provides general recommendations on the methods, equipment, and tools used for the stringing of overhead line conductors and ground wires. The following safety precautions are mandatory:

(1) *Reels.* Adequate braking must be used to stop all payout reels. Personnel must not otherwise touch or attempt to stop the revolving reel.

(2) *Conductors.* The inside end of the coil wire, where accessible, must be securely fastened to the reel to prevent the wire from getting loose when the wire has been payed out. If the inside end of the coil cannot be secured, a tail rope must be fastened securely to the wire before the end is reached to prevent its getting loose.

(3) *Grounding.* Bond and ground all stringing equipment, such as reel stands, trailers, pullers, or tensioners.

d. Primary line installation. Lines must be strung to clear the ground by an amount not less than that specified in the rules of the NESC. These minimums depend upon whether the line is above a street (consider its street traffic classification), above a pedestrian way, or over or near other structures. Wire and guys which are being strung should be kept clear of any possible interference with public traffic of any type. Where it is necessary to block traffic temporarily while wires and guys are being installed, one or more members of the crew should be assigned to direct traffic.

(1) *Stringing wire.* Stringing by facility personnel will normally be done by the tension method, since this keeps the conductor clear of energized conductors and clear of obstacles which might cause surface damage to the wire. Slack stringing may be appropriate for new short line extensions. In either case lines must be sagged to meet the requirements of the NESC.

(a) In stringing wires do not put kinks into any part of the line. Kinks reduce the strength of the wire and may result in fallen wires later.

(b) Before changing the strains on a pole by adding wires, engineering guidance should be requested to ensure that the pole will safely stand the altered strain.

(2) *Clipping in or tieing wires.* This involves the transferring of sagged conductors from their stringing travelers to their permanent insulator positions where they may either be clamped or tied to insulators.

(a) Wires should be securely tied-in at all tie-in type insulators to prevent the possibility of wires becoming loose at points of support and falling to the ground. Where double arms are provided, line wires should be well tied-in to insulators on each arm. This applies to pin- and post-type tie-top insulator work. Clamp-type insulators must have the clamps tightened to meet the manufacturer's requirements.

(b) When it is necessary to connect two parallel circuits at one or more points on the line, the phase wires should 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. (See paragraph 3–5)

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

e. Secondary line installation. Secondary lines must be installed to meet line clearance requirements of the NESC. Lines may be single or triplex wires. Secondary lines with insulation must be handled with the care insulated wire requires. Workers must be particularly careful in stringing secondary services, to avoid any undue hazard in close proximity to primary lines. Locations where the service wires might fall across conductors of a higher voltage are not permitted.

(1) Before stringing secondary wires, nearby or adjacent energized lines must be de-energized and grounded. As an exception, service wires may be installed near overhead energized lines provided the following operations are carried out in the following order. Connect service wires to the building; attach a handline to the other end of each wire and carefully raise the wire to its position on the pole; and then attach service wires to the bracket or crossarm. While these operations are being performed, workers must wear rubber gloves and use insulation to prevent shock from unintentional contact between the service wires and the primary lines. Personnel on the ground must not attempt to install meters or other secondary connections while these operations

are being performed.

(2) In the handling and stringing of weatherproof-covered wires, care must be taken not to injure the weatherproof covering.

f. Removing lines. Removing or salvaging wires requires the same precautions as stringing wires. The wire to be removed should be pulled out and laid flat before coiling the wire by hand or on a nonpower-driven reel.

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

(2) Lines which are being cut or rearranged should not be allowed to sag on, or be blown against other electric power lines, signal lines, signal equipment, metal sheaths of cables, metal pipes, ground wires, metal fixtures on poles, guy wires, and span wires.

(3) Wires which have been cut, or which are being arranged, should not be allowed to fall near or on a roadway where there is danger to traffic. Where it is impossible to keep these wires clear of the roadway by at least 10 feet (3 meters) or more' (depending upon the voltage of the adjacent lines) all traffic should be blocked. All persons working on lower levels of poles, where cutting is taking place, and all personnel on the ground should be notified well in advance of the cutting so that they may stand clear.

g. Guying. No installation or removal of guys should ever be attempted without engineering guidance.

(1) *Installation.* Install guys to meet the following requirements:

(a) When 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 any changes are made in the line wires and care must be taken not to place excessive pull on the pole and wires already in position.

(b) Guys should be installed so that there is minimal interference with the climbing space and guys should clear all energized wires.

(c) Guy strain insulators should be provided, wherever necessary, to secure the required amount of insulation to applicable codes.

(d) Guys should be installed to the correct tension. Where necessary, a guy hook may be used to prevent the guy from slipping down the pole. These hooks should be so located that they do not interfere with climbing and so placed that they will not be used as steps. Where guys are liable to cut into the surface of a pole, the pole should be protected by a guy plate at the point where the guy is attached. The plate must be well secured to the pole to prevent the possibility of injury to a worker climbing up or down the pole.

(e) All guys should be installed so that they do not interfere with street or highway traffic. Guys located near streets, or highways, should be equipped with traffic guards. Traffic guards are sometimes called "anchor shields". Guy guards (traffic shields or anchor shields) should be yellow.

(f) Guy wires should be installed so that they will not rub against messenger or signal cables.

(g) Guy wire containing snarls or kinks should not be used for line work. It is preferable to use guy wires of the correct length to avoid unnecessary splices.

(2) *Removal of guys.* Before guys can be removed, the condition of the pole must be determined. If the pole is weak, it should be securely braced before any changes in pole strains are made.

(a) Where the removal of guys from a pole will change the strain and present a dangerous condition, the pole should be braced temporarily to make such a changed condition safe.

(b) Where it is not possible to install side guys, poles may need to be braced to be self-supporting. The pole bracing should be installed so that it will not interfere with climbing or with street or highway traffic. Pole braced guys should not be used on poles which will be climbed.

h. Insulators. Pick up insulators by their tops to avoid cutting gloves or hands on insulator petticoats. Do not screw down insulators too tightly because their tops may break off, cutting gloves or hands.

6–9. Energized line work

Refer to energized line work requirements covered

in paragraph 3–15. The rules of this paragraph amplify those requirements and cover work on aerial lines, however the nature of live line maintenance work makes it difficult to govern by hard and fast rules. Therefore, the foreman must devise safe methods on the points not covered by rules given in this manual.

a. Live-line work safety rules. Overhead lines should be worked deenergized when this can be done. However, live line maintenance, carefully done by industry-approved standards, has proved to be an effective method for work on electric power circuits. Recognize that energized line work demands maximum attention to safety rules by all personnel. Utilization of insulating equipment in the application of basic principles of isolation must be followed.

(1) The foreman must supervise the workers closely, and advise them as necessary. The entire responsibility for the safety of personnel engaged in live line work, as well as the enforcement of the following rules, rests with the foreman:

(a) Safe working distance from all energized wires must be maintained by workers at all times. See table 3–3 covering qualified worker minimum clearance distances. In congested locations where this is impossible, a Safe Clearance must be obtained (refer to paragraph 3–8).

(b) When it is necessary to work on energized lines carrying more than 750 volts between conductors, gloving or live line tools must be used according to table 3–5. The safety of the work depends on the integrity of the tools and protective rubber equipment. Continual inspection, in service care, and required testing are mandatory to maintain worker safety.

(c) Close cooperation must be obtained from every worker on the job. High-tempered or fractious people should never be assigned to live line work.

(d) Unnecessary conversation must not be allowed, as this would distract attention, cause confusion, and create a hazard.

(e) Haste inconsistent with safety must not be permitted.

(2) A careful check will be made to see that the condition of the structure and lines at the point of the work is such that the job may be performed safely. In addition, the adjacent spans and structures will be carefully checked for defects in conductors, tie wires, insulators, and other equipment. Other precautions include the following:

(a) Live line maintenance work will never be done at night or in wet weather.

(b) Under no circumstances will a worker depend on another worker to hold a live conductor clear of him/her.

(c) When moving heavy conductors, wire tong blocks clamps will be used on the live-line tools so that these lines may be moved slowly and carefully.

(d) While live-line work is in progress, no other work of any nature will be performed on the same pole or structure.

(e) For circuits on wood poles or attached to wooden structures, all wood members should be considered to be at ground potential.

(3) When working on energized equipment provide these precautions:

(a) Workers should, whenever possible, place all protective devices and do all work from a position below live conductors or apparatus.

(b) When it is necessary to change position on a pole, a worker must climb below energized unprotected conductors and apparatus to a position below live conductors and apparatus and then up to the new position. If two workers are on the pole, no work may be done on energized conductors until the worker changing position has reached the new location.

(c) When handling of energized lines and equipment is being done on a pole or structure, a handline must be carried up the pole and securely fastened before any work is done.

(4) Standard requirements for tools and protective equipment. The following requirements should apply:

(a) When the minimum working distance must be reached because the nature of the work requires close access, calibrated insulated measuring sticks or equivalent will be used to verify the distance. Telescoping fiberglass measuring sticks, alternately yellow and red striped at 1-foot intervals (0.l-meter intervals with a black stripe at every 1 meter interval) are recommended for monitoring minimum distances. Marking of live-line sticks to identify the minimum phase-to-ground safe work distance as listed in table 3–3 for the circuit being

worked is recommended. Alternatively, each liveline stick should be equipped with a standard flexible rubber hand guard to indicate how far out a worker can safely hold a stick.

(b) Personnel performing structure-type live-line maintenance should not carry hand tools in their belts, particularly when working from ladders. Hand tools should be raised to a worker on a structure in canvas tool bags. Hand tools should be returned to their canvas tool bags each time their use is completed.

(c) Use tested fiberglass-reinforced plastic (FRP) hotsticks. Wooden hotsticks are not recommended.

(d) Observe all rules for aerial rope use covered in paragraph 6–12.

(e) Only hook ladders made of FRP will be used in live-line maintenance. FRP hook ladders will be equipped with nonconductive safety ropes along both outside rails. Personnel on a ladder will maintain their safety straps around the ladder except when mounting or dismounting, and will have the ladder snap on their safety strap snapped to a rung of the ladder when they are in a working position and when the ladder is being moved.

(5) Link stick lines should be handled as follows—

(a) In removing link stick (fuzz lines) from energized conductors, the worker must take hold of the link stick rope and pull the link stick in before grasping the stick.

(b) When untying conductors workers must cut the tie wires off short or roll them up in a ball so they will not contact pins, crossarms, poles, ground wires, or any other conductor.

