

CHAPTER 7

UNDERGROUND CABLES, STRUCTURES, AND ASSOCIATED ELECTRICAL COMPONENTS

7-1. Underground work

Underground electrical work applies to manhole, vaults, and handholes; duct lines and trenches; cable; and ground-mounted and underground equipment associated with underground electrical lines.

7-2. Work area protection

Work area protection is the safeguarding or protecting of pedestrians, motorists, facility workers, and equipment by the use of barriers, warning signs, lights, flags, traffic cones, high-level standards, barricade rope, and flagmen. Protection is required for approaches to work areas, excavations, open manholes, and parked equipment. An approved fire extinguisher in good operating condition and immediately accessible for underground work is mandatory.

a. Protection methods. Work area protection methods will provide safety for workers, equipment, and the public without excessively impeding public traffic.

(1) During any period in which apparatus must be left open and energized, a suitable enclosure will be erected around the apparatus, or a qualified worker must be stationed at the location to ensure the safety of the public.

(2) All temporary cable installations must be made in a manner providing safety for workers and the public.

b. Impact of vehicular traffic flow. The amount and speed of the traffic will influence the work planning. Where work will require excavation in roads and highways, the appropriate traffic authority should be consulted to maintain safe traffic flow. The public must be warned in advance, then regulated and guided safely through or around the work area.

c. Work space consideration. The extent of the work and the lineup of traffic will effect scheduling, which should be done to cause the least interference to traffic and, minimize the possibility of accidents. Good housekeeping in the storage and equipment space necessary for the work should always be an ongoing concern but especially wherever it impinges on public right-of-ways. It is of the utmost importance that the work area be properly identified and

the warning devices clearly convey the appropriate message to the traveling public, well in advance of arrival at the work area. This same good housekeeping applies to protection of workers.

d. Barricades and warning precautions. Traffic control requires the use of barricades and warning precautions.

(1) *Devices.* Only those signs, standards, barricades, flags, and cones which conform to State or local codes will be used. All State and local traffic codes will be followed when providing work area protection.

(a) During night operations or in periods of reduced visibility, special precautions will be taken. Adequate warning equipment will be used including flashing lights, flares, or area illumination.

(b) Warning devices and equipment will be removed as soon as the hazard is eliminated.

(c) Warning devices and equipment not in use will be stored in a proper manner or removed from the work area.

(d) Barricades of materials having protruding nails will not be permitted.

(2) *Flagmen.* Flagmen or other appropriate traffic controls will be used whenever there is any doubt that the use of signs, signals, and barricades is ineffective.

(a) Flagmen will wear a red or orange warning vest or garment. Warning garments worn at night will be of a reflectorized material.

(b) Flagmen using hand signaling equipment will ensure signals provide sufficient warning to protect themselves and the work site. Signal flays will be red and at least 24 inches (60 centimeters) square. Sign paddles (Stop and slow) will be on a 6-foot (1.8-meter) staff. In periods of darkness or reduces visibility, red lights will be used.

(c) Flagmen will place themselves in a protected position to reduce possibility of injury from traffic.

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(d) Flagmen will ensure that they can fully observe the operation and will guide vehicular traffic in such a manner as to minimize the possibility of accidents or injury.

(e) When flagmen are used at both ends of a job site, reliable communications or prearranged signals will be used to insure proper traffic flow.

(f) Flagmen will face traffic when giving signals.

(g) Flagmen will give positive, direct signals which leave no doubt as to their meaning.

(3) *Barriers and barricade tape.* See chapter 5, paragraph 5-3 for requirements.

(4) *Caution and danger signs.* The following are approved signs:

(a) Danger, High Voltage—Various sizes

(b) Danger—Keep Away—12 by 24 inches (300 by 600 millimeters)

(c) Danger—Personnel Working Overhead—12 by 14 inches (300 by 350 millimeters)

(d) Wear Goggles When Grinding—Various sizes

(e) Danger, Drive Slowly—Personnel Working—15 by 15 inches (380 by 380 millimeters)

(f) Danger—Blasting—15 by 15 inches (380 by 380 millimeters)

(g) Caution—check for Feedback—5.5 by 2 inches (140 by 50 millimeters)

(5) Preparing a manhole work area requires proper use of warning devices.

(a) During the time that manholes or vaults at the sidewalk or street level are open, suitable barricades, traffic cones, warning signs, flags, and lights will be used and maintained.

