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**Safety**

**COMMUNICATIONS CABLE, ANTENNA AND  
COMMUNICATIONS-ELECTRONIC (C-E)  
SYSTEMS**

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The criteria in this standard are the Air Force's minimum safety, fire prevention, and occupational health requirements. Major commands (MAJCOM), direct reporting units (DRU), and field operating agencies (FOA) may supplement this standard when additional or more stringent safety, fire prevention, and health criteria are required. Refer to Air Force Instruction (AFI) 91-301, *Air Force Occupational and Environmental Safety, Fire Protection, and Health (AFOSH) Program*, for instructions on processing supplements or variances. Report conflicts in guidance between this standard, federal standards, or other Air Force directives through MAJCOM, DRU, or FOA ground safety offices to Headquarters, Air Force Safety Center, Ground Safety Division, Safety Engineering and Standards Branch (HQ AFSC/SEGS), 9700 Avenue G, SE, Suite 222, Kirtland AFB NM 87117-5670.

This standard establishes Air Force safety criteria for the installation and maintenance of communications cable and antenna systems and the operation, maintenance, modification, installation, and removal of C-E systems and equipment. It applies to all US Air Force organizations, including all US Air Force Reserve personnel and when Air National Guard personnel are on federal service. The standard implements portions of Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.268, *Telecommunications*, and includes additional requirements not addressed by the OSHA standard. Not included are safety, fire prevention, and occupational health requirements addressed in specific equipment technical orders (TO).

No Technical Order (TO), AFOSH Standard, or Operating Instruction can possibly address every hazard or potential hazard that may arise from a specific task or combination of tasks. Where situations exist that do not appear to be adequately covered by existing directives, use an Operational Risk Management (ORM) process to assess risk associated with those situations and determine adequate safeguards or procedures to manage the risk. **NOTE:** The ORM process may not be used to violate directives or other regulatory guidance. Normal waiver or variance procedures must be followed in all cases (refer to the first paragraph on page 1).

The use of a trade name or mark of any specific manufacturer, commercial product, or service in this publication does not imply endorsement by the Air Force.

**SUMMARY OF REVISIONS**

Administrative changes have been made to update this standard to electronic format. Paragraphs have been renumbered and references updated. ORM process statement has been added (see third paragraph first page). Minor changes will be annotated by an asterisk (\*). **NOTE:** AFOSH 127-series standards are being converted to 91-series standards and 161-series to 48-series standards. However, not all standards have been converted as of the effective date of this standard. To help you locate these documents, references to AFOSH standards are stated in the updated series and standard number, with the outgoing series and standard number stated as “formerly designated as” in the references section of **Attachment 1**.

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## Chapter 1

### HAZARDS AND HUMAN FACTORS

**1.1. Hazards.** Working with C-E equipment and repairing and installing antenna and cable systems present potential hazards to personnel. Improper climbing techniques, misuse of tools, and working in hazardous atmospheres without proper precautions are only a few of the potential causes of injuries in the communications installation and maintenance work environments.

#### 1.1.1. Electrical:

1.1.1.1. Shock. The severity of electric shock is determined by the amount of current flowing through the body, the time of exposure, and the body's physical condition. Normally, any voltage capable of producing a current flow of 50 milliamperes or more through the body can cause a shock that may result in cardiac arrest. Any individual receiving an electric shock should obtain an immediate medical evaluation. Following are some of the effects of current on the body.

1.1.1.1.1. Contraction of the chest muscles, which may interfere with breathing to such an extent that death will result from asphyxiation with prolonged exposure.

1.1.1.1.2. Temporary paralysis of the nerve center, which may result in failure of respiration, a condition which often continues long after the victim is freed from the circuit.

1.1.1.1.3. Ventricular fibrillation, an irregular and erratic heartbeat, which may result in cardiac arrest.

1.1.1.2. Arcing. When a metal object, such as a tool, comes in contact with a high current source and ground, it becomes a conductor. A high current will flow from the terminal through the tool to ground. The result is an arc. This arc can cause serious burns to the body and temporary or permanent blindness.

1.1.1.3. Other. A natural reaction after making contact with an electric current or seeing an arc is to repel oneself away from the source. This can result in falls or abrupt contact with fixed objects causing serious or fatal injuries.

1.1.2. Climbing. The primary hazards associated with climbing are falls and contact with electrical systems. Examples of climbing hazards include:

1.1.2.1. Pole conditions such as knots, knotholes, cracks, excessive gaff marks, crooked or raked poles, splinters, ice on poles, and heavily creosoted or arsenic-treated poles.

1.1.2.2. Pole attachments such as conduits, molding, cable and ground wire, strain plates, signboards, nails, and metal pole numbers.

1.1.2.3. Improper clothing such as badly worn shoes (e.g., loose heels, thin soles); low-cut shoes; trouser legs not folded properly under climbing irons; and jackets too loose or too long.

1.1.2.4. Equipment items that do not fit properly, such as: loose, short, or dull gaffs; climber straps too tight, too loose, too long, or broken; or the wrong sized climbers.

1.1.2.5. Failure to follow approved methods for climbing and working on poles and tower structures.

1.1.2.6. Wearing climbers while working on tower structures.

1.1.2.7. Failure to maintain good physical condition.

1.1.3. Radiation:

1.1.3.1. Nonionizing Radiation. Nonionizing radiation produces heating in body tissues. Absorption by the body is both frequency and body-shape dependent. Thus, it is possible for a person to selectively absorb damaging amounts of nonionizing radiation in deep tissue and organs with little or no sensation of skin heating. AFOSH Standard 48-9, *Radio Frequency Radiation (RFR) Safety Program*, and OSHA 29 CFR 1910.97, *Nonionizing Radiation*, give guidance on the management of hazards associated with nonionizing radiation.

1.1.3.2. Ionizing Radiation. Radioactive material contained in electron tubes presents no significant hazard as long as the tube is intact. The level of radiation in a small number of electron tubes at maintenance shops does not approach a dangerous level; however, at major supply points, the storage of large quantities of radioactive tubes in a relatively small area may create a hazard. Further, a broken radioactive tube is potentially hazardous since the radioactive material may be inhaled or ingested. Radio frequency generators such as certain klystrons, thyratrons, magnetrons, transmit-receive tubes, and similar high voltage devices also emit ionizing radiation. OSHA 29 CFR 1910.1096, *Ionizing Radiation*, provides additional guidance this area.

1.1.3.3. Electron Tubes. Many electron tubes such as spark gap, glow lamp, cold cathode, transmit-receiver, and antitransmit-receiver contain radioactive materials. The amount of radioactive material is such that no significant external radiation hazard is present when the items are handled singly or in small numbers. However, breakage of one or more may present a potential hazard to personnel in the area. Broken tubes may release radioactive material that may be ingested or inhaled by exposed personnel. Radioactive material may also contaminate exposed skin or clothing.

1.1.4. Chemical. Chemicals used in conjunction with C-E equipment maintenance can present health hazards due to skin contact and (or) inhalation of toxic vapors. Disposal of hazardous waste will be coordinated with the host installation environmental management function. **NOTE:** Ensure all personnel have had hazard communication training according to the guidance in AFOSH Standard 48-21, *Hazard Communication*, and have access to material safety data sheets (MSDS) for chemicals used in work processes. Also see OSHA 29 CFR 1910.1200, *Hazard Communication*, and AFOSH Standards 91-68, *Chemical Safety*, and 48-8, *Controlling Exposures to Hazardous Materials*.

**1.2. Human Factors :**

1.2.1. Human factors fall into two major categories:

1.2.1.1. Mental, such as attitude, emotion, job or domestic pressure, distractions, job knowledge, or hurrying;

1.2.1.2. Physical, such as fatigue, physical strength, and reactions to prescription medications or drugs.

1.2.2. These factors can affect workers who, by their commission (what they do) or by their omission (what they fail to do), can contribute to or cause a mishap. Some examples are:

1.2.2.1. Ignoring directions from supervisors.

1.2.2.2. Improper operation of equipment while angry or distracted.

1.2.2.3. Being distracted from job task while thinking of personal problems.

1.2.2.4. Not following proper procedures or taking shortcuts because of a feeling of being behind or hurried.

1.2.2.5. Being drowsy on the job, which may be caused by improperly taking prescription medications or alcohol or drug abuse.

1.2.2.6. Unauthorized use of equipment when not fully qualified.

## Chapter 2

### GENERAL REQUIREMENTS

**2.1. General.** Most hazardous situations can be avoided by simply following established procedures and asking for help if needed. Personal protective equipment (PPE) will be available and used when required. Potential physical, fire, and health hazards can be effectively controlled by proper training prior to task assignments, by appropriately following procedures, and through supervisory controls.

#### **2.2. Personnel:**

2.2.1. Only qualified and authorized communications-electronic systems technicians will install and maintain C-E equipment. Communications cable technicians install and maintain all cable from the central office main frame to all cable distribution terminals. Antenna technicians install and maintain all antenna systems including transmission lines and antenna support structures. Qualified electronics technicians are authorized to install wiring from the load side of power distribution circuit breakers to C-E equipment as a part of their installation work.

2.2.2. Two qualified technicians or one qualified technician and one safety observer will work together when energized high voltage circuits are exposed. All necessary protective equipment and special tools will be available and used.

2.2.3. If a supervisor becomes aware an employee is ill and may be taking medication, or the employee has a medical condition that might interfere with job performance, the supervisor must intercede and provide an alternative to the employee. If necessary, the supervisor should consult with the employee's physician to determine if the employee is physically capable of continuing.

#### **2.3. Training:**

2.3.1. First Aid and Cardiopulmonary Resuscitation (CPR) Training:

2.3.1.1. Personnel who install, maintain, relocate, or inspect communications systems or perform duties as safety observers will receive training in CPR, bleeding control (to include Bloodborne Pathogens training and disposal instructions), shock management, and emergency care of persons having open wounds and burns.

2.3.1.2. Initial first aid and CPR training will be accomplished within 30 days after an individual is assigned or as soon as possible at geographically-separated or remote units. All personnel requiring CPR training will receive refresher training at least every 2 years.

2.3.1.3. The installation medical facility will normally conduct first aid and CPR training for unit instructors who will, in turn, train unit personnel. If CPR training is not provided by the host medical facility, instructor training will be obtained from an approved source (i.e., American Red Cross, American Heart Association, military network, etc.).

2.3.2. Rescue Training:

2.3.2.1. Climbing. The only personnel authorized to climb poles and towers are those who have been properly trained, to include Pole Top rescue, and who are certified or in a training status under the supervision of an instructor. A record of climbing certification will be maintained on AF Form 1098, **Special Task Certification and Recurring Training**, for military and AF Form 971,

**Supervisor's Employee Brief**, for civilian personnel. Personnel who have not climbed within the last 12 months as a part of their normal job will require refresher training under the supervision of a qualified instructor. The amount of training required will be determined by the climbing instructor. Records will be updated whenever recertification is accomplished. (See paragraph 4.12.1.)

2.3.2.2. **Confined Space.** Personnel required to enter confined spaces, such as manholes or underground vaults, will be trained in self-rescue. Safety observers or attendants will be trained in rescue procedures for each type of confined space to be entered. (See AFOSH Standard 91-25, *Confined Spaces*, applicable TOs, and [or] OSHA 29 CFR 1910.146, *Permit-Required Confined Spaces*.)

2.3.3. **Hazard Communication Training.** All personnel require hazard communication training upon initial assignment and before potential exposure to hazardous materials. This training is conducted according to AFOSH Standard 48-21.

2.3.4. **Training Documentation.** All training will be documented on the AF Form 1098 for military and AF Form 971 for civilian personnel or an approved computer automated system. Additionally, safety-related training will be documented on the individual's AF Form 55, **Employee Safety and Health Record**.

**2.4. Safety Observers.** When installing or repairing C-E systems and communication cable and antenna systems that may expose workers to hazards associated with energized equipment or high voltage circuits, 600 volts or above, work will not begin until a qualified safety observer is present. An individual will not be assigned other duties while serving as safety observer. **EXCEPTION:** Climbing instructor may also be the safety observer.

2.4.1. When repairs (or troubleshooting) are to be performed to energized high voltage C-E equipment, the following will apply:

2.4.1.1. Safety observers need not be proficient in the task being observed.

2.4.1.2. Safety observers will be current in CPR.

2.4.1.3. Safety observers will be trained according to the requirements in paragraph 2.3.1.1. They will also be familiar with local procedures to obtain medical assistance.