(c) When untying or tying conductors on pin type insulators, one worker at a time should work and the other should steady the conductor with a tie stick. The foreman must check the condition of tie wires and pins on poles adjacent to the one being worked on to make sure they are safe. Before moving the conductor, the foreman must verify that adequate clearance exists between the conductor and any object or wires crossing under the line in adjacent spans.

(d) Link stick lines must be tied off to a suitable anchorage on all regular live line setups. In no case will they be tied to a car or truck unless the motor is stopped, the ignition key removed, and the brakes set.

(e) If the work to be done is on an angle, the foreman must arrange to take care of strains by providing sufficient tackle. In addition to anchoring the link stick lines, blocks must be used on the ends of the link stick ropes so the conductor can be moved slowly and carefully.

(f) Workers must not allow rope to lie across energized conductors.

(6) Work on 0 to 750 volts nominal, phase-to-phase circuits must be done as follows—

(a) When working on energized secondaries, rubber gloves (Class 0) with leather protectors must be worn.

(b) Each worker working on energized lines and apparatus must be qualified for the highest voltage class of all conductors within reach.

(c) Work must be performed on only one conductor at a time.

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

(7) Work on 750 to 17,000 volts nominal, phase-to-phase circuits must be done as follows—

(a) Where gloving is permitted by table 3–9 use gloves table 3–10 and wear leather protectors.

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

(c) 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.

(d) 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. Workers 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.

(e) When working on energized conductors

or parts, 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 other energized parts by the workers or any conducting object or tool the workers are handling.

(f) 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.

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

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

(i) When work is being done near an energized conductor using an aerial bucket, either ground the truck or barricade the truck and work area. 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.

(8) Work above 17,000 volts to 36,000 volts, nominal phase-to-phase, other than the replacement of fuses and switching, on energized lines or apparatus operating at this voltage range is prohibited. Switching and fusing energized circuits in this voltage classification must be performed under the following conditions:

(a) Must be approved by and be under the direct supervision of a qualified person devoting full time and attention to the workers and the safety of the workers.

(b) Must have at least two qualified workers available.

(c) Must use live-line tools of the proper voltage for lines and apparatus belonging to this voltage class and maintain the minimum clearance from live parts as listed in table 3–3.

(9) Other work above 17,000 volts and all work above 36,000 volts must be done by contract personnel if it is done live-line.

(10) All live-line work regardless of the voltage level, requires that normally, no worker is permitted to approach or take any conductive object closer to exposed energized parts than shown in table 3–3. Exceptions are—

(a) The tool or object has an approved insulating handle.

(b) The worker is insulated or guarded from energized parts. (Glove and sleeves rated for the voltage involved are considered insulation of the worker from the energized part).

(c) The energized part is insulated or guarded from the worker and any other conductive object at a different potential.

(d) The worker is insulated or guarded from any other conductive object.

b. Live-line bare-hand work. Live-line bare-hand work is not permitted.

c. Washing of insulation on energized lines. Washing of energized insulators requires maintaining minimum water resistance, minimum working distance, and minimum nozzle pressure. Also see IEEE/ANSI 957 on cleaning energized insulators. Conform with the minimum requirements of the facility's local utility company. Minimum values are given in IEEE/ANSI 957 but these are admittedly only guides because of the great variety in conditions, practices, contamination possibilities, and electrical system designs used by different utilities.

6–10. Streetlighting

Streetlighting circuits can be either low-voltage multiple circuits or mediumvoltage series circuits. It is important that the type of circuit be identified because of the voltage level differences. There should be no reason that streetlighting circuits cannot be de-energized for daytime work.

a. Precautions. Streetlighting line wires and streetlighting fixtures and wires, not under construction or grounded, must be considered energized and must always be worked with rubber protective equipment, unless a Safe Clearance is obtained and the line grounded. The voltage of streetlighting circuits should be treated as that of the highest voltage occupying one or more poles on which the streetlighting circuit is run. This is necessary because streetlighting

wires sometimes become crossed with live voltage wires during a fire or during the day when not in use.

b. Multiple streetlighting circuits. Multiple streetlighting circuits will be considered to be at the same voltage as the circuits to which they are connected, unless the circuit is on the same structure with a higher voltage wire, in which case it must be considered to be at the higher voltage level.

c. Series streetlighting circuits. Before a series streetlighting circuit is opened and work is performed, the following procedures will be followed:

(1) A circuit will be disconnected from the source of supply by opening disconnecting switches or other absolute voltage cutouts, and a Safe Clearance will be attached to such disconnects or cutouts. Do not depend on time switches or other automatic devices.

(2) A circuit will be properly jumpered to avoid an open-circuit condition.

(3) In replacing lamp globes in series streetlighting brackets, 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. These springs may 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 (1.8-meter) handles will be used for replacing lamps on series streetlighting circuits. Workers must wear rubber gloves when removing or installing lamps where lamp changers cannot be used.

d. Climbing space. Maintain safe access by hanging streetlighting fixtures clear of the climbing space. All bolts, lag screws, and other hardware used in securing the fixtures will be carefully trimmed.

e. Time switches. When winding 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. On time clocks with medium-voltage connections, workers will wear rubber gloves in winding, resetting, and otherwise maintaining the clock.

6–11. Working on or around pole-mounted equipment

See paragraphs 5–6, 5–7, 5–8, and 5–10 for various equipment rules. These rules are the basic equipment safety rules. The rules in this paragraph apply to precautions applicable to equipment that is mounted above grade. Be aware that some state safety orders do not permit grounding of enclosure cases on wood poles, if there is a possibility that an accidental contact with bare aerial lines might occur. Transformers connected to an energized circuit will be considered as being energized at the full primary voltage unless they are adequately grounded.

a. Surge arresters. Check that the permanent ground connection is intact before any work is done. Do not climb or strap off to surge arresters. Wear eye protection when connecting, disconnecting, or discharging surge arresters.

b. Switches and fuses. The maintenance of switches and fuses may require temporary line modifications to permit repairs where service continuity must be maintained. Both sides of fuses must be deenergized for repair work to proceed. Engineering guidance is required in preparing a step-by-step modification procedure.

c. Capacitors. Refer to paragraph 5–8 for discharging capacitors. Individual capacitor banks must be grounded if insulated capacitor mounting racks are not used. Provide discharging method in accordance with the manufacturer's instructions.

d. Power transformers and voltage regulators. Check poles and crossarms before installing a transformer or regulator on an existing pole. Consider that the following transformer requirements apply to regulators where applicable. Only qualified personnel should climb poles to fuse, inspect, and test transformers and equipment. When transformers are installed or replaced, their secondaries must be checked for voltage and phase rotation when necessary. When distribution transformers are installed and before they are energized, the ground connections must be made to the case, secondary neutral, and then to the primary neutral when used, in the order named.

(1) *Energized work.* Except for testing, replacement of fuses, and switching, work on energized pole-mounted transformers and lines is prohibited.

(2) *Installation.* To meet these requirements, engineering guidance may be necessary.

(a) All frames and tackles used in erecting pole-type transformers should be carefully inspected each time before use. Defects should be repaired before the frames and tackles are used.

(b) Wherever possible, junction poles, subsidiary poles, and streetlighting poles should not be used

as transformer poles. When it is necessary to install transformers on junction, subsidiary, or streetlighting poles, take care to maintain proper climbing space and to avoid crowding of wires and equipment.

(c) Transformers must be installed only on poles strong enough to carry their weight. Transformer poles must be straight and, where necessary, guyed to prevent leaning or raking of the pole after the transformer is hung.

(d) When transformers are raised or lowered, all crew members must stand clear and traffic must be detoured if necessary. In congested traffic, the pole space must be roped off. Personnel on the pole must place themselves on the opposite side from that on which the transformer is being raised or lowered. Pole steps and other obstructions in the path of ascent/descent of large transformers should be removed.

(e) When transformers are installed, the pole climbing space should be carefully maintained so that it will not be necessary for climbing workers to come too close to the transformer case.

(3) *Connection.* Pole-type transformers should not be installed until they are supplied with a sufficient amount of good quality oil.

(a) When a three-phase bank of pole-type transformers is replaced, the new transformers should be carefully checked for phase rotation before service is restored, so that the new service connections will be the same as before the change. Any motorized equipment revolving in the wrong direction because of incorrect phase rotation is dangerous.

(b) Rubber gloves or hot sticks must be used when installing a poletype transformer. First connect the primary leads from the transformer to the primary cutouts; second, make sure that 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".

(c) Where one or more transformers feed into a common secondary or are paralleled on the low-voltage side, caution should be exercised in refusing, as the higher voltage terminals will be energized by stepping up the secondary voltage which is supplied by the other transformer.

(4) *Inspection and maintenance.* Only "Qualified Climbers" should be allowed to climb poles to inspect and test pole-type transformers. Never stand on or otherwise contact transformer cases, while working on or near energized circuits.

(a) Before changing or replenishing oil, all energized connections to transformers must be disconnected and a Safe Clearance provided from all live circuits.

(b) When opening transformers, do not use lighted matches or open flames of any kind.

(5) *Fusing.* When installing fuses, workers should be careful to avoid contact with any live lines, or with any grounded surfaces (grounded lines, the casings of grounded transformers, streetlighting fixtures, signal lines, signal equipment, the metal sheathing of cables, metal conduits, span wires, and guy wires).

(a) Before installing fuses in new cutouts, replacing fuses, or opening disconnects, workers must protect their eyes by wearing goggles and by turning their heads. They should use their arms to further protect their eyes and faces from any flashes or arcs that may occur. It is mandatory for the workers to wear rubber gloves or to use a "hot stick" as appropriate to the voltage level. Workers must secure themselves to the pole with their safety belts.

(b) When fuses are taken out of the circuit they should be removed entirely from the fuse enclosures or cutouts.

(c) In phasing out a transformer or in testing it for polarity, small size fuses should preferably be used.

(6) *Service connections.* Do not string service wires from a transformer pole if it is at all possible to install them at some other location. Service wires must never be installed on transformer poles, unless a minimum separation meeting code requirements can be maintained between the service wires and the energized primary conductors or apparatus.

(a) Two workers must be used in stringing services from a transformer pole where primary jumpers energized at 5,000 volts or more extend below the secondary wires.