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

(c) For sidewalk manholes and vaults, the

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

e. Excavation, trenching, and back-filling. Work in increments to minimize open trenches. On a daily basis, remove spoil to an area where it will not constitute a safety hazard.

(1) All equipment and materials, stored where pedestrian or vehicular traffic might be endangered, must be marked with red flags by day and red lights by night, or both. Do not store equipment or materials where they will obstruct fire alarm boxes, hydrants, or fire apparatus.

(2) Keep tools, stones, and dirt away from the edge of a trench. Excavated material removed from trenches in streets should be kept on the traffic side of trenches, whenever possible, until it can be used for fill or removed.

(3) Carefully refill excavations until such time as permanent paving can be done. See that all refilling is well tamped.

(4) Provide ditching machines with suitable walkways, footboards, railing, and proper safeguards over gears, chains, and other moving parts. Do not stand near digging buckets while the machine is in operation.

(5) Protect all open holes along streets and highways or other frequented places by suitable covers.

(6) In excavations which workers may be required to enter, excavated or other material will be kept at least 2 feet (0.6 meters) or more from the edge of the excavation.

(7) When workers are required to be in trenches 4 feet (1.2 meters) deep or more, at least two separate and adequate means of exit, such as ladders or steps, will be provided and located requiring no more than 25 feet (7.5 meters) of lateral travel.

(8) Sides of trenches 5 feet (1.5 meters) or more in depth will be shored, sloped, or otherwise adequately supported to protect those working within them.

(9) Suitable gloves will be worn when using any equipment or tools to excavate, expose, or handle direct-burial cables.

f. Cable pulling protection. Workers will not handle pull-wires or pulling-lines within reaching distance of blocks, sheaves, winch drums, and take-up reels. Workers will not remain in a manhole during pulling operations.

(1) Wire rope will not be used to pull cable in a duct already occupied by conductors.

(2) A nonmetallic duct fishing wire or device will be used when fishing ducts containing energized conductors.

(3) Ducts will always be fished in the direction which presents the least hazard. A worker will be stationed at each end when required.

(4) Avoid parking tool carts and reels on inclined streets. Where this cannot be avoided, equipment should be placed at a slight angle to the curb so that the curb serves as a chock. Chock all wheels with blocks or other suitable items and install a well-fastened upright brace at both the front and rear of the vehicle. Where more than one reel is parked at the same location, lag the reels together. Place and fasten chock blocks and braces so that they cannot be easily dislodged.

7-3. Existing obstruction protection

When obstructions are encountered in digging, the foreman should be notified immediately, so that damaging or hazardous contact with energized cables may be avoided. The following additional rules also apply:

a. Locating buried facilities. Use area utility maps to locate existing utilities as accurately as possible.

b. Direct-burial electrical cable work. Extreme care will be used in excavating near or exposing direct-burial electric underground cable. Before excavating the location of the cable must be determined. If the depth of all direct-burial cable is definitely known, power digging equipment may be used for excavating all but the last 12 inches (300 millimeters) of cover over the cable. The remaining cover will be removed by use of shovels with wooden handles or similar hand-digging tools. Where the depth of direct-burial cables is not established, power digging equipment should not be used, except to break and remove the surface pavement.

(1) Probe rods or bars will not be used to locate any underground direct-burial cables.

(2) When uncovering direct-burial cables, ex-

treme care must be observed to avoid damaging the cable insulation.

(3) All exposed cables in a work area will be protected against damage by boards or other non-conductive materials. When it is necessary to weld adjacent to cables, suitable nonflammable protective material will be utilized.

(4) Under no conditions will workers stand, sit, kneel, or lean on unprotected direct-burial cables.

c. Digging restriction. Mechanical excavating equipment will be used only in areas where there is no known danger of contacting or damaging buried utilities. Elsewhere excavation will be done only by hand digging.

d. Handling damage to existing utility lines. If any existing utility lines are damaged then certain steps must be taken dependent upon the type of line.

(1) If electric cables are damaged the facility should de-energize the damaged line and take immediate steps to repair it.

(2) If health and safety hazard lines such as gas, steam, or hot water are damaged, the hole will be left open until any utility line flow has been dissipated safely. All possible sources will be shut off. Extreme care will be taken to eliminate the possibility of igniting any escaping gas. Any workers or resident of the area will be warned, when necessary, and the public will be kept out of the area. The local fire department and the appropriate maintenance facility will be notified immediately.