2.4.1.4. While the task is being performed, the safety observer will:

2.4.1.4.1. Give a positive warning of potential danger to anyone approaching the equipment.

2.4.1.4.2. Stand where they can plainly see all personnel who are working on the equipment and have access to the main power switch. If not able to maintain visual contact with the main power switch, the lockout and (or) tagout procedure must be used.

2.4.1.4.3. Have ready access to safety equipment listed in paragraph 2.6.9. when high voltage is involved.

2.4.2. When aerial work on communication cable and antenna systems is being performed, safety observers will have a current climbing certification and will be proficient in the following:

2.4.2.1. CPR.

2.4.2.2. Administering emergency first aid treatment that involves control of bleeding, shock, open wounds and burns, and procedures for obtaining medical assistance.

2.4.2.3. The task being observed and its potential hazards. **NOTE:** Normally, the supervisor is also the safety observer.

**2.5. High Voltage.** High voltage has been electrically defined as 600 volts (root-mean-square [RMS]) or greater. However, much lower voltage can be lethal.

2.5.1. The design and development of all military electronic equipment will provide fail-safe features for safety of personnel during the installation, operation, maintenance, or interchanging of a complete equipment assembly or component part. Operators and technicians should not attempt to adjust any electronic equipment when there is a possibility of injury from unprotected high voltage potential. Adjustments on operating high voltage equipment, other than those specified by TO or commercial manuals, shall be authorized by the unit commander. The unit commander should consider all operational requirements, TO or commercial manual guidance, safety precautions, and emergency procedures before authorizing work to proceed.

2.5.2. Only qualified personnel will perform work near energized overhead power lines (**Table 2.1**). Before doing any communications work in the vicinity of overhead power lines, coordination with the civil engineering electrical authority will be accomplished. The following are safety precautions to be considered when working in the vicinity of overhead power lines (OSHA 29 CFR 1910.268 and 1910.333, *Selection and Use of Work Practices*):

2.5.2.1. Any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead power lines shall be operated so a clearance of 10 feet (305 centimeter [cm]) is maintained. If the voltage is higher than 50 kilovolt (kV), the clearance shall be increased 4 inches (10 cm) for every 10 kV over that voltage or twice the length of the line insulator, but never less than 10 feet (see exceptions in paragraph **2.5.2.2**).

2.5.2.2. Under any of the following conditions, the clearance may be reduced:

2.5.2.2.1. If the vehicle is in transit with its structure lowered, the clearance may be reduced to 4 feet (122 cm). If the voltage is higher than 50 kV the clearance shall be increased 4 inches (10 cm) for every 10 kV over that voltage.

2.5.2.2.2. If insulating barriers are installed to prevent contact with the lines, and if the barriers are rated for the voltage of the lines being guarded and are not a part of or an attachment to the vehicle or its raised structure, the clearance may be reduced to a distance within the designed working dimensions of the insulating barrier.

2.5.2.2.3. If the equipment is an aerial lift insulated for the voltage involved, and if the work is performed by a qualified person, the clearance (between the uninsulated portion of the aerial lift and the power line) may be reduced to the distance given in **Table 2.1**.

2.5.3. If an aerial lift or equipment contacts an electrical conductor, the vehicle, equipment, and attachments will be considered energized. Personnel standing on the ground shall not contact any part unless using protective equipment rated for the voltage.

2.5.4. Tree branches hanging on an energized conductor will be removed only with appropriate electrically insulating equipment, and only by authorized personnel.

2.5.5. Line worker's electrical safety boots will be worn to provide additional protection against electrical hazards. Rubber footwear or line worker's overshoes will not be worn.

2.5.6. Warning signs or Air Force Visual Aid (AFVA) 91-306, “**DANGER — HIGH VOLTAGE,**” will be prominently posted in all areas housing high voltage equipment; the highest expected voltage will also be posted.

## 2.6. Safety Equipment and Devices:

2.6.1. Manholes. Motor vehicle traffic is a hazard to personnel working in and around manholes on streets and highways. Warning devices, barriers (**Attachment 2**), and guarding will be used to protect personnel working at these locations. Guarding will meet the requirements of AFOSH Standard 91-22, *Walking Surfaces, Guarding Floor and Wall Openings and Holes, Fixed Industrial Stairs, and Portable and Fixed Ladders*. Ventilating equipment will be positioned so intake is located away from vehicular exhaust.

2.6.2. Aerial. Personnel working on aerial cable installation and pole line construction along streets and highways will use the same barriers and warning and guarding devices as required for manholes. (**Figure A2.1., Figure A2.2., and Figure A2.4.**)

2.6.3. Safety Straps, Harnesses, and Lanyards. Leather safety straps will not be used on any steel structures; nylon straps will be used. Safety harnesses, straps, and lanyards shall be provided and supervisors shall ensure their use when work is performed at positions more than 4 feet above the ground, on poles, and on towers (OSHA 29 CFR 1910.268(g)). Safety straps and harnesses shall also be worn when working at elevated positions on poles, towers, or similar structures, which do not have adequately guarded work areas. Supervisors shall ensure all safety climbing equipment is inspected by a competent person prior to each day’s use to determine it is in safe working condition. Each person using safety harnesses, straps, and lanyards will inspect the equipment prior to each use.

2.6.4. Climbing Safety Devices. Climbing safety devices will be installed on all ladders that are an integral part of the antenna support. Where climbing safety devices are not installed, installation or maintenance will be performed only by a certified climber using prescribed fall protection. Personnel climbing metal antenna support poles equipped with metal steps will use climbing safety devices.

### 2.6.5. Signs or Visual Aids:

2.6.5.1. Signs. Portable emergency signs should be constructed of polycarbonated plastic, cardboard, wood, or other nonconductive materials. The signs should be provided with a nonconductive cord to aid in hanging on equipment when needed. The typical sign should be designed approximately 7-inches high by 10-inches long. Various commercially available danger and caution signs are also available according to the specific hazards in the work area. Some examples of signs that are typically used to support communications maintenance and installation activities are listed in paragraphs **2.6.5.1.1.** through **2.6.5.1.7.** (See AFOSH Standard 91-45, *Hazardous Energy Control and Mishap Prevention Sign and Tags*, for wording of other mishap prevention signs.) **NOTE:** Consideration should be given to providing bilingual signs when they are located in areas where people speak or read a primary language other than English.

**2.6.5.1.1. “DANGER — DO NOT ENERGIZE — PERSON WORKING ON ANTENNA.”** This sign will be placed on the radio frequency (RF) power control switch or transmitter before any work is begun and when the alternating current (AC) power to the transmitter has been disabled. If lockout capability exists, the RF control switch should also be locked out according to local lockout procedures. (See AFOSH Standard 91-45.)

**2.6.5.1.2. “DANGER — DO NOT ENERGIZE — WORK IN PROGRESS ON EQUIPMENT .”** This sign may be used as noted in paragraph 2.6.5.1.1. and in other applications where power has been de-energized. In all cases where lockout capability exists, the signs should be used in conjunction with lockout procedures.

**2.6.5.1.3. “HARD HAT AREA .”** This sign will be placed around any job site when work is being performed aloft.

**2.6.5.1.4. “DANGER — INTERLOCKS DISABLED.”** This sign will be placed on equipment that has had interlocks temporarily disconnected during maintenance as required by TOs.

**2.6.5.1.5. “DANGER — HIGH VOLTAGE .”** This sign will be prominently posted around areas containing circuits, conductor sets, or exposed points of contact with the potential of exceeding 600 volts AC or direct current (DC).

**2.6.5.1.6. “UNAUTHORIZED CLIMBING PROHIBITED .”** This sign will be placed at the installation aerial structures. Several signs strategically located will satisfy warning requirements for antenna farms.

**2.6.5.1.7. “RADIO FREQUENCY AND RADIATION .”** These signs will be posted at access points to all areas where RFR levels exceed permissive exposure levels (PEL). Specific requirements are provided in AFOSH Standard 48-9.

2.6.5.2. Air Force Visual Aids (AFVA). Four of the signs described in paragraph 2.6.5.1. have been established as AFVAs and are available through Air Force publication distribution channels. They are:

2.6.5.2.1. AFVA 91-303, **“DANGER — DO NOT ENERGIZE — PERSON WORKING ON ANTENNA.”**

2.6.5.2.2. AFVA 91-304, **“DANGER — DO NOT ENERGIZE — WORK IN PROGRESS ON EQUIPMENT.”**

2.6.5.2.3. AFVA 91-305, **“DANGER — INTERLOCKS DISABLED.”**

2.6.5.2.4. AFVA 91-306, **“DANGER — HIGH VOLTAGE.”**

2.6.6. Markings. All antenna support, power, telephone, and transmission line poles will be marked 12 feet from the butt of the pole to determine the depth of the pole. The 12-foot mark will be indicated with aluminum pole tags or marker nails. If these are not available, 1-inch galvanized steel roofing nails will be driven into the pole to form the numerals “12.”

2.6.7. Proximity Warning Devices. These devices may be used on cranes or aerial lifts, but their use shall not change the requirements of 2.5.2. (Refer to AFOSH Standards 91-2, *Vehicle-Mounted Elevating and Rotating Work Platforms, Manually-Propelled and Self-Propelled Mobile Work Platforms, and Scaffolds (Towers)*, and 91-46, *Materials Handling and Storage Equipment*, and OSHA 29 CFR 1910.67, *Vehicle-Mounted Elevating and Rotating Work Platforms*, and 1910.180, *Crawler Locomotive and Truck Cranes*.)

2.6.8. Other Tool and Personal Protective Equipment. (Refer to OSHA 29 CFR 1910.268(e) and (i) for additional mandatory requirements for head and eye protection, portable lights, protective devices on tools and appliances, soldering devices, and lead work.)

2.6.9. Emergency Equipment. Emergency equipment will be provided at each operating facility where personnel are exposed to high voltage. Emergency boards may be used to provide an easily identifiable location for displaying emergency equipment or it may be stored in an unlocked cabinet; however, it will be situated in a known accessible location that will also afford maximum protection against chemical, mechanical, or environmental deterioration. Color coding of the emergency board is not mandatory; however, if color coding is used, the color should contrast with the color of the wall for quick identification. Emergency equipment will be inspected or tested frequently for serviceability. Emergency equipment will consist of:

- 2.6.9.1. The safety instructions for the particular site;
- 2.6.9.2. Emergency phone numbers;
- 2.6.9.3. First aid kit;
- 2.6.9.4. A non-conductive cane;
- 2.6.9.5. Rope, preferably 1/2-inch hemp at least 16-feet long. (Rope will be secured in a way that allows it to fall free when needed. Nylon rope should be avoided because it has a low flammability and softening point, which makes it impractical);
- 2.6.9.6. Insulated fuse pullers where required;
- 2.6.9.7. Flashlight (nonmetallic case) in operating condition;
- 2.6.9.8. Grounding stick;
- 2.6.9.9. Building number (if not otherwise prominently displayed);
- 2.6.9.10. Portable emergency signs and (or) AFVAs (see paragraph 2.6.5.);
- 2.6.9.11. CPR mask (face shield) and replaceable mouthpiece; and
- 2.6.9.12. Disposable gloves that are impervious (leakproof) to fluids for first aid use.

**NOTES:**

1. Snake bite kits and wool and rubber insulating blankets are optional items.
2. Follow **TO 00-25-234**, *General Shop Practice Requirements for Repair Electrical Equipment*, whenever electrostatic discharge sensitive items are handled.

2.6.10. Safety Gloves. Electrical safety gloves will be worn when prescribed by TO or manufacturer's manual. They will never be used on voltages higher than the voltage range for the glove class. Before beginning work, safety gloves will be inspected for cuts, punctures, or signs of wear. To avoid cutting or tearing rubber electrical gloves, personnel will wear leather gloves over them. Electrical worker's protective devices in storage and use will be tested and maintained according to requirements outlined in AFOSH Standard 91-31, *Personal Protective Equipment*.

2.6.11. Hard Hats:

- 2.6.11.1. Commanders, supervisors, and team members will ensure all those working on or near underground or aerial installation, removal, and maintenance jobs wear an approved hard hat at all times. Specifically, it will be worn while working on or around poles, overhead structures, vaults, manholes, excavations, demolition areas, and tower and antenna construction jobs. The chinstrap will be worn during work aloft.