(b) When a worker is making connections to secondary buses, the neutral wire must be connected first and energized wires connected last. The procedure must be reversed when disconnecting services.

(7) *Testing.* Testing of transformers, autotransformers, and similar equipment should be performed by qualified personnel under appropriate engineering guidance. All temporary leads used in testing such as secondary leads of potential transformer, thermometer leads, and recording voltmeter leads, should be securely supported on the pole and should clear all traffic. The positions-of these leads should not interfere with the climbing space or with maintenance work which may be required while the testing is in progress.

6–12. Aerial rope use

Ropes are used by workers working on aerial lines. Rope qualities and use in rigging for general lifting is covered in chapter 4, paragraph 4–9. See table 4–1 which gives approximate safe working loads for ropes.

a. Conductivity. Always use properly maintained polypropylene synthetic rope (not natural-fiber rope) for aerial lines, handlines, and taglines for live-line work which meetg ANSI/IEEE 516 requirements. Keep rope stored in a clean, dry location and protected from damage and contamination. Lines will be without wire reinforcement and, at least 1/2 inch (13 millimeters) in diameter.

b. Rope use terms. Rope line terminology applying to aerial line work is as follows—

(1) Handlines raise and lower light materials and tools They may be used for holding small transformers away from the pole during raising or lowering.

(2) Throw lines are used to pull a larger rope into place for performing a task beyond the capacity of a hand line. They are small diameter ropes thrown over support objects such as crossarms or tree limbs.

(3) Bull ropes are used when a handline is not strong enough to raise heavier equipment. They are used also for fastening temporary poles, for holding out heavier transformers, and for lowering trunks or heavy limbs in tree trimming operations.

(4) Running lines are used for pulling several span lengths of wire at one time.

(5) A sling is a looped rope assembly used to hoist heavy equipment, for lashing tools or materials in place, attaching a block or a snatch block to a pole, making temporary installations such as lashing an old pole to a new pole, or tying up line wires.

(6) A safety line is used only for lowering a worker to the ground.

(7) A snatch block is a rope sheave and hook with one side of the sheave open to avoid threading the rope through a hole.

6–13. Tool use

Aerial line work involves the use of portable power tools and the different miscellaneous tools required in the performance of the work.

a. Portable power tools. Only approved portable power tools will be used on poles, towers, or structures.

(1) Electric tools and all supply lines connected thereto will be kept a safe distance under the level of all circuits or apparatus energized in excess of 750 volts, phase to phase. Supply lines will be adequately insulated and properly secured to prevent accidental contact with any conductor.

(2) Air and hydraulic-driven tools will not be used in any position where their unprotected conducting parts can come closer to any energized conductor or apparatus than the minimum working distance given in table 3–3. Cover the energized conductors or apparatus with approved protective equipment for the voltage involved where reduced clearances are required. Supply hoses will be noncurrent-carrying material throughout, properly maintained and, when in use, secured to prevent accidental contact with any energized conductor or apparatus.

(3) Power saws will be secured in an approved manner when used in an elevated position on a pole, tower, or structure.

(4) Except as permitted otherwise, noncurrent-carrying metal parts of hand-held portable electric power tools will be grounded. Approved double insulated tools and tools fed from ungrounded isolated power supplies need not be grounded.

b. Miscellaneous tools. Observe the following precautions in their use.

(1) Pike pole handles must be sound and free from splinters. Spear points (gaffs) must be sharp and securely fastened to a pole. When carried on trucks, pike poles must be placed so that injury is prevented.

(2) Always maintain cant hooks and carrying hooks in a safe condition.

(3) Never use jennies with cracked or broken legs, dull teeth, or loose bolts. Use only approved jennies.

(4) Never use pole jacks with defective releases, or jacks which slip when loaded.

(5) Always use approved bumperboards. These should be either 2 by 6 inch (50 by 150 millimeters) board, 6 to 8 feet (1.8 to 2.4 meters) long or 1 1/2 by 6 inch (38 to 150 millimeters) channel iron, at least 6 feet (1.8 meters) long.

(6) Never use wire reels showing any defects. All wire reels must have suitable brakes.

(7) Never leave closing-type knives open when placing them in tool boxes or other storage containers. Open knives must be kept in scabbards when not in use.

(8) Always maintain personal tools in good condition.

(9) Always maintain hot line tools in good condition. Tools must be kept clean and dry at all times.

6–14. Aerial lifts and insulated buckets

The use of aerial lifts and insulated buckets is covered in paragraph 4–11. See also table 3–9 for voltage levels where their use is mandatory.

a. Requirements. Workers involved in electrical operations with aerial lifts must observe the following instructions:

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

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

(3) Be aware that 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) Do not depend upon the truck, boom, or aerial bucket to be "electrically insulated" without daily proof that each item is insulated to the necessary value. 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, if energized, properly 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 buckets.

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

(7) Bucket liners must be used if the bucket is designed to be used with a liner and must be tested according to paragraph 4–11 requirements.

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

(9) Unauthorized or unqualified persons will not be permitted to operate the aerial bucket boom.

(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 electrically-related work.

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

(12) The manufacturers load limits of the boom or buckets 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: Drivers of aerial bucket trucks must be constantly alert to the fact that the vehicle has exposed equipment above the elevation of the truck cab and be sure that roadways provide the necessary clearance. They must avoid moving the truck into the opposing traffic stream by planning the order of the work to eliminate this hazard. When possible the following precautions should be observed:

(1) 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.

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

(3) 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 knocking down at the job site. Upon arriving at the work area, legally park the truck while the vehicle and pedestrian warning signs, lights, and barricades are being placed. Give careful consideration to the location of overhead conductors and the surrounding conditions before the truck is moved into the work position. 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. Take the following precautions:

(1) 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.

(2) 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.

(3) 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 be approximately level as viewed from the rear.

(4) A warm-up period is needed at the beginning of each day's work. This time may vary with different makes and models, and with different temperatures.

(5) When lowering the boom to a cradled positions, workers will stand clear of the path of the bucket and boom.

(6) 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. Observe proper precautions before and while raising the bucket. Workers will obey the applicable rules for working aloft or working at ground level.

(1) One worker must be responsible for all operations required in placing the bucket in operating position, use of the bucket, and restoring it to the traveling position.

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

(b) If the operator has any doubt as to the stability of the truck, due to terrain, then the outriggers or stabilizers must be checked fro safe operation before a load is lifted.

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

(d) workers will enter the bucket only with the bucket resting in the position for which it is designed.

(2) the operator should always face in the direction in which the bucket is moving so that all obstructions are noted and avoided when the bucket or boom is raised, lowered, or rotated.

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

(b) 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.

(c) the operator must suspend operations if tests indicate the unit is not working properly.

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

(3) Protection for workers aloft will be provided by locating buckets under or to the side of lines, to avoid contacting any conductors or equipment.

(a) If necessary to get within reach of energized conductors or equipment, a worker must be properly protected with rubbed sleeves and rubber gloves, if appropriate to the voltage level.

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

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

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

(e) A worker must not belt onto an adjacent pole, structure, or equipment while performing work from the bucket.

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

(g) When working aloft, secure all tools not in use.

(4) When the bucket is being used in any manner which might result in contact between an energized conductor and the bucket, boom, or any attachment thereto, the vehicle must be considered energized at line potential, and the following safe practices observed fro ground operations.

(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 other required protective devices.

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

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

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

(e) Tools or materials must not be thrown to or from the elevated bucket.

6–15. Aerial cable heating material requirements.

See paragraph 7–6 for safety requirements. Observe the following additional requirements.:

a. Soldering tools must be kept at grade level except when actually in use aloft.

b. When solder is being used aloft, an approved solder catcher must be placed directly under the point of soldering.

6–16. Tree trimming and brush removal

Tree trimming and brush removal is done to maintain the integrity of electric lines and apparatus and provide right-of-way clearance.

a. Training qualification. Workers who climb trees must be certified as "Qualified Climbers." Workers in aerial lifts must be qualified for that work. If using ladders, review the requirements for their safe use in paragraph 4–6. In all cases, when workers are engaged in work near energized lines, they must be qualified to do so. Any trimming must be done in a manner that does not damage the tree, and meets ANSI Z133.1 requirements. The worker must be qualified to do tree trimming.

b. Public Safety. Erect suitable signs and barriers to prevent the public from passing under trees in which personnel are working and to prevent stumbling over brush on the ground. Brush must not be piled on sidewalks nor left on streets and highways overnight.

c. Tool Safety. Raise and lower tools with a handline. Only saws and pruning knives or shears are used for cutting limbs. Do not carry unnecessary tools up the tree. Tools must not be hung or stored on tree limbs.

d. Working near energized lines. Be aware that lines may not always be de-energized fro tree trimming operation. Review the rule for live line safety and for climbing and working on a pole especially in regard to being knowledgeable of the energized lines in the area and the relevant dangers. Workers in trees will use belt and safety straps. When working near energized lines, arrange your safety line so that a slip or fall will carry you away from the energized lines.

e. Climbing and working on trees. Climbing trees should be avoided unless ladders or aerial lifts will not provide the necessary access. Workers in trees must use every precaution to prevent contact with aerial electric and telephone wires, and damage thereto. Ensure that the following precautions are taken.

(1) If climbers are used, make sure they are tree climbers approved for the bark thickness of the tree being climbed. Never use pole climbers.

(a) Use a belt and safety strap of life line. Place the strap around a tree limb of sufficient size to hold the worker's weight, but never around the tree limb being cut.

(b) Do not stand on tree limbs too small to support your weight. Extreme care should be exercised when working in trees which have brittle wood.

(2) Before felling trees inspect tools to be used (such as ropes, tackle, ladders, and chain saws) to ensure they are in proper condition.

(a) Place signs warning pedestrian and vehicular traffic of the danger from work being performed. Station flagmen where necessary.

(b) Inspect each tree for possible dangers (conductors and fences) in the line of fall. Have energized conductors de-energized if possible.

(c) Check each tree for dead or broken tree limbs when climbing. Remove unsound tree limbs during the climb.

(d) Lower cut-off tree limbs with a rope. Falling tree limbs can cause injury and property damage.

(e) Trees greater than 25 feet (7.5 meters) tall and 8 inches (200 millimeters) truck diameter must have ropes attached before felling. Passing workers to the ropes to guide the tree as it falls.

f. Power trimming equipment. Chain-saw operators will follow the manufacturer's operating instructions and will carefully inspect and maintain their saws prior to use. Chain saws are very dangerous. Observation of the following operation and maintenance safety rules will assist in the avoidance of injury.