(3) Environmentally hazardous lines, such as sewer, and oil, will be handled according to the applicable health and safety hazard requirements. Environmental cleanup will be initiated as soon as possible.

(4) Other lines, such as communication, water, or storm drainage, will be repaired as soon as possible by the appropriate maintenance department.

7-4. Preparation for work in underground structures

Underground structures consist of manholes, handholes, and vaults. The word manhole applies to the other structures as appropriate to their size and access.

a. Manhole covers. Before entering a manhole, place all warning signs needed for protection of those working in and around the manhole, for drivers of

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vehicles, and for pedestrians. Before entering the manhole test for oxygen deficiency and dangerous gases. If there is an oxygen deficiency, or if any toxic or combustible gas is entering the manhole, provide adequate ventilation while there are workers in these structures. Smoking is not permitted in manholes.

(1) *Removing a manhole cover.* A manhole cover may weigh from 200 to 350 pounds (90 to 160 kilograms). Two persons, each with a manhole cover hook, are required to remove a cover. They should lift the cover with the leg and arm muscles, and with their feet placed so that they will be clear if the cover should be accidentally dropped. Figure 7-1 shows the methods and steps for removing a circular manhole cover.

(a) If snow, ice, or other surface conditions cause insecure footing around the manhole cover, either clear the working area with a shovel or broom, or spread sand or other suitable material around the cover to ensure firm footing. Do not strike the manhole cover with a steel or iron tool. Use a hardened bronze cold chisel to remove ice from a cover. A bronze cold chisel will not produce sparks in striking the manhole cover. Do not use an open flame or salt to thaw ice around or over the cover. An open flame may cause an explosion if a combustible gas mixture is present in the manhole. A salt solution seeping into the manhole may contribute to cable corrosion. Make test holes in the ice to locate the edge of the manhole cover. A line or cable locator is useful in finding manhole cover locations when records are inadequate or when marking points are covered with ice and snow. If the exact location of the manhole is not known, a small channel may be cut from the outer edge of the general location to the center of the area where the cover should be. If the manhole cover is icebound, use enough hot water to melt the ice around the edge of the cover.

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

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

(d) In a traffic area, the manhole cover is

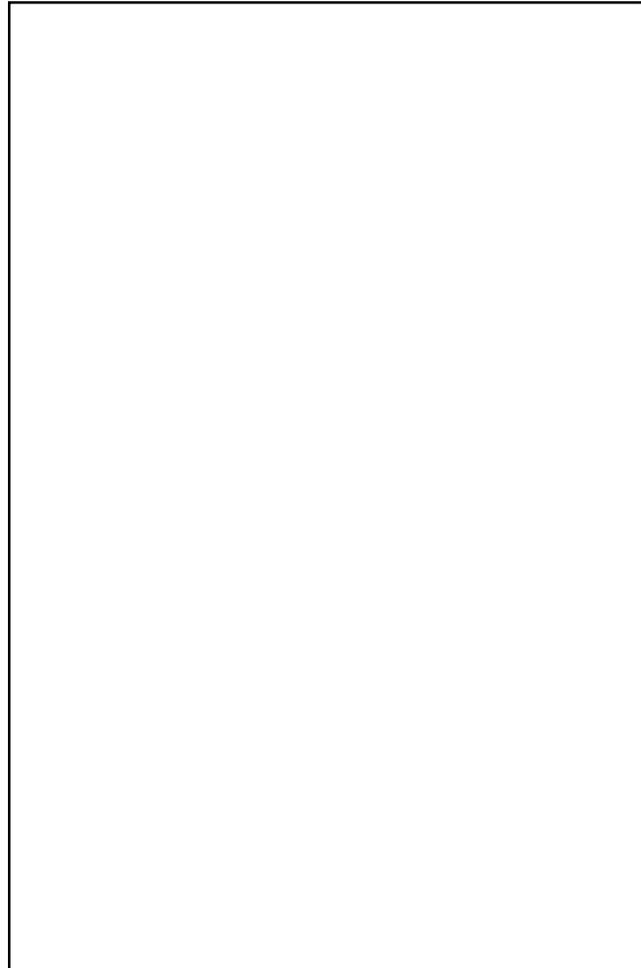


Figure 7-1. Steps in removing a manhole cover.