2.6.11.2. Hard hats will be the electrical worker's safety helmet, Class B, as identified in AFOSH Standard 91-31 and American National Standards Institute (ANSI) Standard Z89.1, *Protective Headwear for Industrial Workers*.

2.6.11.3. Inspection requirements and instructions for use will be according to AFOSH Standard 91-31:

2.6.11.3.1. The preferred color for hard hats is yellow due to its high visibility during inclement weather and darkness.

2.6.11.3.2. Hard hats will not be painted. Markings on hard hats will be of the stick-on type and will be limited to the name of the owner (letters no more than 1/2-inch high by 1/2-inch wide) and a unit emblem (no more than 3 inches in diameter). All markings will be conservative and will not degrade the effectiveness or nonconductivity of the hat.

2.6.12. Reflective Clothing. When mission requirements dictate, light-reflective clothing or accessories will be worn according to AFOSH Standard 91-31 or other applicable guidance.

2.6.13. Electrical Hazard Shoes. Electrical hazard shoes are not a replacement for electrically rated matting in high voltage situations. Shoes are designed to be used when working on low voltage circuits and, even then, as a secondary means of protection. Additional information can be found in AFOSH Standard 91-31.

2.6.14. Fire Extinguishers. Appropriate fire extinguishers will be provided. Installation fire personnel will be consulted to determine types, quantities, and locations of this equipment.

## 2.7. General Safety Practices:

2.7.1. Personnel working near exposed electrical circuits or maintenance and installation activities, regardless of location, will not wear finger rings, watches, or other conductive objects that could increase shock risk or be the source of potentially severe burns when energized. Metal-framed eyeglasses may be worn, if secured with a head or neckband to prevent them from falling into an energized circuit.

2.7.2. When exposed to potentially hazardous noise levels, the installation bioenvironmental engineer (BEE) will be consulted for guidance on hearing protection. (See AFOSH Standards 48-19, *Hazardous Noise Program*, and 48-20, *Hearing Conservation Program*, for additional information.)

2.7.3. Installation medical services personnel will be consulted to determine if first aid equipment should be available and determine the type and quantity of supplies needed. Special consideration will be given to geographically separated units.

2.7.4. Electrical circuits should always be de-energized and locked and tagged out before attempting any work, unless the nature of the work requires the circuits remain energized.

2.7.5. All personnel (including safety observers) will know the location and on-off operation of the power distribution panels and power control switches and stations in their work area. In addition, emphasis will be placed on the need to maintain clear, unrestricted access to these controls at all times. This knowledge is essential to disengage electrical circuits to equipment in the event of a fire or accidental electrical contact.

2.7.6. Personnel will open and close all equipment switches quickly and positively.

2.7.7. The doors to high voltage racks will be closed at all times except for necessary and authorized repairs.

2.7.8. Interlocks will not be permanently disconnected or bypassed. Interlocks can be disconnected during maintenance or adjustments only when prescribed by applicable TOs. During these periods, a sign or AFVA stating “**DANGER — INTERLOCKS DISCONNECTED**” or nearest commercially available equivalent, will be placed on the equipment or nearest available equipment. (See paragraph 2.6.5.).

2.7.9. If the equipment has a defective interlock, all personnel will be made aware of the hazardous condition, and a warning sign or tag will be posted on the equipment.

2.7.10. Only fuses of the proper rating for the circuits involved will be used.

2.7.11. Grounded railings, barriers, or enclosures will be used to protect personnel from shock resulting from contact with conductors, bus bars, switches, control panels, etc.

2.7.12. All contacts, terminals, and devices having voltages between 50 and 599 volts RMS or DC with respect to ground will have barriers or guards to prevent accidental contact by personnel. Holes in the barrier may be provided for maintenance testing. Assemblies operating at potentials in excess of 600 volts RMS or DC will be completely enclosed from the remainder of the assembly. The barrier, guard, or enclosure will be marked to indicate the approximate highest normal voltage (nearest round number) which may be encountered upon its removal.

2.7.13. A face shield or goggles will be worn during unpacking, removal, or installation of transformers, capacitors, and diode stacks. Workers will be especially watchful for any sign of oil or fluid leakage, as it is possible this oil or fluid is Askarel. Askarel has been used for many years as a dielectric and contains high concentrations of polychlorinated biphenyl (PCB) which is extremely hazardous to living organisms. Any sign of leakage from components mentioned above will be reported to the nearest installation BEE, environmental manager, or the installation civil engineering environmental section. If possible, workers will not touch or disturb the leaking fluid without the approval of the appropriate medical activity.

## 2.8. Rubber Insulating Floor Matting:

2.8.1. Insulating matting shall be used near electrical apparatus or circuits in high voltage maintenance areas as an additional safety measure to protect personnel. Insulating matting is for protection against accidental shock only and shall not be depended upon for protection when handling energized wires and circuits. TOs 00-25-232, *Control and Use of Insulating Matting for High-Voltage Application*, and 00-25-234, and Military Manual (Mil M) 15562, *Matting or Sheet, Floor Covering, Insulating for High Voltage Application*, provide information and instructions for the control, use, and marking of insulating matting. Approved electrical insulating matting is permanently marked according to Mil M 15562.

2.8.2. Upon request, the installation ground safety staff will inspect areas where electrical facilities are located and determine whether insulating matting is required for worker protection. Typical examples of high voltage areas where insulating matting is required are:

2.8.2.1. High voltage consoles.

2.8.2.2. Electrical repair and test benches.

2.8.2.3. Equipment and control panels.

2.8.3. Cleaning will be accomplished as often as necessary to prevent contamination, utilizing domestic cleaners such as carpet cleaner or any other locally approved cleaner required for special situations.

2.8.4. Insulating matting will be replaced when worn to one-half its original thickness or the manufacturer's suggested replacement requirements.

2.8.5. Insulating matting on floors in front of and around electronic workbenches, high voltage cabinets, switch panels, etc., will be of one continuous length or strip. Where possible, the matting will continue for 24 inches beyond the end of the equipment. Overlapping at corners is not required if it produces a tripping hazard. If more than one run or strip of matting is required, the activity supervisor will determine the amount needed.

2.8.6. Insulating matting shall not be used for nonskid applications such as walkways or hall runners, in front of workbenches (nonelectronic), or on work- and test-benches, etc. For these applications general-purpose matting shall be used. This is a low-cost matting and is satisfactory for use in areas where shock protection is not required. No certification for use of general-purpose matting is required.

## **2.9. Grounding or Shorting Sticks:**

2.9.1. Electronic equipment with high voltage will have installed grounding sticks for use in discharging capacitors in case of automatic discharge failure. These grounding sticks need only be located in cabinets containing high voltage components. Also, they will be used to check for stray high voltage components and to check for stray high voltage. Where physical size precludes using a permanently attached grounding or shorting stick, a portable grounding or shorting stick will be used.

2.9.2. At least one grounding stick will be provided at every C-E equipment area and will be supplied in addition to any that may be included as integral components of electronics equipment. The grounding stick provided with the safety board will suffice if readily accessible.

## **2.10. Housekeeping:**

2.10.1. Good housekeeping will be maintained, with all flammable wastes disposed of in clearly marked metal containers with self-closing lids. Containers for flammable wastes will be emptied when full and at the end of each working day. The installation BEE, environmental manager, and civil engineering environmental coordinator will be consulted about storage and disposal of used solvents, contaminated rags, and degreasing compounds requirements.

2.10.2. Storage is not allowed in electrical and (or) electronic areas. Storage is permitted in approved areas only.

2.10.3. Food and beverages will not be stored or consumed in the immediate area of C-E equipment where spills or foreign particles could present a hazard to personnel or cause damage to equipment.

2.10.4. Equipment and (or) component cleaning:

2.10.4.1. Vacuuming is the preferred method of cleaning electronic equipment. If compressed air is used, limit the air pressure to less than 30 pounds per square inch (psi). (AFOSH Standard 91-12, *Machinery*.)

2.10.4.2. If solvents are required, use only approved and authorized solvents (AFOSH Standard 48-21). Provide adequate ventilation (AFOSH Standard 161-2, *Industrial Ventilation*). Consult the installation BEE for guidance on safe use of solvents and the adequacy of the ventilation system.

### 2.11. Tools and Equipment:

2.11.1. The supervisor is responsible to ensure all tools and equipment are maintained in a safe condition. Every worker is responsible for the condition and correct use of the tools and equipment they use.

2.11.2. When possible, nonconductive tools will be used while performing work on energized C-E equipment. Taping or plastic coating is not an acceptable means of insulation. Wooden handle tools will not be used on energized C-E equipment.

2.11.3. All tools will be kept clean and free of grease, oil, paint, or other foreign material. **EXCEPTION:** This does not prevent the use of a light film of oil on tools for protection.

2.11.4. Wood or reinforced fiberglass ladders will be used for work performed on or near electrical equipment.

2.11.5. Metal ladders or ladders with metal reinforced side rails will not be used when work is being performed in, on, or near electrical equipment and will not be stored in any area where electronic equipment may be in operation. The side rails of ladders not marked with safety use instructions by the manufacturer shall be stenciled, "**DANGER — DO NOT USE AROUND ELECTRICAL EQUIPMENT**," in 2-inch high red letters or the largest letters the surface will allow. (See AFOSH Standard 91-22.)

### 2.12. Test Equipment Set Up:

2.12.1. Test operators and technicians will follow the exact methods of adjustment, operation, and repair of test equipment given in TOs, commercial instruction manuals, books, or diagrams.

2.12.2. Personnel will be knowledgeable of the characteristics and safe operation of the various instruments before being permitted to use them.

2.12.3. Employees using high voltage to troubleshoot and (or) test cables will be instructed in the precautions necessary for their safety and the safety of others. Workers will be warned to stay clear while voltage is applied. This should be accomplished by briefings and warning signs at affected locations. Before voltage is applied, cable conductors will be isolated to the maximum extent practicable.

### 2.13. Soldering Precautions:

2.13.1. Remove combustible materials from the work area to prevent fires.

2.13.2. Make sure fire extinguishers are accessible in the soldering area.

2.13.3. Never sling excess solder from a soldering iron; wipe it off with a damp cloth or sponge.

2.13.4. Always place the soldering iron in the proper holder when not in use. Never leave the iron plugged in and unattended.

2.13.5. Wear a face shield or safety goggles when soldering. **NOTE:** Normal prescription glasses or plain safety glasses may be used in place of safety goggles for light electronic equipment soldering.

- 2.13.6. Ensure work areas, where soldering is done, are well ventilated. (AFOSH Standard 161-2.)
- 2.13.7. Use approved respiratory devices when working in permit-required confined spaces that are not adequately ventilated. (AFOSH Standards 48-1, *Respiratory Protection Program*, and 91-25). Consult the installation BEE for type of respiratory devices.

#### **2.14. Fabrication of Lead End-Plates:**

- 2.14.1. Maintain a clean working area free of combustible materials.
- 2.14.2. Ensure fire extinguishers are accessible in the work area.
- 2.14.3. Set lead pots on a noncombustible level surface to prevent turnover and do not leave them unattended.
- 2.14.4. Do not drop cold lead or any cold liquid into molten lead. This action may cause splashing, rapid separation, and serious burns.
- 2.14.5. Wear a face shield or safety goggles and gloves when fabricating in place.
- 2.14.6. Make sure work areas are well ventilated.
- 2.14.7. Consult with the installation BEE or the military public health personnel for appropriate training on working with lead and to determine if medical examinations are required.

#### **2.15. Compressed Gases:**

- 2.15.1. When using or transporting compressed gas cylinders (nitrogen cylinders) in a horizontal position, special compartments, racks, or adequate blocking will be provided to prevent cylinder movement and the cylinders will be secured with safety straps. Regulators will be removed and safety caps installed before a cylinder is transported or when not in use.
- 2.15.2. Compressed gas cylinders will be kept away from excessive heat, will be protected from direct rays of the sun, and will not be stored where they might be damaged or knocked over by passing or falling objects. Cylinders will be secured and stored at least 50 feet away from combustible materials. (Refer to TO 42B5-1-2, *Gas Cylinders Use, Handling, and Maintenance*, for additional information.)
- 2.15.3. Acetylene cylinders will be stored and used in a vertical position only, valve-end up.