(1) Operate only if authorized and observe the following operator precautions:

(a) Before starting to cut, the operator must clear away brush or other material that might interfere with cutting operation.

(b) Operators will wear personal protective equipment as prescribed by the designated authority. Eye, ear, hand, foot (safety shoes) and leg protection are required as a minimum unless specifically waved by the designated authority.

(c) the idle speed will be adjusted so that the chain does not move when the engine is idling.

(d) The operator must be sure of his/her footing before beginning cutting operations.

(e) the operator will hold the saw with both hands during all cutting operations. Grip the chain saw properly. Place one hand on the top handle with the thumb curled under the handle. Place the other hand on the control handle.

(f) The operator must stand to the side of the chain saw, not directly behind it, to keep the body away from the path of the guide bar if kickback occurs. Be alert to conditions. That can cause the chain saw to kick back. Kickback occurs when a solid object (such as a tree limb above the cutting area) contacts the chain at the guide bar nose. This causes the saw to be thrown violently up and back toward the operator.

(g) The chain saw must never be used to cut above the operator's shoulder height.

(h) The operator will shut off the saw when carrying it over slippery surfaces, through heavy brush, and when adjacent to personnel. The saw may be carried running (idle speed) for short distances of less than 50 feet (15 meters) as long as it is carried to prevent contact with the chain or muffler.

(i) Never operate a chain saw when physically tired or under the influence of alcohol, medication, or other drugs.

(j) When felling a tree, clear a path of retreat while assuring that the fall does not damage anything.

(2) Chain saws must be kept clean and sharp at all times, and kept in sound mechanical conditions with all guards, spark arresters, mufflers, handles, and other items properly installed and adjusted. Observe the following equipment precautions:

(a) Fuel for chain saws must be stored in approved vented containers that are marked to show their contents. Never store the fuel near flammable materials. Keep the containers clean. Always wipe the spout clean before filling the chain-saw tank. Filtering the fuel mixture will ensure continued smooth engine operation.

(b) make sure that a proper mixture of fuel (gasoline and oil) is used. Check the fuel tank and chain oiling reservoir for proper levels before use. The filler caps for the fuel tank and chain oiling reservoir must be clearly marked and securely attached during operation and storage.

(c) the chain saw will not be started within 10 feet (3 meters) of a fuel container.

(d) the chain saw will not be fueled while running, hot, or near an open flame.

g. Right-of-way brush removal. Brush clearance should be performed as part of electrical maintenance work only to clear right-of-ways. Wear personal protective equipment when using power trimming equipment. Recognize the hazards from poor work practices to workers and to the environment and observe the following rules.

(1) Cutters felling heavy brush or small trees must give sufficient warning to other personnel. Never work so close that one worker could injure another with a swinging ax or hook.

(2) Brush chippers will be operated only if authorized and by standing to the side of the chipper chute while feeding the butt end of brush into the chipper first. Use the automatic shut-off/stop control at the operator's station in an emergency.

(3) Tools such as saws, axes, bush hooks, pruning shears, scythe blades, and pitch forks, must not be thing in bushes or small trees nor stored hidden from easy view of other workers.

(4) Personnel assigned to remove or pile brush must stay a safe distance behind workers using cutting tools.

(5) When burning brush, be careful at all times to see that the fire and sparks are under control. Cover hot ash piles with dirt or douse them with water. Obey local laws concerning open fires. The burning of poison ivy, poison oak, and poison sumac is prohibited. Smoke from burning these plants is very toxic; even the windward side of the fires may not be safe.

(6) Workers assigned to right-of-way cutting should be taught to recognize poison ivy, poison oak, and poison from these plants and should keep away from the vices and leaves. If workers do contact these poisonous plants, they should report to the foreman who will immediately render appropriate first-aid treatment to prevent a rash from breaking out on the worker's skin. A first-aid kit should always be at hand.

(7) Workers must always be on the alert for snakes when cutting right-of-way. A standard snakebite kit must be carried on every such job.

CHAPTER 7

UNDERGROUND CABLES, STRUCTURES, AND ASSOCIATED ELECTRICAL COMPONENTS

7–1. Underground work

Underground electrical work applies to manhole, vaults, and handholes; duct lines and trenches; cable; and ground-mounted and underground equipment associated with underground electrical lines.

7–2. Work area protection

Work area protection is the safeguarding or protecting of pedestrians, motorists, facility workers, and equipment by the use of barriers, warning signs, lights, flags, traffic cones, high-level standards, barricade rope, and flagmen. Protection is required for approaches to work areas, excavations, open manholes, and parked equipment. An approved fire extinguisher in good operating condition and immediately accessible for underground work is mandatory.

a. Protection methods. Work area protection methods will provide safety for workers, equipment, and the public without excessively impeding public traffic.

(1) During any period in which apparatus must be left open and energized, a suitable enclosure will be erected around the apparatus, or a qualified worker must be stationed at the location to ensure the safety of the public.

(2) All temporary cable installations must be made in a manner providing safety for workers and the public.

b. Impact of vehicular traffic flow. The amount and speed of the traffic will influence the work planning. Where work will require excavation in roads and highways, the appropriate traffic authority should be consulted to maintain safe traffic flow. The public must be warned in advance, then regulated and guided safely through or around the work area.

c. Work space consideration. The extent of the work and the lineup of traffic will effect scheduling, which should be done to cause the least interference to traffic and, minimize the possibility of accidents. Good housekeeping in the storage and equipment space necessary for the work should always be an ongoing concern but especially wherever it impinges on public right-of-ways. It is of the utmost importance that the work area be properly identified and the warning devices clearly convey the appropriate message to the traveling public, well in advance of arrival at the work area. This same good housekeeping applies to protection of workers.

d. Barricades and warning precautions. Traffic control requires the use of barricades and warning precautions.

(1) *Devices.* Only those signs, standards, barricades, flags, and cones which conform to State or local codes will be used. All State and local traffic codes will be followed when providing work area protection.

(a) During night operations or in periods of reduced visibility, special precautions will be taken. Adequate warning equipment will be used including flashing lights, flares, or area illumination.

(b) Warning devices and equipment will be removed as soon as the hazard is eliminated.

(c) Warning devices and equipment not in use will be stored in a proper manner or removed from the work area.

(d) Barricades of materials having protruding nails will not be permitted.

(2) *Flagmen.* Flagmen or other appropriate traffic controls will be used whenever there is any doubt that the use of signs, signals, and barricades is ineffective.

(a) Flagmen will wear a red or orange warning vest or garment. Warning garments worn at nigh will be of a reflectorized material.

(b) Flagmen using hand signaling equipment will ensure signals provide sufficient warning to protect themselves and the work site. Signal flays will be red and at least 24 inches (60 centimeters) square. Sign paddles (Stop and slow) will be on a 6-foot (1.8-meter) staff. In periods of darkness or reduces visibility, red lights will be used.

(c) Flagmen will place themselves in a protected position to reduce possibility of injury from traffic.

(d) Flagmen will ensure that they can fully observe the operation and will guide vehicular traffic in such a manner as to minimize the possibility of accidents or injury.

(e) When flagmen are used at both ends of a job site, reliable communications or prearranged signals will be used to insure proper traffic flaw.

(f) Flagmen will face traffic when giving signals.

(g) Flagmen will give positive, direct signals which leave no doubt as to their meaning.

(3) *Barriers and barricade tape.* See chapter 5, paragraph 5–3 for requirements.

(4) *Caution and danger signs.* The following are approved signs:

(a) Danger, High Voltage—Various sizes

(b) Danger—Keep Away—12 by 24 inches (300 by 600 millimeters)

(c) Danger—Personnel Working Overhead—12 by 14 inches (300 by 350 millimeters)

(d) Wear Goggles When Grinding—Various sizes

(e) Danger, Drive Slowly—Personnel Working—15 by 15 inches (380 by 380 millimeters)

(f) Danger—Blasting—15 by 15 inches (380 by 380 millimeters)

(g) Caution—check for Feedback—5.5 by 2 inches (140 by 50 millimeters)

(5) Preparing a manhole work area requires proper use of warning devices.

(a) During the time that manholes or vaults at the sidewalk or street level are open, suitable barricades, traffic cones, warning signs, flags, and lights will be used and maintained.

(b) When working in vehicular traffic areas 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.

(c) 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 or nonflashing lights.

e. Excavation, trenching, and back-filling. Work in increments to minimize open trenches. On a daily basis, remove spoil to an area where it will not constitute a safety hazard.

(1) All equipment and materials, stored where pedestrian or vehicular traffic might be endangered, must be marked with red flags by day and red lights by night, or both. Do not store equipment or materials where they will obstruct fire alarm boxes, hydrants, or fire apparatus.

(2) Keep tools, stones, and dirt away from the edge of a trench. Excavated material removed from trenches in streets should be kept on the traffic side of trenches, whenever possible, until it can be used for fill or removed.

(3) Carefully refill excavations until such time as permanent paving can be done. See that all refilling is well tamped.

(4) Provide ditching machines with suitable walkways, footboards, railing, and proper safeguards over gears, chains, and other moving parts. Do not stand near digging buckets while the machine is in operation.

(5) Protect all open holes along streets and highways or other frequented places by suitable covers.

(6) In excavations which workers may be required to enter, excavated or other material will be kept at least 2 feet (0.6 meters) or more from the edge of the excavation.

(7) When workers are required to be in trenches 4 feet (1.2 meters) deep or more, at least two separate and adequate means of exit, such as ladders or steps, will be provided and located requiring no more than 25 feet (7.5 meters) of lateral travel.

(8) Sides of trenches 5 feet (1.5 meters) or more in depth will be shored, sloped, or otherwise adequately supported to protect those working within them.

(9) Suitable gloves will be worn when using any equipment or tools to excavate, expose, or handle direct-burial cables.

f. Cable pulling protection. Workers will not handle pull-wires or pulling-lines within reaching distance of blocks, sheaves, winch drums, and take-up reels. Workers will not remain in a manhole during pulling operations.

(1) Wire rope will not be used to pull cable in a duct already occupied by conductors.

(2) A nonmetallic duct fishing wire or device will be used when fishing ducts containing energized conductors.

(3) Ducts will always be fished in the direction which presents the least hazard. A worker will be stationed at each end when required.

