

## 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-

## TM 5-682

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 prob-

lems. 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

## TM 5-682

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's 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 one-fourth 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

## TM 5-682

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 step-ladders 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 scaf-

olds 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 boatswain's 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. Tie-backs 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.

## TM 5-682

(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 self-contained 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



Figure 4-1. Grounding path.

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.

(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.

## TM 5-682

(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. Mis-fired 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,

## TM 5-682

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 splinters, 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.

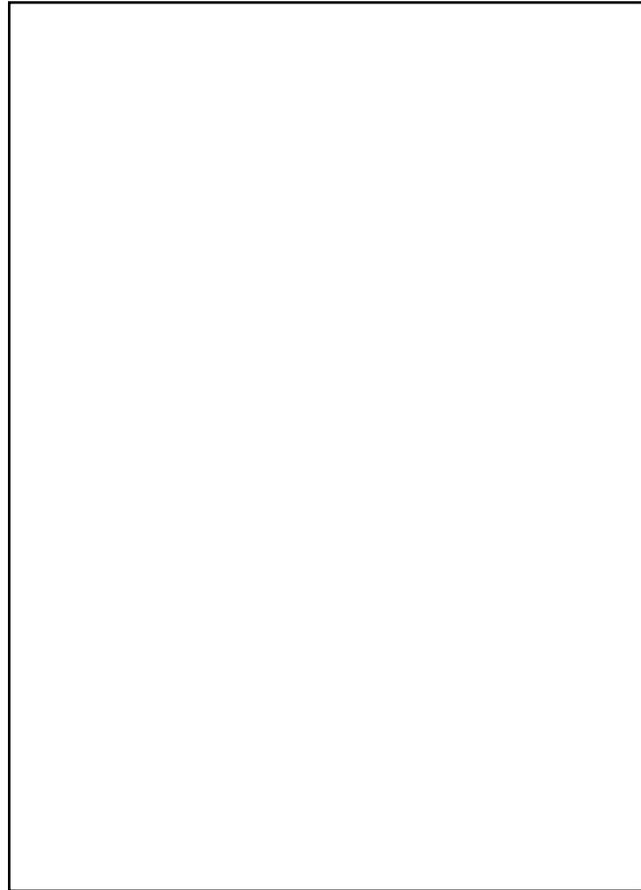


Figure 4-2. Correct lifting instructions.

(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<sub>6</sub> 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

## TM 5-682

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		Polyester		Nylon		Polyethylene	
	lbs	(kg)	lbs	(kg)	lbs	(kg)	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 polyethyl-

ene 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

## TM 5-682

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 rope's 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 alkalis. (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.

## TM 5-682

(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 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 discuss 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 me-

chanical 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 kept 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 in-

tervals 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

## TM 5-682

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-

## TM 5-682

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 0 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.