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

(e) Before removing a manhole cover, mark the cover and the frame with a piece of chalk so the manhole cover may be replaced in its original position. Improper alignment of the cover within the frame may cause considerable noise when vehicles cross over the covers. When the noise condition does exist, place a thin layer of oakum (or similar material) in the cover seat of the frame.

(f) Place the covers of opened manholes on the side away from traffic, when conditions permit. In case of two section covers, place one section on each side of the opening.

(2) *Replacing manhole covers.* Use the same care as used for removing them.

(a) Be careful that manhole covers are properly seated when replaced.

(b) The bearing surfaces must be free from dirt or ice which might prevent them from fitting properly.

b. *Testing before entering structures.* The structure must be tested to assure that the atmosphere is safe for workers. Entering a manhole with an oxygen deficiency can cause sudden unconsciousness and death by hypoxia (blood starvation). Manholes containing less than 19.5 percent oxygen are not to be entered without a supplemental oxygen supply.

(1) *Hazardous conditions.* Toxic or combustible gases may be present or there may be a lock of oxygen in unventilated subsurface structures.

(a) *Toxic or combustible gases.* Since subsurface structures are subject to the accumulation of combustible or toxic gases, they must be considered hazardous until proven clear by test. Combustible gases found in manholes or vaults are usually natural gas or hydrocarbon fuels. Toxic gases usually encountered are hydrocarbon fuels. Toxic gases usually encountered are hydrogen sulfide, carbon dioxide, or mangrove gas.

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

(2) *Testers.* The manhole or unvented vault will be tested with an approved tester prior to entering, after the worker first determines that the instrument is in proper working order and correctly calibrated. These tests will be made as soon as the manhole cover is removed.

(a) Oxygen deficiency tests can be performed with a safety lamp or an oxygen deficiency indicator. The safety lamp cannot be used to indicate the presence of carbon dioxide. Operation of the indicator instrument should be in accordance with the manufacturer's instructions.

(b) For the detection of "toxic gases," one of the simple effective colormetric detectors (color changes to indicate concentration) may be used. Hy-

drogen sulfide can be detected at concentrations as low as one part in 1,000,000. These detectors can be obtained commercially, and a universal test kit is available which will detect concentrations of carbon monoxide, hydrogen sulfide, and other gases. An approved portable unit should be used to measure the amount of combustible and toxic gases in the manhole atmosphere.

(3) *Elimination of combustible or toxic gases.* Never enter a manhole until test results indicate that the manhole is free of combustible or toxic gases.

(a) *Satisfactory test.* If tests made upon removing the manhole cover indicate that the atmosphere is satisfactory, the manhole or vault may be entered and worked in. Additional tests must be made when each crew begins work; the test interval must not exceed 8 hours. When the manhole is covered with a tent or tarpaulin, the test interval must not exceed 2 hours. Place the tent or tarpaulin so that an opening is left in the covering for ventilation.

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

(4) *Structure condition change retesting requirements.* Pumping out structure water or removing duct line plugs can allow gas into the structure.

(a) After a manhole has been pumped, the removable of the water may permit gas to flow into the manhole. Make the test just above any open ducts. If a test indicates that gas is entering, ventilate the manhole.

(b) Immediately upon the removal of the duct plugs, make a test just above the opened duct. If gas is entering, ventilate the manhole.

(5) *Emergency entrance.* If, in an emergency, it becomes necessary for a worker to enter a manhole or vault where gas is present, the worker will use a supplied air respirator or an approved gas mask if adequate oxygen is present and a safety harness with an attached life line attended by another worker stationed at the manhole or vault opening.

c. *Ventilation of structures.* There are three methods that can be used to ventilate a structure. They are the forced air, sail, and natural methods.

(1) *Forced air.* The forced air method consists of a power blower, blowing air into the manhole. The blower hose is placed into the manhole, forcing fresh air to circulate and oxygen-deficient air to be forced out. This is the best method of ventilating a manhole.

(2) *Sail method.* The said method (figure 7-2), ventilates the manhole by using the wind. A piece of plywood or some other material is placed over the manhole. The edge of the plywood facing the wind is lifted up until the plywood forms about a 45 degree angle with the manhole opening. The wind enters the manhole, forcing possible contaminated air out of the manhole.