(4) Avoid parking tool carts and reels on inclined streets. Where this cannot be avoided, equipment should be placed at a slight angle to the curb so that the curb serves as a chock. Chock all wheels with blocks or other suitable items and install a well-fastened upright brace at both the front and rear of the vehicle. Where more than one reel is parked at the same location, lag the reels together. Place and fasten chock blocks and braces so that they cannot be easily dislodged.

7–3. Existing obstruction protection

When obstructions are encountered in digging, the foreman should be notified immediately, so that damaging or hazardous contact with energized cables may be avoided. The following additional rules also apply:

a. Locating buried facilities. Use area utility maps to locate existing utilities as accurately as possible.

b. Direct-burial electrical cable work. Extreme care will be used in excavating near or exposing direct-burial electric underground cable. Before excavating the location of the cable must be determined. If the depth of all direct-burial cable is definitely known, power digging equipment may be used for excavating all but the last 12 inches (300) millimeters) of cover over the cable. The remaining cover will be removed by use of shovels with wooden handles or similar hand-digging tools. Where the depth of direct-burial cables is not established, power digging equipment should not be used, except to break and remove the surface pavement.

(1) Probe rods or bars will not be used to locate any underground direct-burial cables.

(2) When uncovering direct-burial cables, extreme care must be observed to avoid damaging the cable insulation.

(3) All exposed cables in a work area will be protected against damage by boards or other nonconductive materials. When it is necessary to weld adjacent to cables, suitable nonflammable protective material will be utilized.

(4) Under no conditions will workers stand, sit, kneel, or lean on unprotected direct-burial cables.

c. Digging restriction. Mechanical excavating equipment will be used only in areas where there is no known danger of contacting or damaging buried utilities. Elsewhere excavation will be done only by hand digging.

d. Handling damage to existing utility lines. If any existing utility lines are damaged then certain steps must be taken dependent upon the type of line.

(1) If electric cables are damaged the facility should de-energize the damaged line and take immediate steps to repair it.

(2) If health and safety hazard lines such as gas, steam, or hot water are damaged, the hole will be left open until any utility line flow has been dissipated safely. All possible sources will be shut off. Extreme care will be taken to eliminate the possibility of igniting any escaping gas. Any workers or resident of the area will be warned, when necessary, and the public will be kept out of the area. The local fire department and the appropriate maintenance facility will be notified immediately.

(3) Environmentally hazardous lines, such as sewer, and oil, will be handled according to the applicable health and safety hazard requirements. Environmental cleanup will be initiated as soon as possible.

(4) Other lines, such as communication, water, or storm drainage, will be repaired as soon as possible by the appropriate maintenance department.

7–4. Preparation for work in underground structures

Underground structures consist of manholes, handholes, an vaults. The word manhole applies to the other structures as appropriate to their size and access.

a. Manhole covers. Before entering a manhole, place all warning signs needed for protection of those working in and around the manhole, for drivers of

vehicles, and for pedestrians. Before entering the manhole test for oxygen deficiency and dangerous gases. If there is an oxygen deficiency, or if any toxic or combustible gas is entering the manhole, provide adequate ventilation while there are workers in these structures. Smoking is not permitted in manholes.

(1) *Removing a manhole cover.* A manhole cover may weigh from 200 to 350 pounds (90 to 160 kilograms). Two persons, each with a manhole cover hook, are required to remove a cover. They should lift the cover with the leg and arm muscles, and with their feet placed so that they will be clear if the cover should be accidentally dropped. Figure 7–1 shows the methods and stops for removing a circular manhole cover.

(a) 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. Do not strike the manhole cover with a steel or iron tool. 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. 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. Make test holes in 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 tot he 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.

(b) 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.

(c) Do not leave a 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.

(d) 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 the cover removal. The removal position must permit observation of oncoming traffic. When possible, insert manhole cover hoods 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.

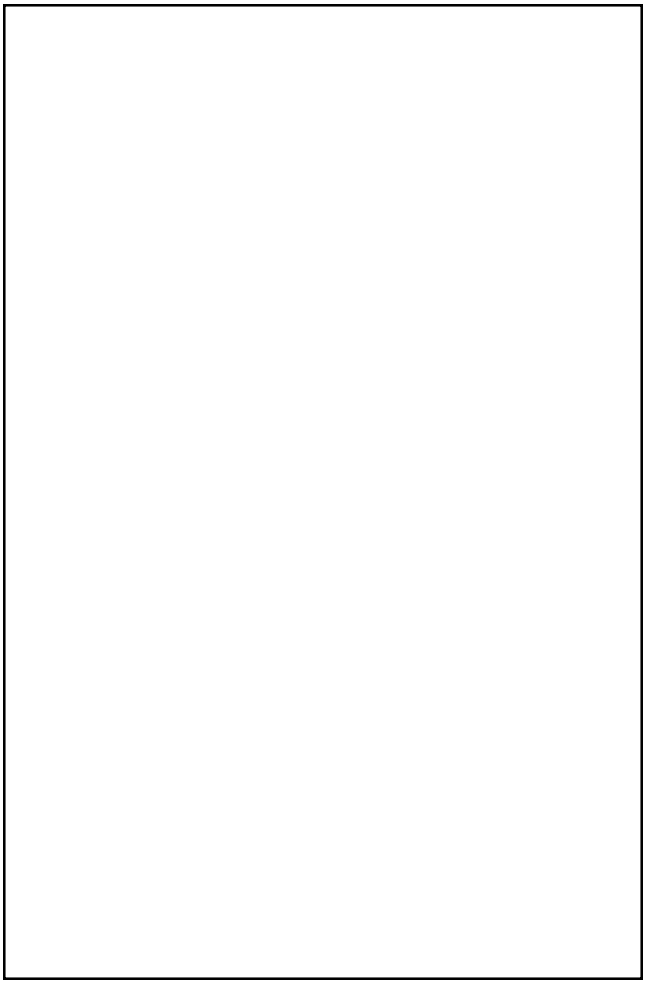

Figure 7–1. Steps in removing a manhole cover.

(e) 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.

(f) Place the covers of opened manholes on the side away from traffic, when conditions permit. In case of two section covers, place one section on each side of the opening.

(2) *Replacing manhole covers.* Use the same care as used for removing them.

(a) Be careful that manhole covers are properly seated when replaced.

(b) The bearing surfaces must be free from dirt or ice which might prevent them from fitting properly.

b. Testing before entering structures. The structure must be tested to assure that the atmosphere is safe for workers. Entering a manhole with an oxygen deficiency can cause sudden unconsciousness and death by hypoxia (blood starvation). Manholes containing less than 19.5 percent oxygen are not to be entered without a supplemental oxygen supply.

(1) *Hazardous conditions.* Toxic or combustible gases may be present or there may be a lock of oxygen in unventilated subsurface structures.

(a) Toxic or combustible gases. Since subsurface structures are subject to the accumulation of combustible or toxic gases, they must be considered hazardous until proven clear by test. Combustible gases found in manholes or vaults are usually natural gas or hydrocarbon fuels. Toxic gases usually encountered are hydrocarbon fuels. Toxic gases usually encountered are hydrogen sulfide, carbon dioxide, or mangrove gas.

(b) Lack of oxygen. 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 for fumes. Provisions must be made for a continuous supply of air when necessary.

(2) *Testers.* The manhole or unvented vault will be tested with an approved tester prior to entering, after the worker first determines that the instrument is in proper working order and correctly calibrated. These tests will be made as soon as the manhole cover is removed.

(a) Oxygen deficiency 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 should be in accordance with the manufacturer's instructions.

(b) For the detection of "toxic gases," one of the simple effective colormeteric 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, and a universal test kit is available which will detect concentrations of carbon monoxide, hydrogen sulfide, and other gases. An approved portable unit should be used to measure the amount of combustible and toxic gases in the manhole atmosphere.

(3) *Elimination of combustible or toxic gases.* Never enter a manhole until test results indicate that the manhole is free of combustible or toxic gases.

(a) Satisfactory test. 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 test 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 test. 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 the test is satisfactory, 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 the test is satisfactory. 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 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 re-enter until ventilation has been restored and the atmosphere test is satisfactory. Operate the blower outside of a manhole tent or tarpaulin.

(4) *Structure condition change retesting requirements.* Pumping out structure water or removing duct line plugs can allow gas into the structure.

(a) After a manhole has been pumped, the removable of the water may permit gas to flow into the manhole. Make the test just above any open ducts. If a test indicates that gas is entering, ventilate the manhole.

(b) Immediately upon the removal of the duct plugs, make a test just above the opened duct. If gas is entering, ventilate the manhole.

(5) *Emergency entrance.* If, in an emergency, it becomes necessary fro a worker to enter a manhole or vault where gas is present, the worker will use a supplied air respirator or an approved gas mask if adequate oxygen is present and a safety harness with an attached life line attended by another worker stationed at the manhole or vault opening.

c. Ventilation of structures. There are three methods that can be used to ventilate a structure. They are the forced air, sail, and natural methods.

(1) *Forced air.* The forced air method consist of 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.

(2) *Sail method.* The said method (figure 7–2), ventilates the manhole by using 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 a 45 degree angle with the manhole opening. The wind enters the manhole, forcing possible contaminated air out of the manhole.

(3) *Natural method.* This method consists of taking the manhole cover off and letting the internal air escape as much as it can. This method of venting a manhole is the least effective because a gas heavier than air could remain in the bottom of the manhole. Use this method of venting a manhole only as an emergency measure.

7–5. Work inside underground structures

Work inside underground structures requires special attention to general safety rules, familiarity with the cable and equipment being worked on, and rules applying to such underground work.

a. General safety. All work must be done in a manner that observes the following precautions:

(1) Continuous adequate ventilation is required.

(2) While work is being performed in manholes or vaults, a worker must be available on the surface in the immediate vicinity to render emergency assistance if required.