**2.16. Grounding and Bonding.** These two terms are not the same. Most electricians and electronics workers consider the ground to be a stake or other direct connection into the ground (earth) to which the electrical system of the facility is connected. In a two-wire electrical cord, there is a ground wire and a hot wire. The ground wire is the "neutral" for the system and is white. The other wire is the hot wire and it may be any color other than white or green. In a three-wire system, the third wire is the ground wire and it is always green or green with one or more yellow stripes. Bonding, on the other hand, consists of interconnecting two or more pieces of conductive equipment with a suitable wire or strap to equalize the resistance and, in effect, make them as one piece of equipment as far as electrical potential is concerned, thus eliminating the potential for electrostatic discharge. For specific guidance refer to TO 31-10-24, *Communications Systems Grounding, Bonding, and Shielding*.

#### **2.17. Aerial Work:**

2.17.1. General. Appropriate safety equipment will be worn while performing aerial work. Steps and ladders will be installed on all antenna towers and structures when their design permits. These steps and ladders will be equipped with cages or safety devices where possible. Exceptions to this requirement are structures designed to provide equivalent protection of a safety cage (e.g., triangular antenna towers that are climbed internally where structural members provide approximately the same protection normally afforded by a safety cage). Safety cages, ladder devices, or similar equipment are not required on wooden poles. Design specifications for protective devices on existing facilities will be retrofitted as required. This may require coordination with the installation civil engineer. New towers, poles, and masts will have protective devices included in the original design. When installed, use of protective devices will be strictly enforced. Supervisors will ensure personnel on the ground or in the air do not remove or tamper with guys, guying hardware, or supporting ropes when workers are aloft. In addition, the chief of maintenance or supervisor will never allow an individual to climb if the individual has a fear of heights or is subject to dizziness or fainting. (Additional precautions for aerial work may be found in AFOSH Standard 91-22 and OSHA 29 CFR 1910.24, *Fixed Industrial Stairs*, and 1910.27, *Fixed Ladders*.)

2.17.2. Radome Installation, Maintenance, and (or) Removal:

2.17.2.1. Personnel engaged in radome work will be experienced riggers and work under the direction of a qualified supervisor.

2.17.2.2. All personnel working on or in the immediate vicinity of the radome will wear hard hats and safety-toed shoes.

2.17.2.3. Personnel will make frequent contact with the nearest weather forecasting agency to allow time to lash down equipment for impending inclement weather.

2.17.2.4. When workers mix resin, they will follow the manufacturer's instructions.

2.17.2.5. Personnel will never try to replace panels when the wind is blowing more than 30 miles per hour.

2.17.2.6. Workers will never remove more than one panel at a time under normal conditions.

2.17.2.7. Personnel will use the maintenance rope to lift the maintenance ladder to the top of the radome. Prior to each use, they will inspect the rope for frayed or worn spots and replace if needed.

**2.18. Antenna Supports (Towers and Poles):**

2.18.1. Check guy wires for proper tension and attachment hardware and anchor rods for corrosion. If hardware shows signs of corrosion, dig down 18 inches around the anchor rod to determine the extent of corrosion to the anchor rod. (Refer to TOs 31-10-19, *Antenna Systems —Anchors and Supports*, and 31R-10-5, *Antenna Systems: Maintenance Repair and Testing*.)

2.18.2. Check poles for deterioration. Prior to placing body weight on step, check steps on poles for proper depth and tightness. (Refer to TO 31-10-3, *Outside Plant Installation*.)

2.18.3. Check tower antenna supports and mounts for corrosion. **NOTE:** Check bolts on towers because they corrode before tower sections. (Refer to TO 31R-10-5.)

2.18.4. Check natural fiber, nylon, and wire ropes, used in dismantling of antenna supports, for deterioration and splices and discard them if found to be unsafe. Make sure wire ropes are made of

improved plow grade steel. Ensure loads placed on ropes do not exceed the safe working load limits prescribed by the diameter of the rope. (Reference TOs 31-10-3, 31-10-28, *Erection of Steel Towers*, and 31R-10-5.)

2.18.5. Do not carry bulky and heavy tools, parts, or other materials on safety harnesses while climbing. (Refer to TO 31-10-3.)

2.18.6. Before starting work, make certain power to antennas is turned off and locked out, the capacitors are discharged, and appropriate signs or tags are posted. (Refer to TO 31R-10-5 and AFOSH Standard 91-45.)

2.18.7. Ensure only special purpose vehicles designed for heavy steel antenna erection and removal, and capable of handling the maximum weight of items to be lifted, are used. Check the vehicle manufacturer's specifications and handbook for safe operation and proper use. (Reference TO 31-10-3.)

**2.19. Inspection and Maintenance of Lifting Devices.** (See AFOSH Standards 91-20, *Vehicle Maintenance Shops*, and 91-46.)

### **2.20. Single Phase Portable and Vehicle-Mounted Generators:**

2.20.1. Portable Generators. Under the following conditions, the frame of a portable generator is not required to be grounded and may be permitted to serve as the grounding electrode for a system supplied by the generator:

2.20.1.1. The generator supplies only equipment mounted on the generator and (or) cord- and plug-connected equipment through receptacles mounted on the generator, and

2.20.1.2. The noncurrent-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame.

2.20.2. Vehicle-Mounted Generators. Under the following conditions the frame of a vehicle may be permitted to serve as the grounding electrode for a system supplied by a generator located on the vehicle:

2.20.2.1. The frame of the generator is bonded to the vehicle frame;

2.20.2.2. The generator supplies only equipment located on the vehicle and (or) cord- and plug-connected equipment through receptacles mounted on the vehicle or on the generator; and

2.20.2.3. The noncurrent-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame.

2.20.3. Neutral Conductor Bonding. A neutral conductor shall be bonded to the generator frame when the generator is a component of a separately derived system. The bonding of any conductor other than a neutral within the generator to its frame shall not be required.

2.20.4. Metallic Encased Tools. The tools and equipment being powered by generators will contain a three-wire cord with grounded plugs.

2.20.5. Fixed Wiring Systems. Portable and vehicle-mounted generators that supply fixed wiring systems shall be grounded according to Article 250 of National Fire Protection Association (NFPA) 70, *The National Electrical Code (NEC)*.

**2.21. Elevated Areas .** Elevated areas of C-E facilities and mobile electronic equipment vans, where work such as calibration, adjustment, and maintenance of electronic equipment is required on a frequency of more than once per month, will be provided with safety railings consistent with the requirements set forth in AFOSH Standard 91-22.

**Table 2.1. Approach Distances for Qualified Employees—Alternating Current.**

Voltage Range (Phase to Phase)	Minimum Approach Distance
300 volts (V) and less.....	Avoid Contact
Over 300 V, not over 750 V.....	1 foot 0 inches (30.5 cm)
Over 750 V, not over 2 kV.....	1 foot 6 inches (46 cm)
Over 2 kV, not over 15 kV.....	2 feet 0 inches (61 cm)
Over 15 kV, not over 37 kV.....	3 feet 0 inches (91 cm)
Over 37 kV, not over 87.5 kV.....	3 feet 6 inches (107 cm)
Over 87.5 kV, not over 121 kV.....	4 feet 0 inches (122 cm)
Over 121 kV, not over 140 kV.....	4 feet 6 inches (137 cm)

## Chapter 3

### C-E SYSTEMS

#### 3.1. General Safety Practices:

- 3.1.1. Do not rely on safety devices such as interlocks, high voltage disconnect relays, or automatic circuit grounds. Each of these is subject to failure. Use lockout and (or) tagout procedures whenever possible.
- 3.1.2. Always be aware of the location of power switches and electrical danger areas.
- 3.1.3. Never attempt adjustments on a potential ground when any portion of the body may come into contact with equipment frames or other ground connections.
- 3.1.4. Recommend placing one hand in a pocket or under a layer of clothing while making adjustments on energized circuits, except where use of both hands is necessary to perform the work.
- 3.1.5. Avoid working in wet clothing.
- 3.1.6. When near energized electrical circuits, do not use (or carry in pockets) metallic measuring rules, tools, or metal-cased objects.
- 3.1.7. Close high voltage rack doors at all times except during period of authorized maintenance.
- 3.1.8. When the potential for exposure to flash exists, wear suitable goggles or face shields.
- 3.1.9. Provide installation fire department and the hospital ambulance section with maps indicating routes to locations of remote sites. Where practical, establish a letter of agreement with the emergency rescue units to allow actual tests to evaluate the route suitability and response times.
- 3.1.10. Ensure all areas containing flammable materials have appropriate fire prevention signs posted and fire extinguisher available.
- 3.1.11. Make sure all power unit exhausts are vented to the building exterior. (Reference venting requirements in AFOSH Standard 161-2.)
- 3.1.12. Ensure all grounding of electrical and electronic equipment is sized according to grounding requirements of the NEC. Where possible, use a copper strap or heavy gauge copper wire as the ground connection. Ensure water or cooling pipes meet the requirements of Air Force Joint Manual (AFJMAN) 32-1083, *Electrical-Interior Facilities*. Never use nonmetallic water or cooling pipes as the grounding electrode. Where equipment is installed to meet red and (or) black criteria, make sure grounding of the electrical and electronic equipment follows the applicable installation requirements in the red and (or) black National Agency Communications Security (COMSEC) Installation Manual (NACSIM) 5203. Do not fill ground strap ends with solder to facilitate clamping as the solder may melt and leave a loose connection, thus defeating the ground.
  - 3.1.12.1. Install an earth electrode subsystem, consisting of a ring ground or interconnected ground rods, for lightning protection purposes and for grounding of all C-E equipment utilizing high voltages.
  - 3.1.12.2. If possible, provide duplicate bleeder circuits on high voltage capacitors to reduce the voltage to a nonhazardous level as rapidly as practical (dual resistor banks are recommended).

### 3.2. Repairs and Adjustments.

3.2.1. Repair and maintenance operations are not permitted in electrical or electronic areas, except for those repair and maintenance operations performed directly on equipment which is impractical to remove from the electrical or electronic area.

3.2.2. Repairs and adjustments will be made to energized circuits only when a power-on condition is essential.

3.2.3. Repairs and adjustments of components, when the equipment slides are extended from their cabinets and voltages are applied, will be permitted only when:

3.2.3.1. Repairs and adjustments are specified by applicable TOs, commercial manuals, or approved isolation and troubleshooting methods;

3.2.3.2. Personnel not essential to the operation are removed from the area before power is applied; and

3.2.3.3. The following additional precautions are observed when high voltages are present or transmitters of 1-kilowatt (kW) power rating or higher are involved:

3.2.3.3.1. Approval of the unit commander is obtained prior to the work being performed and the adjustments are not specified by TO or commercial manuals.

3.2.3.3.2. Insulated gloves are used when directed by TOs or the manufacturer's manuals.

3.2.3.3.3. Insulating matting is used.

3.2.3.3.4. A qualified safety observer is present.

**3.3. Carbon Blocks and Heat Coils .** Prior to removal of operating carbon blocks or heat coils, a measurement of line potential will be made using a voltmeter having a minimum input impedance of 20,000 ohms per volt to ensure the foreign electromotive force (FEMF) which energized these protective devices is no longer present. If the FEMF is still present, carbon blocks and (or) heat coils will not be removed or replaced.

**3.4. Power Distribution Panels and Interlocks.** Power distribution panels and interlocks will be secured to prevent personnel from coming in contact with energized circuits. When equipment must be removed from service for inspection or repair, the appropriate circuit breaker or interlock will be locked open (off), if possible, and posted with a danger tag, warning sign, AFVA, or other suitable identification until the equipment is again ready for use. (Refer to AFOSH Standard 91-45 and paragraph 2.6.5. of this standard.) Tape will not be used to "lock" open circuit breakers.

### 3.5. Fuses and Circuit Breakers:

3.5.1. The inside cover of fuse and circuit breaker panels will indicate the equipment controlled.

3.5.2. Whenever possible, overcurrent devices will be installed in electrical circuits of a size and type to interrupt the current flow when the current exceeds the current rating of the equipment or exceeds the capacity of the conductor, whichever is smaller.

3.5.3. Blown fuses will be replaced by the type required by the manufacturer. When possible, clip type or flat-mount cartridge fuses will only be removed and replaced by using insulated fuse pullers. Wire, tinfoil, solder, and similar materials will not be used as substitutes for fuses.