(3) *Natural method.* This method consists of taking the manhole cover off and letting the internal air escape as much as it can. This method of venting a manhole is the least effective because a gas heavier than air could remain in the bottom of the manhole. Use this method of venting a manhole only as an emergency measure.

7-5. Work inside underground structures

Work inside underground structures requires special attention to general safety rules, familiarity with the cable and equipment being worked on, and rules applying to such underground work.

a. *General safety.* All work must be done in a manner that observes the following precautions:

(1) Continuous adequate ventilation is required.

(2) While work is being performed in manholes or vaults, a worker must be available on the surface in the immediate vicinity to render emergency assistance if required.

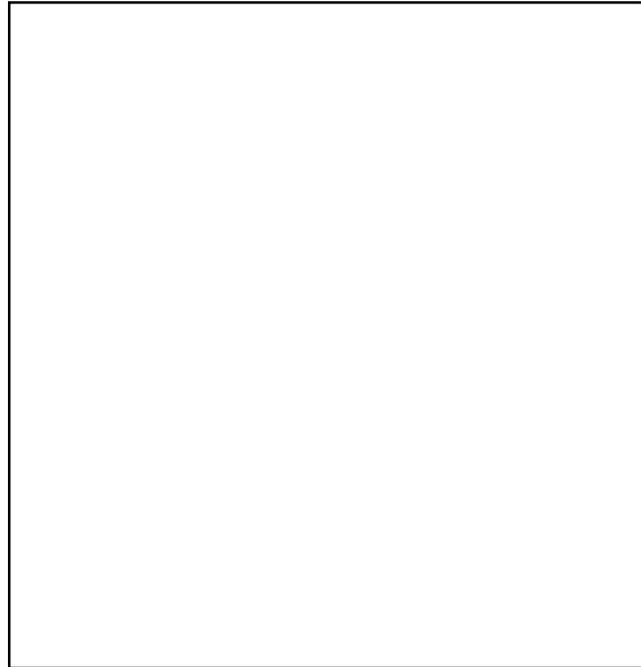


Figure 7-2. Sail method of manhole ventilation

(3) A ladder will always be used when entering or leaving a manhole or vault. Climbing into or out of manholes or vaults by stepping on cables or cable supports is forbidden. Manhole ladders, when not in use, must be placed as not to be a hazard to workers, pedestrians, or vehicular traffic. Hard hats are required when entering or working in manholes.

(4) Tool handling must be done in a manner that protects the workers and work area.

(a) Always place tools or materials a safe distance from manhole openings, where they will not cause a stumbling hazard or come in contact with energized conductors or equipment.

(b) Do not throw tools or materials into or out of manholes. Use canvas buckets or hand lines for lowering tools or equipment into and removing them from manholes. Warn workers before lowering tools.

(c) Consider providing a windless handcrank subsurface worker rescue assembly or an approved retracting lifeline system.

(5) Before starting work, an inspection should be made to determine if there are any dangerous conditions such as burnt or cut cables or loose or defective ladders. Use of portable ladders is preferred. Ladders in manholes, if provided, may have rusted and become unsafe. Before using open flames in manholes or excavations where combustible gases or liquids may

be present, such as near gasoline service stations, the atmosphere must be again retested and found safe or cleared of the combustible gases or liquids. When open flames must be used in manholes, extra precautions must be taken to provide adequate ventilation.

(6) Use only flashlights or facility approved lighting units for illumination in manholes.

(7) Low-voltage (less than 600 volts) equipment is especially hazardous in or around subsurface structures. Motor frames and equipment cases may be energized by electrical conductors with frayed or damaged insulation. The faults may occur only momentarily or may be prolonged through high-resistance grounding paths. Contact with energized equipment surfaces and the damp and will-grounded floors and walls often results in electrocution. It is recommended that only pneumatic tools and low-voltage (24 volt) lighting systems be used in maintaining subsurface vaults and facilities.

b. Precautions before commencing work. The worker must be familiar with the system and then proceed to any necessary tagging of cable and equipment.

(1) Every possible precaution will be exercised to correctly identify voltage, circuit, and phase of cable or apparatus to be worked upon.

(b) The external appearance of medium-voltage and low-voltage cables is often similar. For this reason, a very careful check should be made of duct locations and tag numbers before starting work. Any errors found in the tagging of cables or in the manhole records or maps should be immediately reported to the supervisor. Under no circumstances should an identification tag be removed or placed on a circuit without direct permission from the supervisor.