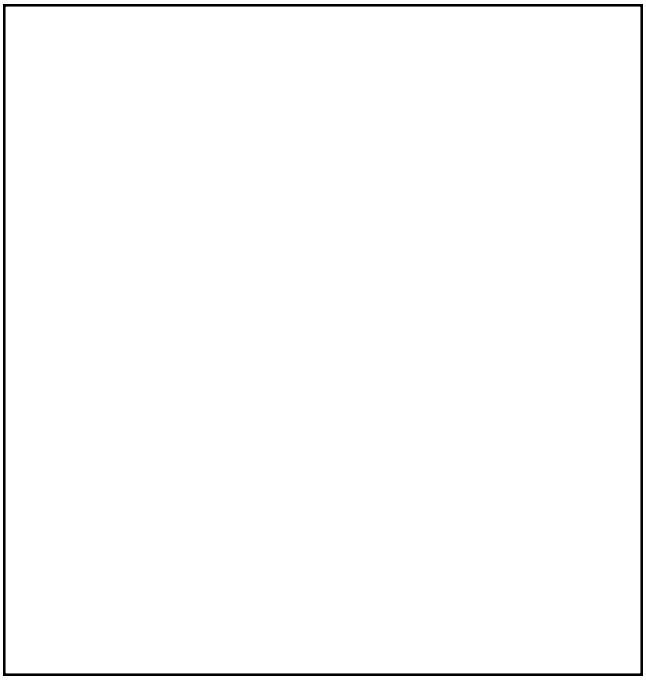

Figure 7–2. Sail method of manhole ventilation

(3) A ladder will always be used when entering or leaving a manhole or vault. Climbing into or out of manholes or vaults by stepping on cables or cable supports is forbidden. Manhole ladders, when not in use, must be placed as not to be a hazard to workers, pedestrians, or vehicular traffic. Hard hats are required when entering or working in manholes.

(4) Tool handling must be done in a manner that protects the workers and work area.

(a) Always place tools or materials a safe distance from manhole openings, where they will not cause a stumbling hazard or come in contact with energized conductors or equipment.

(b) Do not throw tools or materials into or out of manholes. Use canvas buckets or hand lines for lowering tools or equipment into and removing them from manholes. Warn workers before lowering tools.

(c) Consider providing a windless handcrank subsurface worker rescue assembly or an approved retracting lifeline system.

(5) Before starting work, an inspection should be made to determine if there are any dangerous conditions such as burnt or cut cables or loose or defective ladders. Use of portable ladders is preferred. Ladders in manholes, if provided, may have rusted and become unsafe. Before using open flames in manholes or ecavations where combustible gases or liquids may

be present, such as near gasoline service stations, the atmosphere must be again retested 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.

(6) Use only flashlights or facility approved lighting units for illumination in manholes.

(7) 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. Contact with energized equipment surfaces and the damp and will-grounded floors and walls often results in electrocution. It is recommended that only pneumatic tools and low-voltage (24 volt) lighting systems be used in maintaining subsurface vaults and facilities.

b. Precautions before commencing work. The worker must be familiar with the system and then proceed to any necessary tagging of cable and equipment.

(1) Every possible precaution will be exercised to correctly identify voltage, circuit, and phase of cable or apparatus to be worked upon.

(b) The external appearance of medium-voltage and low-voltage cables is often similar. For this reason, a very careful check should be made of duct locations and tag numbers before starting work. Any errors found in the tagging of cables or in the manhole records or maps should be immediately reported to the supervisor. Under no circumstances should an identification tag be removed or placed on a circuit without direct permission from the supervisor.

(2) Refer to paragraph 3–8 for requirements for de-energized work Safe clearance procedures.

(a) Where cables are being de-energized to be worked on, all instructions pertaining to the clearing of circuits, tagging, and grounding must be complied with.

(b) Standard practice for cable work is to provide complete isolation of cable and protection against premature energizing. An absolute check to ensure that no potential exists must be made prior to cutting into any cable. Remove the cable (lead or other) sheathing and test for voltage. Use only approved voltage detectors.

(3) Working on cable and equipment should normally be done after de-energizing the cable or apparatus to be worked on, whenever possible, and consistent with facility mission requirements.

(4) The cable or apparatus will be considered energized and worked with adequate protective devices until the following steps have been taken:

(a) The item has been tested with an approved device and proven to be de-energized.

(b) The item has been grounded from all possible sources of power (including transformer secondary backfeeds).

(c) The item has been proved de-energized at the work location. Grounds may be omitted or removed for test purposes with the approval of the supervisor in charge after the circuit has been tested and proven to be de-energized. Omission of grounds will only be permitted if their application increases the work hazard.

(d) Before working on any section of cable or apparatus to which cable is connected, care must be exercised to ensure the cable has been grounded for a sufficient length of time to drain off any static charges.

(5) The procedure for proving cables de-energized at the work location will be as follows—

(a) For positively identified cables normally energized at 600 volts or less, phase to phase, remove the insulation to expose a spot on the conductor for direct metallic contact and test with an approved voltage detector.

(b) Cables normally energized at more than 600 volts, phase to phase, or any cable whose voltage or identity is questionable, will be proved to be de-energized by following the rules given for medium-voltage work de-energized proving.

(6) Medium voltage work can be proved to be de-energized using an approved test device on cable terminals or apparatus which are equipped with capacitive test points or have bare exposed parts. Medium-voltage cable terminals and apparatus which cannot be proved de-energized with an approved test devices will be proved as follows—

(a) The item will be grounded from all possible sources of power and positively traced from the grounded point to the work location.

(b) Grounding can be done by the cable spike method which uses a wire tong or C-clamp device attached to a hot stick to provide a proven ground. Do not use a pike pole as a spike for this grounding method, as the pike does not have the rating of a hot stick. 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 de-energized.

c. Requirements for working on cables and apparatus. All workers must maintain the work distance given in table 3–7 as appropriate to the voltage level and whether the item being worked on is energized or de-energized. Be aware of what items are de-energized and what items are energized.

(1) *De-energized work.* All cable and apparatus must be tagged properly.

(2) *Protection.* When a worker is in proximity to live parts, rubber blankets or other suitable insulating barriers must be placed in the correct position to prevent accidental contact.

(3) *Working procedures.* Avoid hazards by observing the following procedures:

(a) The secondary voltage of any transformer fed from a de-energized feeder cable should be checked. The cable must be grounded on each side of the work location.

(b) Neural conductors will not be opened without the prior installation of suitable bypass conductors.

(c) Energized underground cables will be moved with extreme with extreme care to avoid damage to the cable insulation. Moving will be done only a the discretion of the foreman in charge. Lead-sheathed underground cables will be moved only when approved by the supervisor. Prior to moving energized electric underground cable, they will be examined for any defects which might result in failure if the cable is moved. No energized cable may be moved where such movement requires changing bends. All energized cables will be handled with rubber gloves or hot-line tools as appropriate to the voltage level.

(d) Before separating or connecting a dead-break type separable connector, the circuit must be de-energized and tested dead utilizing the associated capacitive test point and an approved test device. Only suitable live line tools will be utilized in separating or connecting these separable connectors, unless the circuit is tested de-energized and ground.

(e) Avoid sparks in connecting or disconnecting cable, apparatus, or switching devices.

(4) Before operating a primary grounding switch, the authorized operator must make certain of the following—

(a) Personnel are at the correct location.

(b) The tags on the feeder cable and equipment in the vault or manhole bear the same number as shown on single line drawings.

(c) Network protectors are in the open position or, in the case of radial transformers, that the secondary fuses have been removed and transformer secondaries are dead.

d. Cutting of cable. Before making an opening in or removing a part of the sheath or sleeve or a cable, the line will be grounded at the first possible grounding point on each side of the work location.

(1) Always wear rubber gloves when sawing into a cable or removing the sheathing. Install a metallic jumper between two sides of the location where a cable sheath is to be removed or cut.

(2) When a medium-voltage cable is to be cut, a short section of the shielding, if any, will be removed completely from around the cable. Tests will be made with two statoscopes or other approved testing devices, to determine whether or not the cable is de-energized. If no indication of a live cable is obtained, the worker may proceed with the work.

(3) When opening a splice in a medium-voltage cable, the sleeve over the splice will be cut completely around near the splice and then cut lengthwise and removed. No effort will be made to remove the compound. Workers will then test over each side of the conductor with two statiscopes or other approved testing devices. If no indication of a live cable is obtained, the compound will be removed. If shielding tape is then encountered, it will be removed and another test made over each side of the conductor with two statiscopes or other approved testing devices. If no indication of a live cable is then obtained, the splice will be cut through until the saw touches one of the conductors. Before sawing further a statiscope test will be made on the blade of the saw.

(4) When cutting or opening splices on low-voltage cable, the same procedure as outlined above for

medium-voltage cables will be followed, except in testing. To determine whether the cable is energized the insulation will be cut away to the conductor and tested with an approved tester. On multiple-conductor cables, only one conductor will be cut into at a time and tests made on at least two conductors before proceeding with the work.

7–6. Heating materials

Heating materials and equipment used in splicing cable will be heated in such manner as to prevent any hazard to the those working in manholes or vaults and to vehicular or pedestrian traffic.

a. Hazard elimination. Observe the following precautions to protect yourself, others, and the workplace:

(1) Gloves will be worn while heating or working with hot insulating compound.

(2) Furnaces and tanks containing liquefied petroleum gas, such as butane or propane, will not be placed in a manhole or vault.

(3) Heating pots for solder, oil, or compound will be safely positioned so that the contents cannot enter the vault or manhole in case of spillage.

(4) Torches or furnaces must be kept at a safe distance from flammable materials.

b. Work rules. The following work rules apply to the use of torches, furnaces, pots, and soldering devices. Only workers who are familiar with the use of torches and furnaces will be allowed to use them.

(1) Only approved soldering pots, furnaces, and ladles in good condition will be used.

(2) Keep lighted furnaces or torches 4 feet (1.2 meters) or more from manhole openings wherever practicable and where they will be the least possible hazard to property, workers, and the public. If necessary to use torches or furnaces in manholes, adequate ventilation must be provided to support combustion and provide sufficient air for workers.

(3) Solder ladles must be heated before use. Be sure that scraps of cold solder are dry before remelting. Moisture and molten metal must never come in contact with one another because this will cause a splash of hot metal. Bars or pigs of solder, tools, and ladles should be heated over the furnaces before being put into a pot of hot solder. New workers should be cautioned about this hazard.

(4) Furnaces must be lighted carefully and guarded with a three-sided windshield at all times when burning in public places. Never light or burn furnaces in dangerous locations and never leave them unattended. Lighted or hot torches or furnaces must not be transported in trucks or other moving vehicles.

(5) Always take special care not to splash solder on any person or equipment.

(a) Soldering pots must not be placed on furnaces without a pot guard.

(b) Never attempt to do soldering unless a fellow worker is stationed on the ground as a guard. If necessary, rope off a safe distance.