**3.6. Cathode Ray Tubes (CRT).** Precautions will be taken to minimize the danger of breaking the glass envelope of a CRT. For protection of both tubes and personnel, tubes are packaged and centrally positioned in shipping and storage containers. They will be retained in their original containers until removed for actual installation or for inspection and test. A tube will not be stored without its original packaging. In addition to the danger of implosion due to breakage, rough handling may also cause displacement of the electrodes within the tube. A sharp blow on the service bench can displace the electrodes enough to cause faulty operation of the tube and even destroy it. Tubes will be exposed or changed only in areas where a minimum number of personnel are present. All personnel working in the vicinity will wear eye protection whenever a CRT is removed from its container. Handling of large diameter tubes will be done by two workers. Workers who handle tubes will:

3.6.1. Wear PPE, consisting of an apron, gauntlet-type gloves, goggles and full-face shield, during tube installation or removal of CRTs larger than 6 inches in diameter.

3.6.2. Avoid scratching the glass of a tube since such scratches weaken the tube and can cause failure.

3.6.3. Use a raspy pad or suitable material.

3.6.4. Remove tube from its shipping or storage container face up by grasping the larger, or bell end. Avoid handling large tubes by the neck since the narrow portion of the tube is particularly susceptible to breakage from bumping or striking other objects. This will also minimize strain due to mechanical misalignment.

3.6.5. Special handling instructions are normally provided by the manufacturer for tubes having an external insulation coating applied to areas of the bell end. If not otherwise instructed, grasp the rim of the bell, holding the neck end only to guide the base into position.

3.6.6. Permanently mount a protective shield on tubes used regularly for testing equipment. For those tubes not having integral implosion protection, use a safety glass faceplate over the screen. **NOTE:** New tubes use a bonded faceplate or a similar method of integral implosion protection, eliminating this requirement. However, many of the older type tubes are still in use and the safety precautions cited herein will be observed.

3.6.7. Handle old or unusable tubes with the same precautions for new tubes. Unless otherwise directed, destroy old or unusable tubes prior to disposal. Place the tube into a steel container or sealed carton that has a hole in the top just large enough for a crowbar or similar instrument and smash the tube. An alternate method is to break the evacuation tube located at the end of the neck. After destroying the tube, and before placing into bulk waste containers, seal the residue in the original or an equivalent container, using tape.

3.6.8. If broken glass from a tube cuts the skin, immediately wash the cuts to remove dirt, phosphorus, or other particles and obtain immediate medical attention.

3.6.9. In the event of equipment fires, use only approved extinguishers on sets containing CRTs. (Refer to paragraph 2.6.14.)

3.6.10. Contact the installation BEE for an evaluation of the X-ray hazard of all color video display tubes (VDT) manufactured before 1970 and operating at tube potentials greater than 16 kV, or for

VDTs manufactured after 1970 when maintenance procedures have the potential for violating manufacturer-applied warning labels.

### **3.7. Electron Tubes Containing Radioactive Materials:**

3.7.1. Hazards associated with radioactive material are outlined in paragraph 1.1.3. If breakage does occur, do not touch the tube or the immediate area. Notify the immediate supervisor plus the radiological protection officer (usually the installation BEE).

3.7.2. Carefully handle tubes and ensure they are packaged correctly to prevent breakage. The use of cushioning material is necessary. Leave tubes in the packing, shipping or storage container and remove them just prior to installation.

3.7.3. Control of the disposition operations (packaging, marking, identifying temporary storage, and shipping) is the responsibility of assigned radiological monitors and the radiological protection officer. Consult TO 00-11ON-7, *Requisition, Handling, Storage and Identification of Radioactive Material*, for additional information on disposal of radioactive electron tubes.

### **3.8. Grounding:**

3.8.1. Electrical and electronics equipment will be grounded so a potential cannot exist between the unit and the ground. Fixed electrical equipment will be electrically bonded to a grounding connector. Special protection will be provided to safeguard grounding wires from mechanical damage. Metal workbenches and metal framed or legged workbenches used for repairing and testing of electronic equipment will be grounded. The size and type of material for grounding conductors will be selected according to the NEC, Article 250. All workbenches used for "power on" maintenance of any electronic equipment will be provided with a means for grounding the equipment. This will be interconnected to the facility ground system.

3.8.2. Grounding circuits, as a minimum, shall have:

3.8.2.1. A separate circuit for each chassis, cabinet, and frame. Each chassis ground may terminate at its cabinet or frame ground.

3.8.2.2. A circuit not connected to the electrical circuits, i.e., neutral.

3.8.2.3. Connections that are mechanically secure by:

3.8.2.3.1. A spot-welded terminal lug.

3.8.2.3.2. A portion of the chassis or frame that has been identified as a grounding point.

3.8.2.3.3. The use of a terminal on the ground wire by a lockwasher and screw or a lockwasher and nut.

3.8.2.3.4. Grounding braids installed on panels and cabinets that are removable or hinged so bonding is not accomplished through hinges, slides, or mounting hardware.

3.8.3. System grounding within mobile equipment will be by means of a grounding conductor. As these grounding conductors are replaced, they will be of the appropriate gauge and will have a green insulated cover.

3.8.4. Bus bars will be clean and free of corrosion, splices will be tight, and paint will be removed from all vertical angles at the point of attachment to the ground bus bar.

**3.9. Test Equipment Setup:**

- 3.9.1. Test equipment shall be designed, constructed, and installed to provide safe work procedures and to minimize personnel exposure to hazardous work situations.
- 3.9.2. When tests involve live circuits, the area should be enclosed. Only authorized personnel who have been briefed about the potential hazards involved should be in this area when tests are to be performed. At least one safety observer will be present when high voltage is involved.
- 3.9.3. Approved and effective warning signs and (or) signals will be used to indicate when power is on. A means of emergency power shutdown should be provided outside the test area in addition to the main power switch within the test area.
- 3.9.4. All personnel involved in test operations will be provided with approved PPE.
- 3.9.5. Connections to test tables, bus bars, plug racks, terminal cabinets, and distribution boards will be secure.
- 3.9.6. Test operators and technicians will follow technical publications or commercial manuals on method of adjustment, operation, and repair of test equipment.

**3.10. Battery Maintenance and Charging Rooms:**

- 3.10.1. Personnel servicing batteries will wear eye protective devices (face shields) with side protection. Acid-resistant aprons and gloves will be provided to and worn by all personnel handling wet cell batteries. (Refer to AFOSH Standard 91-31.)
- 3.10.2. Smoking or open flame is not permitted.
- 3.10.3. Positive ventilation will be provided. (Refer to AFOSH Standard 161-2.)
- 3.10.4. Personnel will follow the manufacturer's technical publications when servicing batteries.
- 3.10.5. Battery and ground terminal blocks will be clearly marked for ready identification by personnel working on the main distribution frame.
- 3.10.6. The installation BEE and host installation ground safety officials may be contacted for guidance on health and safety criteria for battery maintenance and charging rooms. (Refer to TOs 31W2-10-6, *Telephone Inside Plant Engineering*, *Central Office Building Design Criteria*, 36Y4-1-171, *Operational Maintenance and Storage Vehicle and Powered Group Equipment Storage Batteries, Nickel, Iron, Alkaline and Lead Acid*, and 36Y4-1-194, *Operations and Organizational Field and Depot Maintenance Storage Batteries, Lead Acid Type*, and AFOSH Standard 91-20.)
- 3.10.7. Emergency shower and eyewash units will be available and operable in the immediate area. (Refer to AFOSH Standard 91-32, *Emergency Shower and Eyewash Units*.)

**3.11. Radar and Microwave Equipment:**

- 3.11.1. Radar and microwave equipment are sources of nonionizing radiation. Personnel will be instructed in the hazards of nonionizing radiation and will not be exposed to nonionizing radiation levels above the permissible exposure limits outlined in AFOSH Standard 48-9. Installation bioenvironmental engineering (BE) personnel will be consulted for evaluation of nonionizing radiation personnel hazards and safety procedures.

3.11.2. Special precautions will be taken to ensure a transmitter, connected to an antenna that is being inspected or worked on, cannot be energized and is locked out. A danger tag, warning sign, AFVA, or other suitable identification advising others of the nature of work in progress will be posted on the console of the transmitter and also in all other critical locations.

3.11.3. Workers will not look into an open waveguide that is connected to an energized source of microwave radiation.

3.11.4. A nonionizing radiation warning sign will be posted in areas where a hazard may exist. (Refer to AFOSH Standard 48-9.)

## Chapter 4

### CABLE AND ANTENNA SYSTEMS

#### 4.1. Entering Manholes and Unvented Vaults. (See AFOSH Standard 91-25 and TO 31W3-10-12, *Outside Plant Cable Placement*.)

4.1.1. Manholes and vaults will be evaluated and tested to determine the classification of the confined spaces and whether entry permits will be required. Additionally, manholes, vaults, and handholes will be positively identified as to utility type (communication, electrical power distribution, sewer, etc.) prior to entry. In the absence of positive identification, personnel will coordinate with the installation ground safety officials and contact the appropriate installation organizations to establish positive identification. These will normally include the installation civil engineering electrical shop, communication unit, and fire department.

4.1.2. Unidentified cables will be positively identified as to the utility type. Cables will be evaluated using a nonintrusive device, such as a clamp-on voltmeter, to determine the absence or presence of electrical voltage and current prior to beginning any work on the cable. Although discouraged, a small percentage of manholes, vaults, or handholes may be joint use. In these few instances, extreme caution will be used and the communication cable shall be positively identified. When requested, the installation civil engineering electrical shop will provide an electrician to assist in determining guarding and safe procedures.

#### 4.2. Aerial Cables:

4.2.1. Maintain minimum distances (40 inches up to 87,000 volts and 60 inches over 87,000 volts) between power and communications cables on joint-use poles. If minimum distances can not be maintained, de-energize the power line before performing installation or maintenance work. Workers will comply with the requirements in paragraph 2.5.2. and **Table 2.1**.

4.2.2. Observe caution when installing messenger strand so the loose ends do not make contact with power lines.

4.2.3. When crossing over roadways, railroads, walkway, etc., ensure proper overhead clearances are maintained. (Refer to TO 31W3-10-19, *Outside Plant Cable Open Wire and Pole Line Installation, Maintenance, and Repair*.)

4.2.4. Before riding or placing a ladder against an aerial strand, test the strand by suspending approximately 300 pounds in the middle of the span. An easy test method is to place a rope over the strand and have two workers suspend their weight on it.

4.2.5. Never ride a cable car over power lines (primary or secondary).

4.2.6. Check handlines for serviceability prior to use. The line worker will remove the handline from the safety harness when they reach the work position and secure it to the pole.

4.2.7. Use safety straps and safety harnesses while working on elevated work platforms such as aerial splicing platforms, pole platforms, ladder platforms, and terminal balconies. (Refer to TO 31W3-10-19.)

4.2.8. Wear insulating rubber gloves when handling suspension strand that is being installed on joint-use poles.

**4.3. Underground and Buried Cables:** (See TO 31W3-10-12.)**4.4. Heaters and Torches Used in Ground and Aerial Tents:**

4.4.1. Flame-type heaters will not be used within ground tents or on platforms within aerial tents unless the tent covers are constructed of fire-resistant materials and adequate ventilation is maintained.

4.4.2. Torches may be used on aerial splicing platforms or in buckets enclosed by tents, provided the tent material is constructed of fire-resistant material and the torch is turned off when not in actual use. The tent will be adequately ventilated while the torch is in use.

**4.5. Trenching and Excavations.** (See TO 31W3-10-12, US Army Corps of Engineers Manual [EM] 385-1-1, *Safety and Health Requirements Manual*, and [or] OSHA 29 CFR 1926.652, *Excavations — Requirement for Protective Systems*.)**4.6. Pressurized Cables.** (See TO 31W3-10-16, *Outside Plant Cable Pressurization*.)**4.7. RF Transmitting Antenna:**

4.7.1. Exercise caution when working on or adjacent to transmitter antennas. (See paragraph 3.11.)

4.7.2. Ensure a transmitter connected to an antenna, which is being inspected or worked on, is locked out and cannot be energized. Be sure adjacent antennas, which create hazardous levels of RF radiation at the work location, are also secured.

4.7.3. Make sure workers remove all jewelry prior to working on equipment.

4.7.4. Review the site standard operating procedures (SOP) for radiation hazard control and site RF hazards reports and drawings to ensure locations where RF hazards exist are known and appropriate measures (shutdown or blanking of antennas) are taken to prevent exposure of personnel working in those areas.