(2) Refer to paragraph 3-8 for requirements for de-energized work Safe clearance procedures.

(a) Where cables are being de-energized to be worked on, all instructions pertaining to the clearing of circuits, tagging, and grounding must be complied with.

(b) Standard practice for cable work is to provide complete isolation of cable and protection against premature energizing. An absolute check to ensure that no potential exists must be made prior to cutting into any cable. Remove the cable (lead or other) sheathing and test for voltage. Use only approved voltage detectors.

(3) Working on cable and equipment should normally be done after de-energizing the cable or apparatus to be worked on, whenever possible, and consistent with facility mission requirements.

(4) The cable or apparatus will be considered energized and worked with adequate protective devices until the following steps have been taken:

(a) The item has been tested with an approved device and proven to be de-energized.

(b) The item has been grounded from all possible sources of power (including transformer secondary backfeeds).

(c) The item has been proved de-energized at the work location. Grounds may be omitted or removed for test purposes with the approval of the supervisor in charge after the circuit has been tested and proven to be de-energized. Omission of grounds will only be permitted if their application increases the work hazard.

(d) Before working on any section of cable or apparatus to which cable is connected, care must be exercised to ensure the cable has been grounded for a sufficient length of time to drain off any static charges.

(5) The procedure for proving cables de-energized at the work location will be as follows—

(a) For positively identified cables normally energized at 600 volts or less, phase to phase, remove the insulation to expose a spot on the conductor for direct metallic contact and test with an approved voltage detector.

(b) Cables normally energized at more than 600 volts, phase to phase, or any cable whose voltage or identity is questionable, will be proved to be de-energized by following the rules given for medium-voltage work de-energized proving.

(6) Medium voltage work can be proved to be de-energized using an approved test device on cable terminals or apparatus which are equipped with capacitive test points or have bare exposed parts. Medium-voltage cable terminals and apparatus which cannot be proved de-energized with an approved test devices will be proved as follows—

(a) The item will be grounded from all possible sources of power and positively traced from the grounded point to the work location.

(b) Grounding can be done by the cable spike method which uses a wire tong or C-clamp device attached to a hot stick to provide a proven ground. Do not use a pike pole as a spike for this grounding method, as the pike does not have the rating of a hot stick. A temporary ground should be placed on the cable before splicing takes place. This allows the dissipation of any capacitance charge and helps to ensure the cable is de-energized.

c. *Requirements for working on cables and apparatus.* All workers must maintain the work distance given in table 3-7 as appropriate to the voltage level and whether the item being worked on is energized or de-energized. Be aware of what items are de-energized and what items are energized.

(1) *De-energized work.* All cable and apparatus must be tagged properly.

(2) *Protection.* When a worker is in proximity to live parts, rubber blankets or other suitable insulating barriers must be placed in the correct position to prevent accidental contact.

(3) *Working procedures.* Avoid hazards by observing the following procedures:

(a) The secondary voltage of any transformer fed from a de-energized feeder cable should be checked. The cable must be grounded on each side of the work location.

(b) Neutral conductors will not be opened without the prior installation of suitable bypass conductors.

(c) Energized underground cables will be moved with extreme care to avoid damage to the cable insulation. Moving will be done only at the discretion of the foreman in charge. Lead-sheathed underground cables will be moved only when approved by the supervisor. Prior to moving energized electric underground cable, they will be examined for any defects which might result in failure if the cable is moved. No energized cable may be moved where such movement requires changing bends. All energized cables will be handled with rubber gloves or hot-line tools as appropriate to the voltage level.

(d) Before separating or connecting a dead-break type separable connector, the circuit must be de-energized and tested dead utilizing the associated capacitive test point and an approved test device. Only suitable live line tools will be utilized in sepa-

rating or connecting these separable connectors, unless the circuit is tested de-energized and ground.

(e) Avoid sparks in connecting or disconnecting cable, apparatus, or switching devices.

(4) Before operating a primary grounding switch, the authorized operator must make certain of the following—

(a) Personnel are at the correct location.

(b) The tags on the feeder cable and equipment in the vault or manhole bear the same number as shown on single line drawings.

(c) Network protectors are in the open position or, in the case of radial transformers, that the secondary fuses have been removed and transformer secondaries are dead.

d. *Cutting of cable.* Before making an opening in or removing a part of the sheath or sleeve on a cable, the line will be grounded at the first possible grounding point on each side of the work location.