(c) Before lowering hot solder or compound into a manhole, warn those in the manholes to stand clear. Do not lower anything until given instructions from below to do so.

(6) If compound kettles have no breathers, punch holes through the top crust of the compound to the bottom before heating so that air and moisture can escape. Heat the compound slowly.

(7) Place compound kettles on the goods or plates provided and never directly on top of the furnaces.

(8) Do not allow paraffin to reach a temperature exceeding 390˚ F (198˚C).

c. Procedures for use of bottled liquid fuels. Follow the manufacturer's instructions for installing the torch on and removing it from fuel cylinder, lighting the torch and using it, and cleaning the torch orifice.

(1) Always remove the torch from the fuel cylinder after the job is completed and it is no longer needed.

(2) Observe the following precaution:

(a) Operate only in well-ventilated areas.

(b) Do not store full cylinders near heat or fire, or in living spaces.

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PART THREE
INTERIOR SYSTEMS

CHAPTER 8
MEDIUM-VOLTAGE SYSTEMS

8–1. Interior medium-voltage work

Additional knowledge is required to provide protection from the electrical hazards of specialized electrical equipment used in interior medium-voltage electrical systems.

a. Applicability. The same safety background requirements covered in chapter 5 for outdoor medium-voltage substations will be applied. Consult the manufacturer's instruction manual and review the applicable safety directions given in chapter 5 for the type of apparatus being maintained. Only electrical workers with training and experience on medium-voltage circuits are qualified for the job. Unless specifically approved, work is not permitted on energized circuits. Temporary ground wires should be used to drain off all induced voltages and currents from live circuits, stored energy devices, and equipment metal guards before starting work.

b. Associated guidance. The worker should be familiar with the following pertinent facility maintenance manuals: TM 5-683/NAVFAC MO-116/ AFJMAN 32-1083, chapter 12; TM 5-684/NAVFAC MO-200/AFJMAN 32-1082, chapter 1, section 2 and 3, and chapter 5 section 2; and, TM 5-685/NAVFAC MO-912, appendix E.

8–2. Medium voltage safety background

Review the applicable directions covered in chapter 5 for the type of apparatus being maintained before starting work. Additional specific equipment safety concerns should be covered by the manufacturer's instructions. All such instructions require the use of qualified electrical workers with training and experience on medium-voltage circuits who are familiar with the work to be performed. Equipment must be de-energized and grounded and worked on only by qualified facility maintenance personnel if accidents are to be avoided.

8–3. Motion hazards

Rotating electrical equipment such as motors and generators need guards to protect workers from accidental contact with live electrical parts, rotating parts, and such areas where operating conditions provide hot machine surfaces. Rotation may loosen grounding connections and hold-down bolts and gray flexible or cord connections. Sparking of brushes can occur as well as insulation failures causing flame or molten metal to be ejected from open type motors or generators. Consider all these dangers when dealing with motors and generators.

8–4. Working on indoor equipment

Working on indoor equipment involves checking the safety aspects imposed by applicable codes for building premises.

a. Limitation of space Space is usually at a premium. Clearances provided are usually less generous than for outdoor installations. Changes in NEC requirements may mean that older installations do not meet current clearance and entrance requirements for electrical rooms. Where installation do not conform to current NEC/OSHA requirements, additional safety instruction must be provided to maintenance workers. Ensure special attention is given to additional guarding of live parts where current NEC clearances are not met. Ensure that emergency exit routes are provided if clear exits do not meet current NEC requirements.

b. Grounding systems. Test that existing permanent electrical systems grounds are adequate for personnel protective grounding and provide additional temporary grounding to meet requirements given in paragraph 3–11.

c. Interconnection with other electric power sources. Check single line diagrams to assure that all inputs and interconnections to any electric power source are locked and tagged open. Verify single line diagram connections with the actual line connections of the applicable equipment.

d. Other existing systems. If the room's ventilation system is affected by the work, ensure that adequate temporary ventilation is provide. Fire protection and fire alarm systems, as they apply to the equipment and its installation space, may require

temporary power and any interference with these systems must have the approval of the local fire marshal.

e. Other work area requirements. Noise abatement below that required by paragraph 3–3, may be required so as not to disturb personnel working in spaces adjoining the area where the maintenance work is required. The custodial service should be informed when they will be locked out of certain areas and of any additional trash removal for which their service will be responsible.

CHAPTER 9
LOW-VOLTAGE SYSTEMS

9–1. Interior low-voltage work

There are additional devices for which facility workers must have qualified training to safely maintain low-voltage systems.

a. Applicability. The same safety background requirements covered in chapters 5 and 8 should be applied. Only electrical workers who are familiar with the NEC and have experience on low-voltage circuits are qualified for the job. Only in an emergency, such as loads requiring continuous electric power, may a worker be allowed to work energized circuits; but only with appropriate personnel protective apparel and the presence of another worker or helper.

b. Associated guidance. The worker should also be familiar with the following standards and pertinent facility maintenance manuals: TM 5-683/NAVFAC MO-116/AFJMAN 32-1083, chapter 12; TM 5-685/NAVFAC MO-912, appendix E.

9–2. Low-voltage safety background

The same safety background requirements given in chapter 8 apply. In most cases complex controls or special equipment will be maintained by contract personnel or specially trained facility workers, otherwise, observe the precautions set forth in this chapter. As a part of their qualified training in safely maintaining low-voltage systems, workers will also be familiar with the following requirements.

a. Battery rooms. Be familiar with storage battery safety rules given in paragraph 5–13. In addition, ensure that the following conditions are met before any work is done:

(1) Check that there is adequate ventilation, forced or natural, to prevent buildup of explosive mixtures.

(2) Check that warning signs are securely attached and in legible condition.

(3) Check that eyewash apparatus is in operable condition. If none is permanently installed provide temporary eyewash apparatus.

(4) Verify that cell ventilation openings are unobstructed.

b. Fire alarm systems. Maintaining fire alarm systems with their appropriate safety requirements requires special training. Workers must have the following or equivalent training:

Factory trained and certified.

(2) National Institute for Certification in Engineering Technologies Fire Alarm certified.

(3) International Municipal Signaling Association Fire Alarm certified.

(4) Certified by State or local authority.

(5) Trained and qualified personnel by an organization listed by a national testing laboratory for the servicing of fire alarm system.

c. Motors and generators. For maximum safety, each motor and generator should be of the type and size required for the load and for the conditions under which it must operate. See paragraph 8–3.

(1) After work has been performed on circuits to rotating machines, check direction of rotation.

(2) Always take positive steps to ensure that rotating equipment being repaired cannot be set into motion.

(3) A megohmmeter (megger) can be used to check insulation of motor and generating windings using a current of high voltage and low amperage. Never start a megohm test if there is nay external voltage in the test circuit.

d. Solid-state equipment. Variable frequency motor controllers and uninterruptible power supply (UPS) equipment are complex solid-state devices which should generally be maintained by manufacturer's personnel on a contract basis. Facility personnel are not normally trained for such work. Even with initial training, maintenance work is usually done on such an infrequent basis that subsequently workers cannot be considered fully qualified. Such installations should contain adequate precautionary labeling warning workers of the electric shock dangers involved in operating and maintenance of such equipment.

9–3. Review of low-voltage work precautions

Personnel should assume that all parts of electric circuits are energized. Workers must personally inspect circuits before starting work for assurance that circuits are de-energized or that they can be safely worked on while energized.

a. Repair work rules. Whenever possible, circuits operating at less than 300 volts between conductors will be de-energized before repair work is begun.

(1) No work will be performed on energized interior electrical circuits or equipment operating at more than 300 volts between conductors.

(a) The supply or line side of switches or fuses can be energized when all work to be performed on the load side of such switches or fuses, provides sufficient clearance between energized and de-energized parts so that work can be done safely.

(b) Before beginning work on de-energized circuits or equipment, a reliable voltage detector must be used. Where considerable work is to be performed, it is good practice to short-circuit and ground circuits or equipment.

(c) Approved testing may be performed on energized interior electric circuits or equipment operating at more than 300 volts between conductors.

(2) When working on or near energized circuits, workers must stand on a dry surface, other than cement or masonry, or wear electrician's rubber footwear.

(3) When using fish tape near energized parts, cover live parts with rubber protective equipment.

(4) When working near running machinery, use extreme care, and provide barricades where necessary.

(5) Place all tools clear of machinery before starting machinery. Never use a wrench on running machinery.

(6) Provide adequate illumination.

(7) Use extreme care when working in cramped places to avoid injury to your head, arms, and other parts of your body.

(8) Wear goggles hen soldering larger joints or tinning lugs on connectors.

(9) Remove tripping hazards.

(10) Do not work on slippery surfaces.

(11) All electrical apparatus requiring frequent attention must be capable of being completely isolated electrically.

(12) Provide ventilation, particularly where obnoxious fumes are present. Take particular precautions if explosive or toxic vapors are present or suspected.

(13) Never use flame in any form until satisfied that explosive vapors are not present.

(14) Use extreme care when using torches to avoid igniting combustible material. Never leave torches unattended.

b. Installation. Proper selection and installation of electrical equipment will help to prevent accidents.

(1) Each worker should become familiar with the applicable electrical codes and standards. The foreman must be notified when equipment does not meet the requirements of these codes and standards.

(2) All electrical equipment should be installed to provide adequate working space in accordance with the NEC and local codes. Install equipment so that the possibility of accidental contact with energized conductors is reduced to a minimum.

(a) Tape or cover bare or exposed places on one energized conductor before exposing another energized conductor.

(b) Never leave joints or loose ends of wire untapped or otherwise unprotected.

(3) Equipment should be installed in the less congested areas of a plant, in special rooms, or be provided with suitable guards or barriers.

(4) Warning signs should be displayed near exposed current-carrying parts and in hazardous areas such as medium-voltage installations.

c. Switches. An open knife switch is hazardous because of the exposure of live parts and because of the arc formed when the switch is opened. Such switches should be enclosed in grounded metal cabinets having the control lever operable from outside the cabinet.

(1) A knife switch should be mounted so that

the blades are dead when the switch is open, and should be installed so that gravity will not tend to close the switch.

(2) Double-throw switches should be mounted horizontally so that their operation will not be affected by gravity. Double-throw switches installed vertically will be provided with a locking device to hold moveable blades in the correct position.

d. Fuses and circuit breakers. Fuses or other overcurrent devices should be provided according to the NEC and should be of a size and type that will interrupt the current flow when it exceeds the capacity of the conductor.