**4.8. Pole Climbing.** (See TO 31-10-3 and AFOSH Standard 91-31.)**4.9. Special Purpose Vehicles:** (See AFI 24-301, *Vehicle Operations*, and Air Force Manual [AFMAN] 24-309, *Vehicle Operations*.)

## 4.9.1. Inspection:

## 4.9.1.1. Prior to operation:

4.9.1.1.1. Visually inspect the vehicle to determine if it is safe, serviceable, and in good condition.

4.9.1.1.2. Inspect for correct assembly and storage of equipment.

4.9.1.1.3. Inspect for worn equipment.

## 4.9.1.1.4. After operation:

4.9.1.1.5. Document and correct, if possible, any operating deficiencies.

4.9.1.1.6. Report defects that require repair to organizational maintenance.

4.9.1.1.7. Replace unserviceable equipment.

4.9.2. Truck-Mounted Winches:

4.9.2.1. Telephone line and maintenance trucks are equipped with front- and (or) back-mounted drum-type winches. A safety observer will stand to the front and well clear of the winch when it is being used.

4.9.2.2. Winches are extremely powerful tools; therefore, extreme caution will be exercised in their use. A vehicle operator will be thoroughly trained and familiar with both the operation of a winch gear train and a power takeoff lever movement. Winch operators will:

4.9.2.2.1. Wear leather palm gloves when handling a winch line and never hand feed the line onto the drum.

4.9.2.2.2. Inspect the winch line before use for defects such as broken or worn strands, kinks, flat spots, and worn eye loops. Remove damaged or badly kinked winch lines from service.

4.9.2.2.3. Never rig a winch line so it will pull against the flange of the winch drum.

4.9.2.2.4. Set the hand brake on the truck and chock the wheels before operating the winch. **NOTE:** Some winches are designed for pulling while others are designed for raising or lowering. Ensure each winch is being used for its designed purpose.

4.9.3. Cable Reels. The safe handling, moving, and positioning of cable reels require well-trained operators in good physical condition. Pre-planning the move and final positioning will identify any problems with the surface condition and the best methods to use. Always use a spotter when backing cable reel trailers.

4.9.3.1. Caution will be used when handling cable reels and cable reel trailer.

4.9.3.2. A full reel of large cable may weigh as much as 10 tons. Therefore, it is necessary to carefully control the movement of the reel:

4.9.3.2.1. Never permit the reel to tilt.

4.9.3.2.2. On uneven or soft ground, provide a substantial runway of heavy planks.

4.9.3.2.3. Level the reel by blocking it in a manner that prevents tilting.

4.9.3.2.4. After positioning in the desired storage location, block the reel to prevent rolling.

**4.10. Control Towers.** Fire protection and life safety requirements for control towers are contained in the *Design Guide for Air Traffic Control Towers* dated June 1987 (or latest revision). Installation Air Traffic Control Managers, with assistance from the installation civil engineer, will ensure existing control towers meet the criteria established in the design guide:

4.10.1. If the tower does not meet the fire protection and life safety criteria described in the *Design Guide for Air Traffic Control Towers* and cannot be upgraded, a second means of egress should be considered. The installation fire marshal is the approval authority for means of egress.

4.10.2. If a tower escape device is employed as a second means of egress, the device will be stored and maintained in serviceable condition according to the manufacturer's recommendations. An operating instruction (OI) prescribing the type of training required on the escape device will be main-

tained. Actual escape practice, when required, will be conducted at the minimum height necessary to ensure effective training.

4.10.3. Tower evacuation procedures will be included as part of safety, fire prevention, and health on-the-job training prescribed by AFI 91-301.

4.10.4. Stairs or catwalks leading to control towers will be protected with nonskid treads, nonskid paints, or other appropriate nonskid surfacing materials. Stairs and catwalks will be kept free of debris.

4.10.5. Low hanging guards or beams will be padded and highlighted to preclude head injuries.

4.10.6. Air traffic control managers will make sure periodic facility inspections are conducted and all areas are maintained free of unnecessary combustible materials. Particular attention will be paid to rodent control and bird nests in cable trough areas and discarded combustibles in the maintenance area.

#### 4.11. Ground Controlled Approach (GCA) Radars:

4.11.1. Before ascending to the roof of the GCA trailer or other rotating antenna location, the supervisor will inform all nearby personnel that work is being performed on the roof and will ensure the following is accomplished:

4.11.1.1. The surveillance antenna control switch is turned off, locked out, and a warning sign or AFVA 91-303, “**DANGER — DO NOT ENERGIZE — PERSON WORKING ON ANTENNA,**” is placed on the high voltage power supply switch. (See AFOSH Standard 91-45 for additional information on lockout and tagout requirements and paragraph 2.6.5. of this standard for signs and visual aids.)

4.11.1.2. The roof-mounted antenna safety switch is turned off.

4.11.2. TO 36-1-3, *Corrosion Prevention — Painting and Marking of USAF Support Equipment*, requires rooftops of mobile GCA vans be painted to warn personnel of rotating antenna hazards. **NOTE:** In combat areas, the sweep area covered by antenna rotation may be indicated by a broken line of 3/4-inch-wide red dashes.

#### 4.12. Special Authorization and Requirements for Climbing:

4.12.1. Personnel engaged in climbing communication poles, antenna supports, etc., will be issued suitable protective equipment (line worker boots, hard hat with chin strap, safety harnesses, safety straps, etc.), which will be worn at all times while climbing and working aloft. When protective equipment is not used during climbing, it will be attached to the harness or elsewhere as prescribed; it will not be carried in the hand, over the shoulder, or by other unauthorized methods. Chinstraps will be used while climbing and working aloft. Climbing equipment will be inspected according to AFOSH Standard 91-31.

4.12.2. The unit commander determines who is authorized to climb structures, based on mission requirements. All climbing shall be restricted to official duties. (Climbing is defined as moving from one level to another using both the hands and feet. Certification is not required, for example, to walk up and down stairways.)

4.12.3. Upon assignment to a unit, each individual whose future duties will require climbing poles, towers, and structures 20 feet or more in height will be trained and briefed as applicable. The individual will be tested (oral and [or] written and by practical demonstration) to ascertain knowledge of standard climbing safety practices and proficiency in climbing practices and procedures. This requirement ensures individuals who must climb and use protective devices are fully qualified and physically capable of climbing and working aloft.

4.12.3.1. Individuals determined qualified to climb and work aloft will have certification documented on AF Form 1098 (military) or AF Form 971 (civilians). Units supported by a computerized information management system may use it to record training. Each individual requiring certification will be retested annually.

4.12.3.2. For Air Force Specialty Codes (AFSC) other than 2E6X1, 2E7X1, and 2E7X3, commanders will restrict climbing authorizations to those structures that must be climbed to accomplish mission requirements. The allowable height of climbing will be limited to specific requirements. Such limited authorizations to climb will be documented. (See paragraph 2.3.4.)

4.12.3.3. Individuals designated by the commander (e.g., supervisors, and chiefs of maintenance) will accomplish testing and certification or recertification of personnel required to climb.

4.12.3.4. Determination of who requires certification or recertification should be based on unit mission, not the AFSC. Personnel assigned duties that do not require climbing are not required to recertify annually. If a person in this category is assigned to a special project that requires climbing to heights of more than 20 feet, and recertification has not been accomplished within the last 12 months, the person will be retested and certified prior to climbing.

4.12.4. Commanders, supervisors, and each team member have the responsibility to prohibit persons from climbing if it would be potentially unsafe because of their mental or physical condition or lack of experience. The supervisor or team member will make sure that personnel who have not been exposed to a climbing environment within the previous 120 days are current on climbing safety practices and in good mental and physical condition to climb. Personnel determined not qualified will be restricted from climbing until recertified.

FRANCIS C. GIDEON, JR., Maj Gen, USAF  
Chief of Safety

**Attachment 1****GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION*****References***

Listing of all References Used When Writing the Standard:

Air Force Instruction (AFI) 24-301, *Vehicle Operations*.

AFI 91-301, *Air Force Occupational and Environmental Safety, Fire Protection, and Health (AFOSH) Program*.

Air Force Manual (AFMAN) 24-309, *Vehicle Operations*.

Air Force Joint Manual (AFJMAN) 32-1083, *Electrical-Interior Facilities*.

Air Force Occupational Safety and Health (AFOSH) Standard 48-1, *Respiratory Protection Program*.

AFOSH Standard 48-8, *Controlling Exposures to Hazardous Materials*.

AFOSH Standard 48-9, *Radio Frequency Radiation (RFR) Safety Program*, (formerly designated as AFOSH Standard 161-9).

AFOSH Standard 48-19, *Hazardous Noise Program*.

AFOSH Standard 48-20, *Hearing Conservation Program* (formerly designated as AFOSH Standard 161-20).

AFOSH Standard 48-21, *Hazard Communication* (formerly designated as AFOSH Standard 161-21).

AFOSH Standard 91-2, *Vehicle-Mounted Elevating and Rotating Work Platforms, Manually-Propelled and Self-Propelled Mobile Work Platforms, and Scaffolds (Towers)*.

AFOSH Standard 91-12, *Machinery* (formerly designated as AFOSH Standard 127-12).

AFOSH Standard 91-20, *Vehicle Maintenance Shops* (formerly designated as AFOSH Standard 127-20).

AFOSH Standard 91-22, *Walking Surfaces, Guarding Floor and Wall Openings and Holes, Fixed Industrial Stairs, and Portable and Fixed Ladders* (formerly designated as AFOSH Standard 127-22).

AFOSH Standard 91-25, *Confined Spaces*.

AFOSH Standard 91-31, *Personal Protective Equipment* (formerly designated as AFOSH Standard 127-31).

AFOSH Standard 91-32, *Emergency Shower and Eyewash Units* (formerly designated as AFOSH Standard 127-32).

AFOSH Standard 91-45, *Hazardous Energy Control and Mishap Prevention Signs and Tags* (formerly designated as AFOSH Standard 127-45).

AFOSH Standard 91-46, *Materials Handling and Storage Equipment* (formerly designated as AFOSH Standard 127-46).

AFOSH Standard 91-68, *Chemical Safety* (formerly designated as AFOSH Standard 127-68).

AFOSH Standard 161-2, *Industrial Ventilation*.

American National Standards Institute (ANSI) Standard Z89-1, *Protective Headwear for Industrial Workers*.

Design Guide for Air Traffic Control Towers.

Military Manual (Mil M) 15562, *Matting or Sheet, Floor Covering, Insulating for High Voltage Application*.

National Agency Communications Security (COMSEC) Installation Manual (NACSIM) 5203 (Red and Black Installation Criteria).

National Fire Protection Association (NFPA) 70, *National Electrical Code (NEC)*.

Occupational Safety and Health Administration (OSHA) Standard 29 Code of Federal Regulations (CFR) 1910.24, *Fixed Industrial Stairs*.

OSHA 29 CFR 1910.27, *Fixed Ladders*.

OSHA 29 CFR 1910.67, *Vehicle-Mounted Elevating and Rotating Work Platforms*.

OSHA 29 CFR 1910.97, *Nonionizing Radiation*.

OSHA 29 CFR 1910.146, *Permit-Required Confined Spaces*.

OSHA 29 CFR 1910.180, *Crawler Locomotive and Truck Cranes*.

OSHA 29 CFR 1910.268, *Telecommunications*.

OSHA 29 CFR 1910.333, *Selection and Use of Work Practices*.

OSHA 29 CFR 1910.1096, *Ionizing Radiation*.

OSHA 29 CFR 1910.1200, *Hazard Communication*.

OSHA 29 CFR 1926.652, *Excavations — Requirement for Protective Systems*.

Technical Order (TO) 00-11ON-7, *Requisition, Handling, Storage, and Identification of Radioactive Material*.

TO 00-25-232, *Control and Use of Insulating Matting for High-Voltage Application*.

TO 00-25-234, *General Shop Practice Requirements for Repair Electrical Equipment*.

TO 31-10-3, *Outside Plant Installation*.

TO 31-10-19, *Antenna Systems — Anchors and Supports*.

TO 31-10-24, *Communications Systems Grounding, Bonding, and Shielding*.

TO 31-10-28, *Erection of Steel Towers*.

TO 31R-10-5, *Antenna Systems: Maintenance Repair and Testing*.