(1) Always wear rubber gloves when sawing into a cable or removing the sheathing. Install a metallic jumper between two sides of the location where a cable sheath is to be removed or cut.

(2) When a medium-voltage cable is to be cut, a short section of the shielding, if any, will be removed completely from around the cable. Tests will be made with two stoscopes or other approved testing devices, to determine whether or not the cable is de-energized. If no indication of a live cable is obtained, the worker may proceed with the work.

(3) When opening a splice in a medium-voltage cable, the sleeve over the splice will be cut completely around near the splice and then cut lengthwise and removed. No effort will be made to remove the compound. Workers will then test over each side of the conductor with two stoscopes or other approved testing devices. If no indication of a live cable is obtained, the compound will be removed. If shielding tape is then encountered, it will be removed and another test made over each side of the conductor with two stoscopes or other approved testing devices. If no indication of a live cable is then obtained, the splice will be cut through until the saw touches one of the conductors. Before sawing further a stascopo test will be made on the blade of the saw.

(4) When cutting or opening splices on low-voltage cable, the same procedure as outlined above for

medium-voltage cables will be followed, except in testing. To determine whether the cable is energized the insulation will be cut away to the conductor and tested with an approved tester. On multiple-conductor cables, only one conductor will be cut into at a time and tests made on at least two conductors before proceeding with the work.

7-6. Heating materials

Heating materials and equipment used in splicing cable will be heated in such manner as to prevent any hazard to the those working in manholes or vaults and to vehicular or pedestrian traffic.

a. Hazard elimination. Observe the following precautions to protect yourself, others, and the workplace:

- (1) Gloves will be worn while heating or working with hot insulating compound.
- (2) Furnaces and tanks containing liquefied petroleum gas, such as butane or propane, will not be placed in a manhole or vault.
- (3) Heating pots for solder, oil, or compound will be safely positioned so that the contents cannot enter the vault or manhole in case of spillage.
- (4) Torches or furnaces must be kept at a safe distance from flammable materials.

b. Work rules. The following work rules apply to the use of torches, furnaces, pots, and soldering devices. Only workers who are familiar with the use of torches and furnaces will be allowed to use them.

- (1) Only approved soldering pots, furnaces, and ladles in good condition will be used.
- (2) Keep lighted furnaces or torches 4 feet (1.2 meters) or more from manhole openings wherever practicable and where they will be the least possible hazard to property, workers, and the public. If necessary to use torches or furnaces in manholes, adequate ventilation must be provided to support combustion and provide sufficient air for workers.
- (3) Solder ladles must be heated before use. Be sure that scraps of cold solder are dry before remelting. Moisture and molten metal must never come in contact with one another because this will cause a splash of hot metal. Bars or pigs of solder, tools, and

ladles should be heated over the furnaces before being put into a pot of hot solder. New workers should be cautioned about this hazard.

(4) Furnaces must be lighted carefully and guarded with a three-sided windshield at all times when burning in public places. Never light or burn furnaces in dangerous locations and never leave them unattended. Lighted or hot torches or furnaces must not be transported in trucks or other moving vehicles.

(5) Always take special care not to splash solder on any person or equipment.

(a) Soldering pots must not be placed on furnaces without a pot guard.

(b) Never attempt to do soldering unless a fellow worker is stationed on the ground as a guard. If necessary, rope off a safe distance.

(c) Before lowering hot solder or compound into a manhole, warn those in the manholes to stand clear. Do not lower anything until given instructions from below to do so.

(6) If compound kettles have no breathers, punch holes through the top crust of the compound to the bottom before heating so that air and moisture can escape. Heat the compound slowly.

(7) Place compound kettles on the goods or plates provided and never directly on top of the furnaces.

(8) Do not allow paraffin to reach a temperature exceeding 390° F (198°C).

c. Procedures for use of bottled liquid fuels. Follow the manufacturer's instructions for installing the torch on and removing it from fuel cylinder, lighting the torch and using it, and cleaning the torch orifice.

(1) Always remove the torch from the fuel cylinder after the job is completed and it is no longer needed.

(2) Observe the following precaution:

(a) Operate only in well-ventilated areas.

(b) Do not store full cylinders near heat or fire, or in living spaces.

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