(1) Substitution of copper wires or other conductors for fuses will not be permitted.

(2) When it is necessary to remove a cartridge fuse, the operating switch, if provided, should be opened to remove the load. Take fuses entirely out of holders when removing them from circuits. The fuse should be pulled only with an insulated fuse puller. On circuits 300 to 600 volts, use both fuse tongs and rubbed gloves.

e. Control equipment. The space behind the switchboard should not be used for storage and should be kept clear of rubbish.

(1) Good illumination should be provided for the front and rear of switchboards.

(2) Switchboard framework and metal parts of guards should be grounded according to the NEC.

(3) connections, wiring, and equipment of switchboards should be arranged in an orderly manner. Switches, fuses, and circuit breakers should be plainly marked, labeled, or arranged to afford ready identification of the circuits or equipment supplied through them.

f. Grounding. Low-voltage electrical accidents are most frequently caused by a failure to understand the hazards of low-voltage wiring. By far the most misunderstood subject is the “theory of grounding.”

(1) Each worker should carefully study and understand the grounding requirements of the NEC.

(2) Use properly grounded portable electric tools, particularly in damp locations or near grounded equipment or piping.

(3) Do not open a ground connection to a water pipe or ground rod until the ground wire has been disconnected at the equipment.

APPENDIX A
REFERENCES

Government publications and forms

Departments of the Army, Navy, and Air Force

Publications

AR 25-400-2
The Modern Army Record-keeping system (MARKS)

TB 43-0142
Safety Inspection and Testing of Lifting Devices.

TM 5-683/NAVFAC MO-116/AFJMAN 32-1083
Electrical Interior Facilities.

TM 5-684/NAVFAC MO-200/AFJMAN 32-1082
Electrical Exterior Facilities

TM 5-685/NAVFAC MO-912
Operation, Maintenance, and Repair of Auxiliary Generators.

TM 5-811-1/ARM 88-9
Electrical Power supply and Distribution

Prescribed Forms

DA Form 5140
Caution Tag. (Prescribed in para 3-8c(10).)

DA Form 5168-R
Safety Clearance Order (Electrical Facilities) (Prescribed in para 3–8c(1).)

DA Form 7407-R
Caution Order (Electrical Facilities) (Prescribed in para 3–8c(5).)

DA Form 7408
Danger Tag. (Prescribed in para 3–8c(9).)

Other Government Publications

Code of Federal Regulations (CFR): Superintendent of documents, U.S. Government Printing Office, Washington, DC 20402

29 CFR 1910
Occupational Safety and Health, General Industry Standards

29 CFR 1926
Occupational Safety and Health, Safety and health Regulations for construction.

30 CFR part II
Respiratory Protective Devices; Tests for Permissibility.

Federal highway Administration (FHWA): 6300 Georgetown Pike, McLean, VA 22101.

MUTCD
Manual on Uniform Traffic control Devices for Streets and Highways.

Non-Government Publications

American Burn Association (ABA): 525 East 68th Street, Room 706, New York, NY 10021.

Listing of Certified Burn Centers.

American Electrician's Handbook by Terrell Croft and Wilford J. Summers, McGraw hill, Inc., 1221 Avenue of the Americas, New York, NY 10020-1001.

American National Standards Institute (ANSI): 11 West 42nd Street, New York, NY 10036.

ANSI B30.9
Slings.

ANSI C2
National Electrical Safety Code.

ANSI S3.19

Method for Measurement of Real-Ear Protection of hearing Protectors and Physical Attenuation of Ear Muffs.

ANSI Z88-6
Respiratory Protection, Respirator use, Physical Qualification for Personnel.

ANSI/IEEE 141
Recommended Practice for Electric Power Distribution for Industrial Plants.

APPENDIX B
SAMPLE SAFETY EXAMINATION

B–1. Examination development.

The appendix provides a listing of items from which a proficiency examination can be developed to review the workers' understanding of safety rules.

B–2. General knowledge

The examinee should demonstrate general knowledge. Test questions developed for a specific test should include determining the examinee's familiarity with basic safety requirements.

a. List your personal responsibilities fro your safety, for your co-workers' safety, and for the public's safety.

b. List your classification, the work you are qualified to do, and the safety methods applying to the work you do.

c. List work area hazards applying to the work you do.

d. List minimum safe approach distances for the work you are qualified to do.

e. List safe grounding practices for electrical de-energized work and safe working practices fro energized electrical work for which you are qualified.

f. List safety-tagout procedure requirements.

g. If you are qualified for energized line work, list the safety requirements for the voltage levels for which you are qualified.

h. List your knowledge of the safety precautions to be taken for general work area control.

B–3. specific knowledge.

The examinee should demonstrate specific knowledge. The topics developed for a specific test should be based on those needed to be reviewed to meet current facility safety problems. Test questions as given below can determine the breadth of the examinee's specific safety awareness.

a. Discuss your knowledge of the inspection, maintenance, and testing requirements for lineman's and cableman's tools and equipment and the electrical testing devices noted in the topics list for this test.

b. Discuss your knowledge of the safe handling requirements for the materials noted in the topics list for this test.

c. Discuss your knowledge of the basic safety precautions applying to the safety items noted in the topics list for the test.

d. Discuss your knowledge of the safety rules including the safety checklist requirements for the apparatus noted in the topics list for this test.

e. Discuss your knowledge of the safety rules applying to the type of overhead line work noted in the topics list for this test.

f. discuss your knowledge of the safety rules applying to the type of underground work noted in the topics list for this test.

g. Discuss your knowledge of the safety rules applying to the type of interior medium-voltage work noted in the topics list for this test.

h. Discuss your knowledge of the safety rules applying to the type of interior low-voltage work noted in the topics list for this test.

i. Discuss your knowledge of the first aid procedures to be applied for emergency treatment of the physical impairments noted in the topics list for this test.

ANSI S3.19
Method for Measurement of Real-Ear Protection of hearing Protectors and Physical Attenuation of Ear Muffs.

ANSI Z87.1
Practice for Occupational and Educational Eye and Face protection.

ANSI Z87.1
Practice for Occupational and Educational Eye and Face protection.

ANSI Z88.2
Respiratory Protection.

ANSI Z89.1
Personal Protection, Protective Headwear for Industrial Workers, Requirements.

ANSI Z133.1
Tree Care Operations, Pruning, Trimming, Repairing, maintaining, and Removing Trees, and Cutting Brush, Safety Requirements.

ANSI/IEEE 516
IEEE Guide for maintenance Methods on Energized Power Lines.

ANSI/IEEE 524
IEEE Guide for Installation of Overhead Transmission Conductors.

ANSI/IEEE 935
IEEE Guide on Terminology for Tools and Equipment to be used in Live Line Working.

ANSI/IEEE 957
IEEE Guide for Cleaning Insulators.

ANSI/SIA A92.2
Vehicle-Mounted Elevated and Rotating Aerial Devices.

ANSI/UL 711
UL Standard for Safety Rating and Fire Testing Fire Extinguishers.

American Red Cross (ARC): 17th and D streets NW, Washington DC 20006-0000.

First Aid, Responding to Emergencies.

Adult CPR.

American Society for Testing and materials (ASTM): 1916 Race Street, Philadelphia, PA 19103-1187

ASTM A 603
Standard Specification for Zinc-Coated Steel Structural Wire rope.

ASTM A 906
Standard Specification for Alloy Steel chain sling for Overhead Lifting.

ASTM D 120
Standard Specification for Rubber Insulating Gloves.

ASTM F 18-Series
ASTM Standard on Electrical Protective Equipment for Workers.

ASTM F 855
Standard Specifications for Temporary Grounding systems to be used on De-energized Electric Power lines and Equipment.

Cordage Institute (CI): 42 North street, Hingham, MA 02043.

CIF-1
Fundamentals of Fall Protection,

CIE-4
Knot Tying and Rigging.

Electrical Equipment Testing and maintenance by A.S. Gill, Prentice Hall, Route 9W, Englewood Cliffs, NJ 07632-0000.

Institute of Electrical and Electronics Engineers, Inc. (IEEE): 445 Hoes Lane, P.O. box 1331, Piscataway, NJ 08855-1331

IEEE 978
Guide for in-Service maintenance and Electrical Testing of Live-

IEEE 1048
Guide for Protective Grounding of Power Lines.

National Fire Protection Association (NFPA): One Battlemarch Park, P.O. Box 9101, Quincy, MA 02269-9101

NFPA 10
Standard for Portable Fire Extinguishers.

Cordage Institute (CI): 42 North Street, Hingham, MA 02043

CIE-1
The Splicing Handbook.

Edison Electric Institute (EEI): 1111 19th Street NW, Washington, DC 20036-3691

Use and Care of Pole Climbing Equipment.

Hot Sticks-A Manual on High-voltage Line Maintenance. A.B. Chance Company, 210 North Allen Street, Centrailia, MO 65240

National Fire Protection Association (NFPA): One Battlemarch Park, P.O. Box 9101, Quincy, MA 02269-9101

FPA 70
National electrical Code.

NFPA 70E
Standard for Electrical Safety Requirements for Employee workplaces.

NFPA 101
Code for Safety from Fire in Buildings and Structures.

NFPA 780
Lightning Protection Code.

The Lineman's and Cableman's Handbook by Edwin B. Kurtz and Thomas M. Shoemaker, McGraw-Hill, Inc., 1221 Avenue of the Americas, New York, NY 10020-1001.

INDEX

This proponent agency of this publication is the Chief of Engineers, United States Army. Users are invited to send comments and suggested improvements on DA form 2028 (Recommended Changes to publications and Blank forms) directly to HQUSACE, (Attn: CECPW-EE), Washington, DC 20314-1000.

By Order of the Secretary of the Army:

ERIC K. SHINSEKI
General, ***United States Army***
Chief of Staff

Official

JOEL B. HUDSON
Administrative Assistant to the Secretary of the Army

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4. LINE OR EQUIPMENT INVOLVED

5. TIME APPLIED *(Read Down)*	6. DETAILS OF CLEARANCE PROCEDURES	7. TIME REMOVED *(Read Up)*

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8c. TIME ISSUED	8d. DATE ISSUED *(YYYYMMDD)*
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c. TIME ISSUED	8d. DATE ISSUED *(YYYYMMDD)*
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