TO 31W2-10-6, *Telephone Inside Plant Engineering, Central Office Building Design Criteria*.

TO 31W3-10-12, *Outside Plant Cable Placement*.

TO 31W3-10-16, *Outside Plant Cable Pressurization*.

TO 31W3-10-19, *Outside Plant Cable Open Wire and Pole Line Installation, Maintenance, and Repair*.

TO 36-1-3, *Corrosion Prevention — Painting and Marking of USAF Support Equipment*.

TO 36Y4-1-171, *Operational Maintenance and Storage Vehicle and Powered Group Equipment Storage Batteries, Nickel, Iron, Alkaline and Lead Acid.*

TO 36Y4-1-194, *Operations and Organizational Field and Depot Maintenance Storage Batteries, Lead Acid Type.*

TO 42B5-1-2, *Gas Cylinders Use, Handling, and Maintenance.*

US Army Corps of Engineers (EM) 385-1-1, *Safety and Health Requirements Manual.*

### ***Abbreviations and Acronyms***

**AC**—Alternating Current

**AFI**—Air Force Instruction

**AFJMAN**—Air Force Joint Manual

**AFMAN**—Air Force Manual

**AFOSH**—Air Force Occupational Safety and Health

**AFSC**—Air Force Safety Center

—Air Force Specialty Code

**AFVA**—Air Force Visual Aid

**ANSI**—American National Standards Institute

**BE**—Bioenvironmental Engineering

**BEE**—Bioenvironmental Engineer

**C-E**—Communications-Electronic Systems

**cm**—Centimeter

**COMSEC**—Communications Security

**CFR**—Code of Federal Regulations

**CPR**—Cardiopulmonary Resuscitation

**CRT**—Cathode Ray Tube

**DC**—Direct Current

**DRU**—Direct Reporting Unit

**EM**—Engineers Manual

**FEMF**—Foreign Electromotive Force

**FOA**—Field Operating Agency

**FRP**—Fiberglass Reinforced Plastic

**GCA**—Ground Controlled Approach

**Ghz**—Gigahertz

**HQ**—Headquarters

**kHz**—Kilohertz

**kV**—Kilovolt

**kW**—Kilowatt

**MAJCOM**—Major Command

**MDF**—Main Distribution Force

**Mhz**—Megahertz

**Mil M**—Military Manual

**MSDS**—Material Safety Data Sheet

**NACSIM**—National Agency Communications Security Installation Manual

**NEC**—National Electric Code

**NFPA**—National Fire Protection Association

**OI**—Operating Instruction

**ORM**—Operational Risk Management

**OSHA**—Occupational Safety and Health Administration

**PCB**—Polychlorinated Biphenyl

**PDO**—Publishing Distribution Office

**PEL**—Permissible Exposure Levels

**PPE**—Personal Protective Equipment

**psi**—Pounds Per Square Inch

**RF**—Radio Frequency

**RFR**—Radio Frequency Radiation

**RMS**—Root-Mean-Square

**SOP**—Standard Operating Procedure

**SPV**—Special Purpose Vehicle

**TO**—Technical Order

**V**—Volt

**VDT**—Video Display Tubes

**US**—United States

**USAF**—United States Air Force

**WWW**—World-Wide Web

***Terms***

**Aerial Lifts**—Aerial lifts include the following.

Extendible boom platforms.

Extendible aerial ladders.

High reach bucket truck.

NOTE: These devices may be made of metal, wood, fiberglass reinforced plastic (FRP), or other material; they may be powered or manually operated.

**Aerial Splicing Platform**—A platform approximately 3 feet by 4 feet in size used to perform aerial cable work.

**Aerial Tent**—A small tent designed to protect an individual from the weather elements while performing aerial cable work from a ladder or aerial platform.

**Aerial Work**—Installation, maintenance, or dismantling of structures (i.e., towers, scaffolds, poles); the use of ladders; the installation of fixed ladders or open stairways; and the act of climbing or mounting such structures to accomplish designated tasks.

**Antenna Element**—The portion of an antenna that is part of the radiating system, i.e., transmits or receives radio frequency (RF) energy. It does not include boom or supporting structure.

**Antenna Support**—A structure of either wood, metal, fiberglass, or concrete that supports or provides a mounting for an antenna or an element of an antenna.

**Barricade**—A physical obstruction such as tapes, cones, or an “A” frame structure, used to warn and limit access to a work area.

**Barrier**—A physical obstruction that is intended to prevent contact with energized lines or equipment or to prevent unauthorized access to a work area.

**Bonding**—An electrical union between two metallic surfaces used to provide a low-impedance path between them. Bonding is the procedure by which the conductive surface of a subassembly or component is electrically connected to another. This prevents development of electrical potentials between individual metal surfaces for all frequencies capable of causing interference. (See TO 31-10-24.)

**Cable**—A conductor with insulation; a stranded conductor with or without insulation or other coverings; or a combination of conductors insulated from one another used to connect communication equipment.

**Cable Car**—Used to perform inspection of aerial cable.

**Capacitor**—An electric charge storage device. Because of dielectric absorption, energy may remain stored even after capacitor is discharged.

**Cardiopulmonary Resuscitation (CPR)**—Emergency first aid treatment involving mouth-to-mouth resuscitation and closed chest heart massage.

**Cathode Ray Tube (CRT)**—A sealed evacuated glass tube containing an electron source and a luminescent face often used to provide a visual image display. A television tube is a common example.

**Certified Climber**—A worker who has been successfully trained and certified to climb poles, towers, and other high structures. This certification does not apply to tasks such as climbing interior or exterior stairs. (Refer to paragraph 2.3.4. for certification documentation procedures.)

**Certified Climbing Instructor**—Individual designated to certify climbers. The individual should have had climbing experience and be knowledgeable of the subject. Any certified climber may act as instructor to certify other climbers when designated by the commander.

**Communications-Electronics (C-E)**—The broad field of activity encompassing the functions of program formulation, policy planning, inspection, and direction of communications-electronics operation and maintenance. It includes:

Supervisory and technical responsibilities for the construction, installation, operation, and maintenance of communications and electronics systems and equipment;

All radio, wire, and other means used for the electrical and visual transmission and reception of information or telephone calls, message and radio traffic, etc., that are unencrypted or by cryptographic means;

All radar and radiation aids to air traffic control and navigation and enemy aircraft warning and interception; and

All ground electronic devices and systems for the control and tracking of aircraft and guided missiles, electronic weather equipment, electronic countermeasure devices, and related electronic systems and equipment.

**Conductor**—A material suitable for carrying an electric current.

**Downlead**—A conductor connecting an antenna to a transmitter or receiver.

**Energized**—A circuit electrically connected to a source of potential difference or an electrical charge.

**Equipment Ground**—Connection to ground from one or more of the noncurrent-carrying metal parts of the wiring system or of the apparatus connected to the system.

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

**Grounding Stick**—A conductive metal rod, to which a conductive metal braid has been bonded. The metal rod is equipped with a nonconductive handle on one end. The other end is usually formed into a hook. The grounding stick is used to discharge residual energy from electric circuits.

**Ground System**—Complete ground circuit for any equipment, facility, or system.

**High Voltage**—Any circuit, set of conductors, or exposed point of contact in which the potential to ground or between conductors is 600 volts AC or DC, or greater.

**Joint Use**—The sharing of a common facility, such as a manhole, trench, or pole, by two or more utilities (e.g., power and telecommunications).

**Main Distribution Frame (MDF)**—The terminating point between outside plant cables and the inside plant subscriber.

**Manhole or Handhole**—A subsurface enclosure where personnel enter for the purpose of installing, operating, and maintaining telecommunications equipment and cables.

**May**—Indicates an acceptable or satisfactory method of accomplishment.

**Microwave and Radar Equipment**—Equipment emitting electromagnetic radiation in a frequency range of about 10 Megahertz (MHz) to 300 Gigahertz (GHz). (Refer to AFOSH Standard 48-9.)

**Overcurrent Device**—A protective element that opens a circuit when an overcurrent condition exists.

**Qualified C-E Technician**—An individual who by reason of training and experience has demonstrated ability to safely and knowledgeably perform duties involving the maintenance and repair of electronic

equipment.

**Radioactive Tubes**—Electron tubes containing radioactive material. Transmit-receiver, anti-transmit receiver, spark-gap, glow-lamp, and cold-cathode tubes usually contain intentionally added radioactive material to produce a continuous supply of ionized particles. This ensures the gas within the tube will always ionize at the same voltage.

**Radio Frequency Radiation (RFR)**—RFR is, for the purpose of this standard, electromagnetic radiation in the frequency range of 10 kilohertz (kHz) to 300 GHz. (See AFOSH Standard 48-9 for additional information.)

**Respirator**—An approved device designed to provide the wearer with respiratory protection against inhalation of a contaminated atmosphere and for some devices, oxygen-deficient atmospheres. (Refer to AFOSH Standard 48-1.)

**Safety Observer**—A worker who is proficient in CPR, first aid, and equipment turn-off procedures and who is responsible for administering immediate assistance to a technician in the event of an emergency.

**Shall**—Indicates a mandatory requirement.

**Should**—Indicates a preferred method of accomplishment.

**Special Purpose Vehicle (SPV)**—A vehicle that is specifically designed to do work which general purpose vehicles cannot do. For example: trenchers, line trucks, and splicing vans are used to install, repair, and maintain communications equipment.

**Telephone Line Truck**—A special purpose truck used to transport workers, tools, and equipment. It serves as a traveling workshop for telephone communications installation and maintenance personnel.

**Test Desk (Test Board)**—A permanently installed fixture consisting of a volt and (or) ohm meter, keys, and jacks that are used as a testing point between outside plant cables and inside plant switching equipment.

**Test Equipment Setup**—Configuration of test equipment to perform repairs, checks, and adjustments on C-E equipment.

**Transmission Line**—A conductor used to transfer electromagnetic energy from a source to a load; i.e., from a transmitter to an antenna. Conductors may be flexible or rigid, wire, or coaxial cable.

**Waveguide**—A transmission line comprising a hollow conducting tube within which electromagnetic waves may be propagated. Waveguide may be rigid or flexible.

**Will**—Is also used to indicate a mandatory requirement and to express a declaration of intent, probability, or determination.

Attachment 2

LOCATION OF WARNING DEVICES, TRAILERS, NIGHT WARNING

Figure A2.1. Location of Warning Devices Manhole Off Highway.

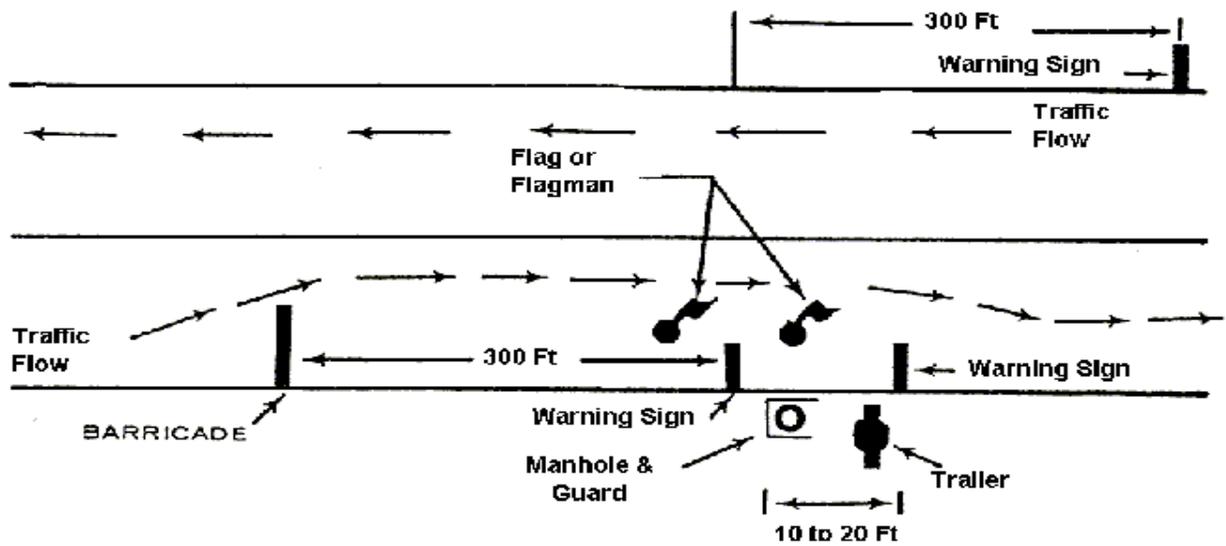


Figure A2.2. Location of Warning Devices -- Manhole In Two-Lane Highway.

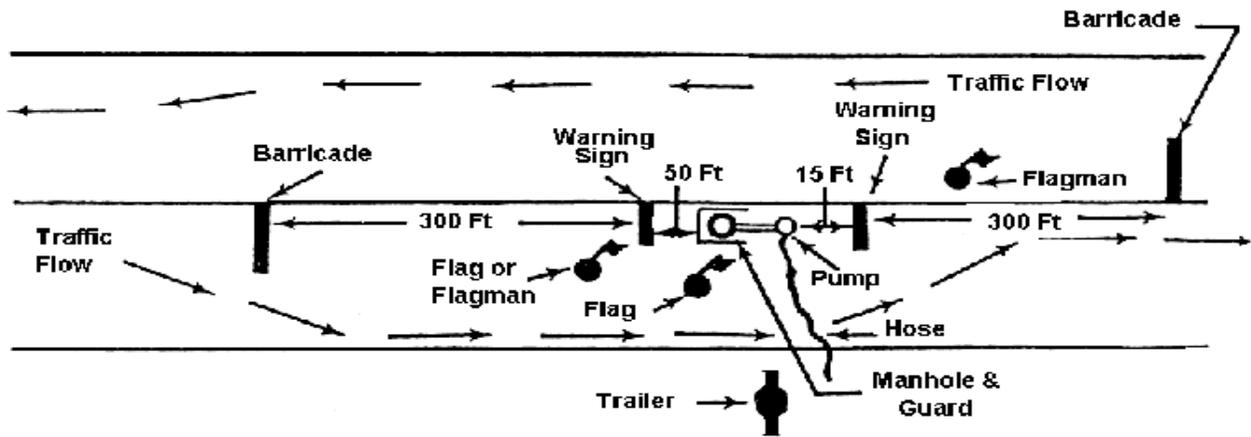


Figure A2.3. Location of Trailer.

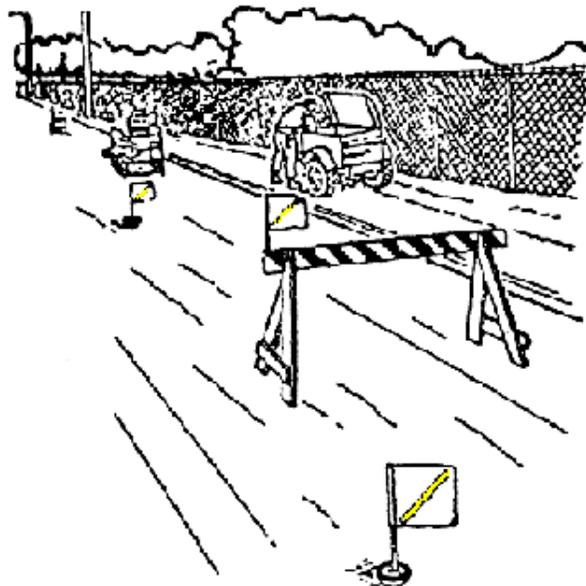


Figure A2.4. Night Warning--Arrangements of Warning Signs.

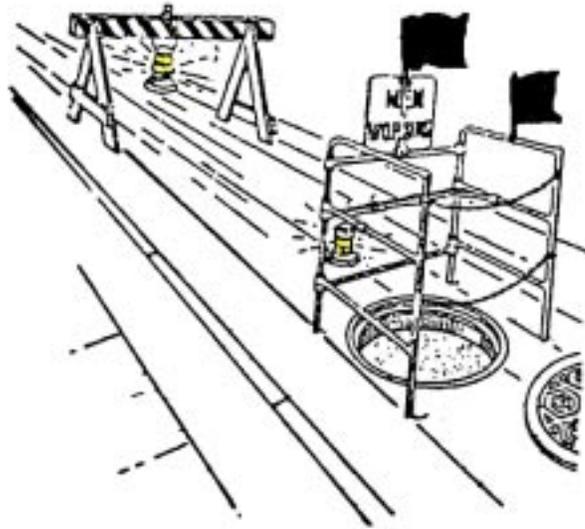
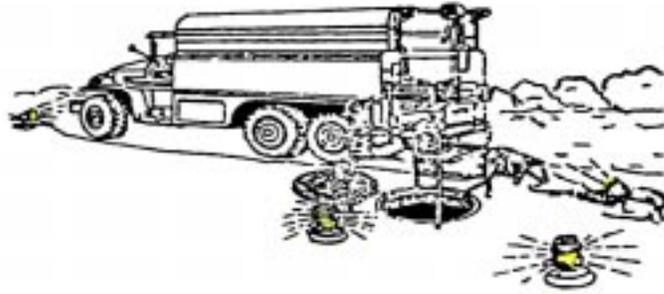


Figure A2.5. Night Warning--Use of Floodlights.



**Attachment 3****COMMUNICATIONS CABLE, ANTENNA AND  
COMMUNICATIONS-ELECTRONICS SYSTEMS CHECKLIST**

This is not an all-inclusive checklist. It simply highlights some critical items in this standard. Other requirements exist that are not included in the checklist. Where appropriate, MAJCOMs, DRUs, FOAs, local safety personnel, and supervisors will add to the checklist to include command or individual shop-unique requirements or situations.

**CHAPTER 2 — GENERAL REQUIREMENTS****Training:**

**A3.1.** Do all personnel that are required to perform duties on communications systems or act as safety observers receive first aid and CPR training? Is this training documented properly? (Refer to paragraphs 2.3.1. and 2.3.4.)

**A3.2.** Are personnel who are required to enter confined spaces trained in self-rescue? (Refer to paragraph 2.3.2.)

**A3.3.** When performing work on aerial communication cable and antenna systems, are safety observers current in climbing certification? (Refer to paragraph 2.4.2.)

**High Voltage:**

**A3.4.** When working close to energized overhead power lines, are procedures used to prevent equipment or aerial lifts from violating minimum distances? (Refer to paragraph 2.5.2.)

**Safety Equipment and Devices:**

**A3.5.** Are warning devices and barriers used when motor vehicle traffic is a potential hazard to personnel working in manholes or on aerial lifts? (Refer to paragraphs 2.6.1. and 2.6.2.)

**A3.6.** Are appropriate warning signs or AFVAs available and used when working in and around communications systems work sites? (Refer to paragraph 2.6.5.)

**A3.7.** Is emergency equipment available to personnel who are exposed to high voltage when performing communications maintenance tasks? (Refer to paragraph 2.6.9.)

**Hard Hats:**

**A3.8.** Are hard hats issued to personnel who work on and around poles, overhead structures, tower and antenna construction jobs, etc., and are policies established to ensure they are worn? (Refer to paragraph 2.6.11.)

**Polychlorinated Biphenyl (PCB) Protection:**

**A3.9.** Are personnel trained on the proper procedures to be accomplished in case signs of leakage of suspected PCB is experienced during work on transformers? (Refer to paragraph 2.7.13.)

**Rubber Insulating Floor Matting:**

**A3.10.** Are all strips of insulating matting marked to identify it as approved matting according to Mil M-15562? (Refer to paragraph 2.8.1.)

**A3.11.** Is insulating matting only used for the purpose for which it was designed? (Refer to paragraph 2.8.6.)

**Housekeeping:**

**A3.12.** Are good housekeeping practices enforced and are procedures established to properly control and dispose of flammable and toxic wastes? (Refer to paragraph 2.10.)

**Tools and Equipment:**

**A3.13.** Are all tools and equipment maintained in safe conditions? (Refer to paragraph 2.11.1.)

**A3.14.** Are all ladders, used to support electrical work, of the proper design (wood or fiberglass)? (Refer to paragraph 2.11.4.)

**A3.15.** If metal ladders or wood ladders with metal reinforced siderails are used, are they stored away from electrical equipment and are the side rails of metal ladders stenciled “**DANGER-DO NOT USE AROUND ELECTRICAL EQUIPMENT**”? (Refer to paragraph 2.11.5.)

**Soldering Precautions:**

**A3.16.** Is the soldering work area: (Refer to paragraphs 2.13.1., 2.13.2., and 2.13.6.)

Free of combustible materials?

Equipped with fire extinguishers?

Has adequate ventilation?

**A3.17.** Is eye protection available for personnel performing soldering tasks? (Refer to paragraph 2.13.5.)

**Compressed Gases:**

**A3.18.** Are regulators removed and safety caps installed on properly secured compressed gas cylinders during transport or when not in use? (Refer to paragraph 2.15.1.)

**A3.19.** Are compressed cylinders secured and stored away from excessive heat and protected from the direct rays of the sun? (Refer to paragraph 2.15.2.)

**Aerial Work:**

**A3.20.** During work on or near radomes, are personnel required to wear hard hats and safety-toed shoes? (Refer to paragraph 2.17.2.)

**A3.21.** Are natural fiber, nylon, or wire ropes inspected for deterioration, fraying, or broken strands prior to use and discarded if found to be unsafe? (Refer to paragraphs 2.17.2. and 2.18.4.)

**CHAPTER 3 — C-E SYSTEMS****General:**

**A3.22.** Do personnel wear goggles or face shields when work tasks expose them to a potential for flash? (Refer to paragraph 3.1.8.)

**A3.23.** Have the installation fire department and the hospital ambulance section been provided routes to and locations of remote work sites? (Refer to paragraph 3.1.9.)

**Fuses and Circuit Breakers:**

**A3.24.** Do the inside covers of fuse and circuit breaker panels indicate the equipment that is controlled? (Refer to paragraph 3.5.1.)

**Cathode Ray Tubes (CRT):**

**A3.25.** Are cathode ray tubes stored in their original packaging? (Refer to paragraph 3.6.)

**Electron Tubes Containing Radioactive Materials:**

**A3.26.** Are procedures established to protect personnel and notify the installation radiological protection officer if an electron tube containing radioactive materials is inadvertently broken? (Refer to paragraph 3.7.1.)

**Grounding:**

**A3.27.** Are metal workbenches and those that are metal framed or metal legged, which are used for repairing and testing electronic equipment, grounded? (Refer to paragraph 3.8.1.)

**A3.28.** Are doors on circuit breaker panels and cabinets bonded with a separate braided bonding strap instead of bonding through mounting hardware of door hinges? (Refer to paragraph 3.8.2.)

**Battery Maintenance and Charging Room:**

**A3.29.** Are eye protection devices, aprons, and rubber gloves provided to personnel servicing batteries? (Refer to paragraph 3.10.1.)

**A3.30.** Are emergency showers and (or) eyewash units available in battery maintenance or charging rooms? (Refer to paragraph 3.10.7.)

**Radar and Microwave Equipment:**

**A3.31.** Are personnel instructed in the hazards of nonionizing radiation associated with radar and microwave equipment? (Refer to paragraph 3.11.1.)

## CHAPTER 4 — Cable and Antenna Systems

### Aerial Cables:

**A3.32.** Do personnel wear safety straps and harnesses when working on elevated work platforms? (Refer to paragraph 4.2.7.)

### Heaters and Torches Used in Ground and Aerial Tents:

**A3.33.** Do personnel who use heaters and torches in tents ensure the tent material is fire resistant and the tent is adequately ventilated during use of this equipment? (Refer to paragraph 4.4.)

### Trenching and Excavations:

**A3.34.** Do personnel who are engaged in trenching and excavation activities comply with all applicable safety requirements? (Refer to paragraph 4.5.)

### RF Transmitting Antenna:

**A3.35.** Are personnel who work on RF transmitting antennas instructed in the dangers of ionizing radiation? (Refer to paragraph 4.7.)

### Special Purpose Vehicle:

**A3.36.** Are vehicle operators of telephone or line trucks equipped with winches trained in their operation? (Refer to paragraph 4.9.2.)

**A3.37.** Are cable reels that are not in service or in storage properly blocked and secured? (Refer to paragraph 4.9.3.)

### Control Towers:

**A3.38.** Does the air traffic control tower have an escape device for secondary egress and are personnel trained in its use? (Refer to paragraph 4.10.)

### Special Authorization and (or) Requirements:

**A3.39.** Are personnel who are assigned to duties that require climbing poles or structures over 20 feet in height trained, and is this training documented? (Refer to paragraph 4.12.3.)